APPENDIX A

TRAFFIC VOLUME DIAGRAMS: 2012 AND 2032

TENNESSEE DEPARTMENT OF TRANSPORTATION
PROJECT PLANNING DIVISION

PROJECT NO.: ____________ ROUTE: AIRWAYS BLVD.
COUNTY: SHELBY CITY: MEMPHIS
PROJECT PIN NUMBER: ____________
PROJECT DESCRIPTION: FROM NORTH OF KETCHUM RD. TO SOUTH OF THE I-240 INTERCHANGE.

[1] AIRWAYS BLVD. TRAFFIC DATA
[2] I-240 TRAFFIC DATA

DIVISION REQUESTING:

MAINTENANCE ☐
PLANNING ☒
PROG. DEVELOPMENT & ADM. ☐
PUBLIC TRANS. & AERO. ☐
PAVEMENT DESIGN ☐
STRUCTURES ☐
SURVEY & DESIGN ☐
TRAFFIC SIGNAL DESIGN ☐
OTHER ____________ ☐
YEAR PROJECT PROGRAMMED FOR CONSTRUCTION: ____________
PROJECTED LETTING DATE: ____________

TRAFFIC ASSIGNMENT:

	BASE YEAR		DESIGN YEAR					DESIGN ROADWAY % TRUCKS		DESIGN AVERAGE DAILY LOADS	
	AADT	YEAR	AADT	DHV	%	YEAR	DIR.DIST.	DHV	AADT	FLEX	RIGID
[1]	47,840	2012	57,420	5,742	10	2032	54-46	4	6		
[2]	161,590	2012	171,260	13,701	8	2032	52-48	7	11		

REQUESTED BY: NAME BILL HART DATE 12-11-06
DIVISION PLANNING
ADDRESS 900 J. K. POLK BUILDING
NASHVILLE TN 37243

REVIEWED BY: TONY ARMSTRONG Tony Armstrong DATE 1-16-07
TRANSPORTATION MANAGER 1
SUITE 1000, JAMES K. POLK BUILDING

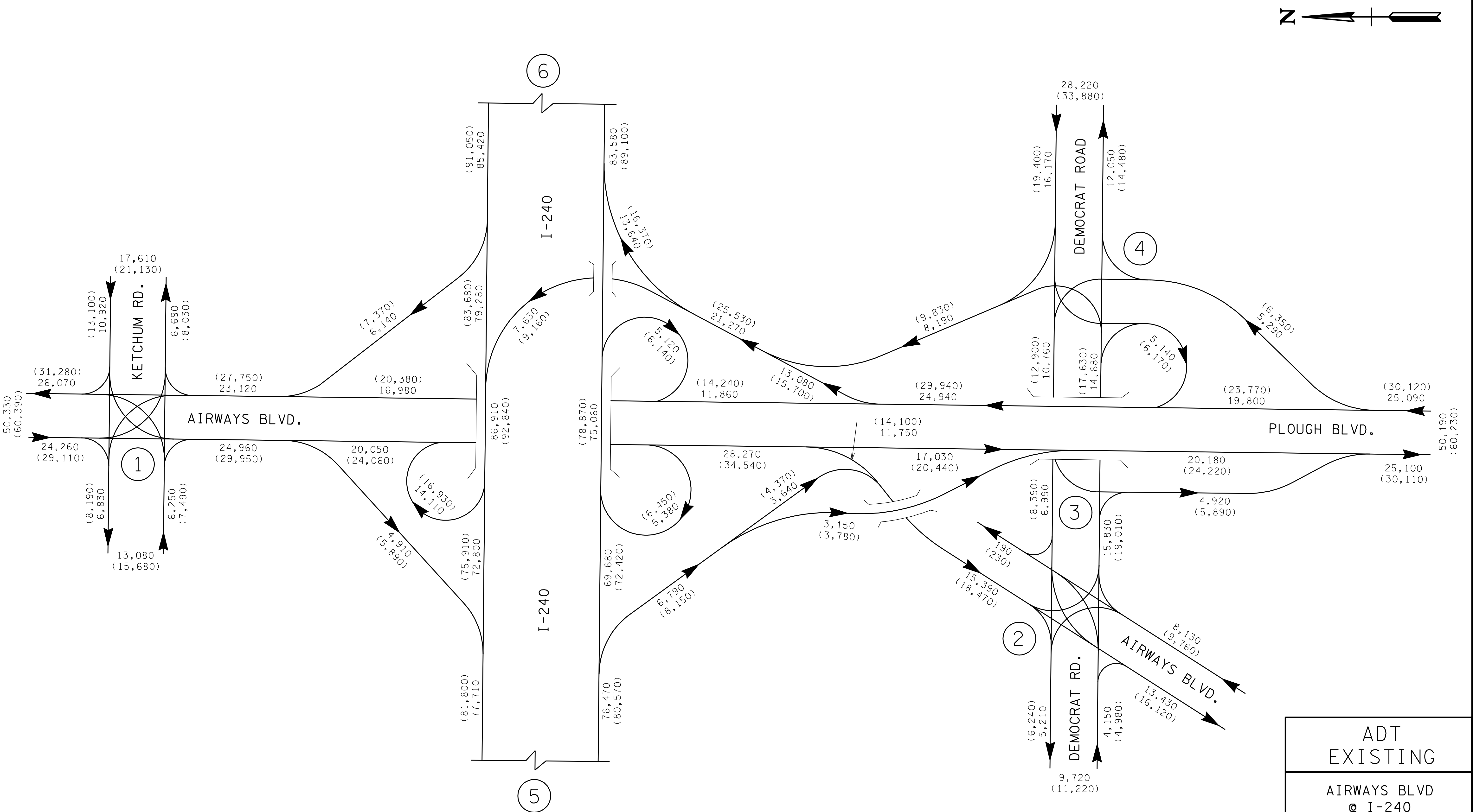
APPROVED BY: BILL HART Bill Hart DATE 1.16.07
TRANSPORTATION MANAGER 2
SUITE 900, JAMES K. POLK BUILDING

COMMENTS:

THIS TRAFFIC IS BASED ON 2006 CYCLE COUNTS, 2006 RAMP COUNTS AND 1-12 HOUR TURNING MOVEMENT COUNT FROM THE CITY OF MEMPHIS DONE IN MARCH OF 2005. THE FUTURE TRAFFIC IS BASED ON GROWTH RATES FROM THE MEMPHIS COMPUTER ASSIGNMENT MODEL.

DHV'S ARE NOT REQUIRED FOR SIDE ROADS LESS THAN 1000 AADT.

NOTE: FOR BRIDGE REPLACEMENT PROJECTS, ADLs ARE NOT REQUIRED FOR AADT's OF 1000 OR LESS AND PERCENTAGE OF TRUCKS OF 7% OR LESS.
SEE ATTACHMENTS FOR TURNING MOVEMENTS AND/OR OTHER DETAILS. (REV. 11/6/06)

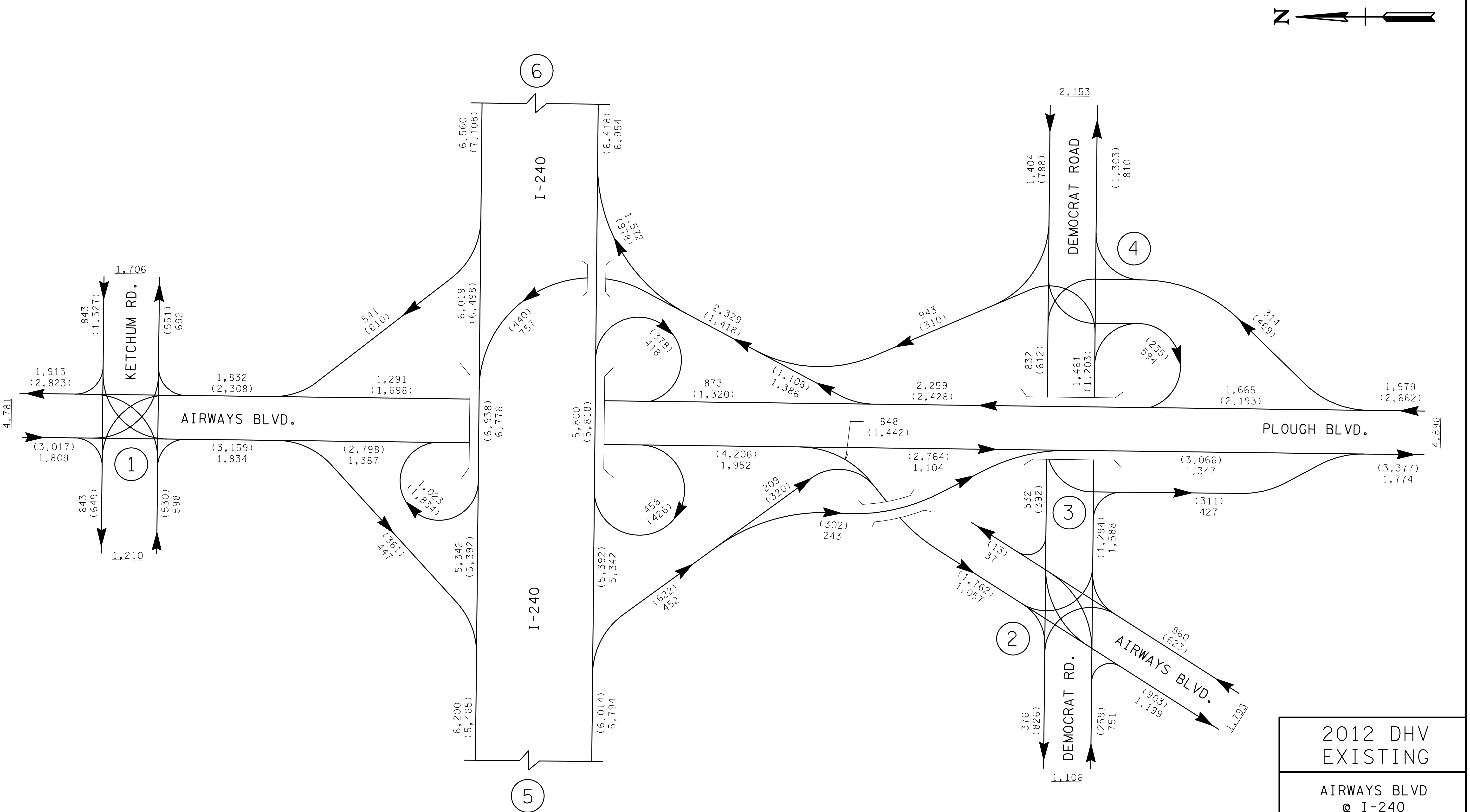


ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.

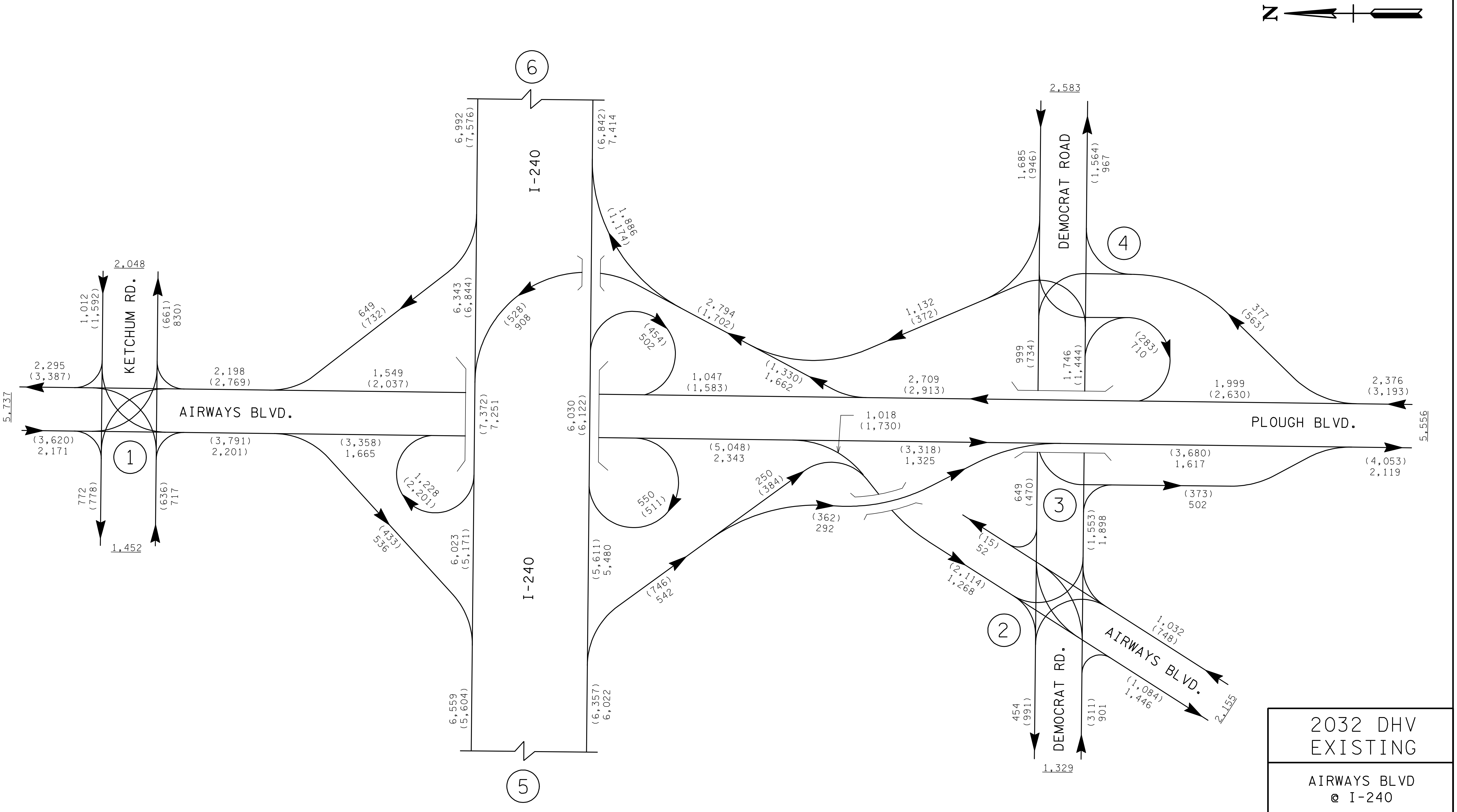


2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

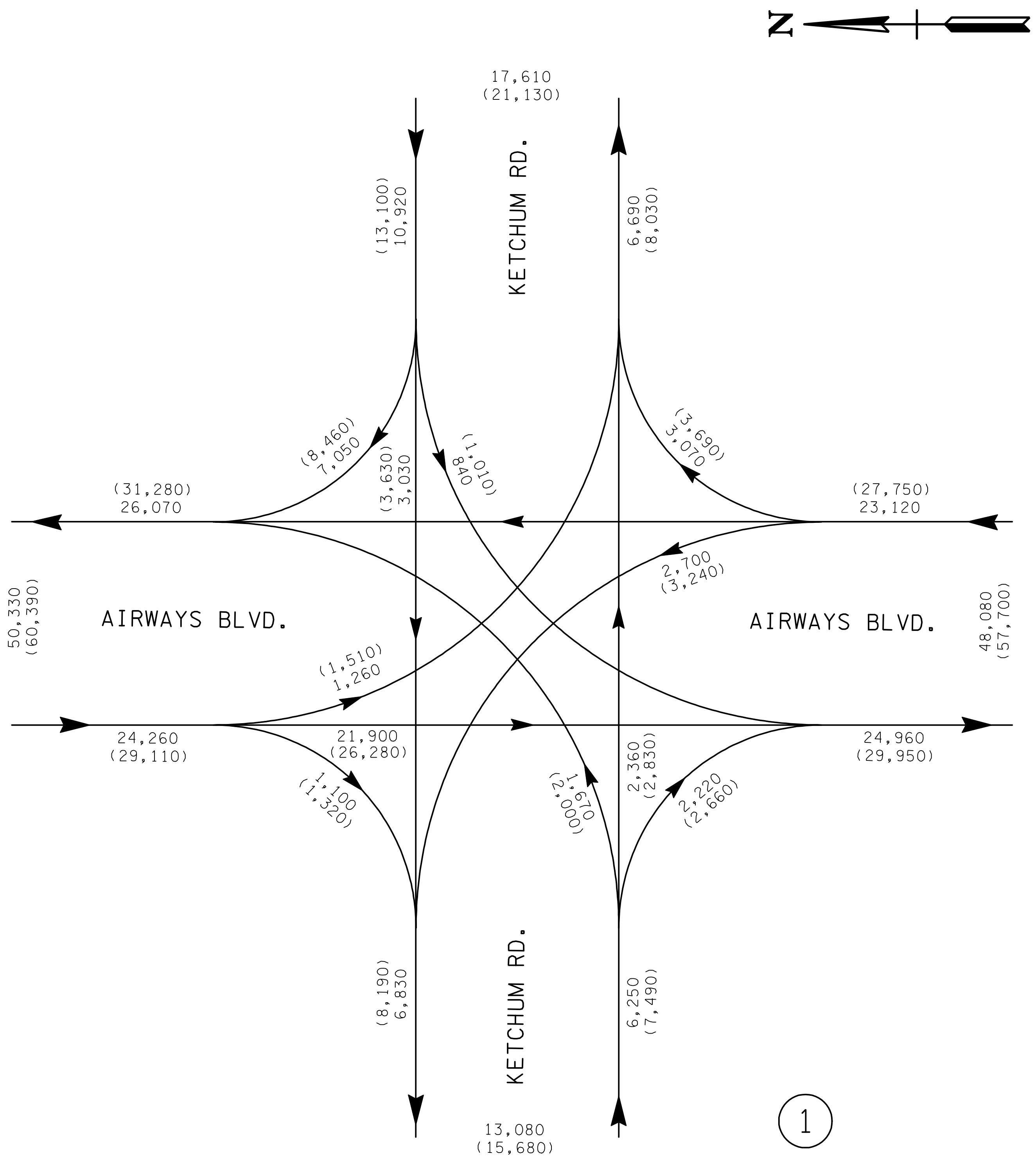


2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

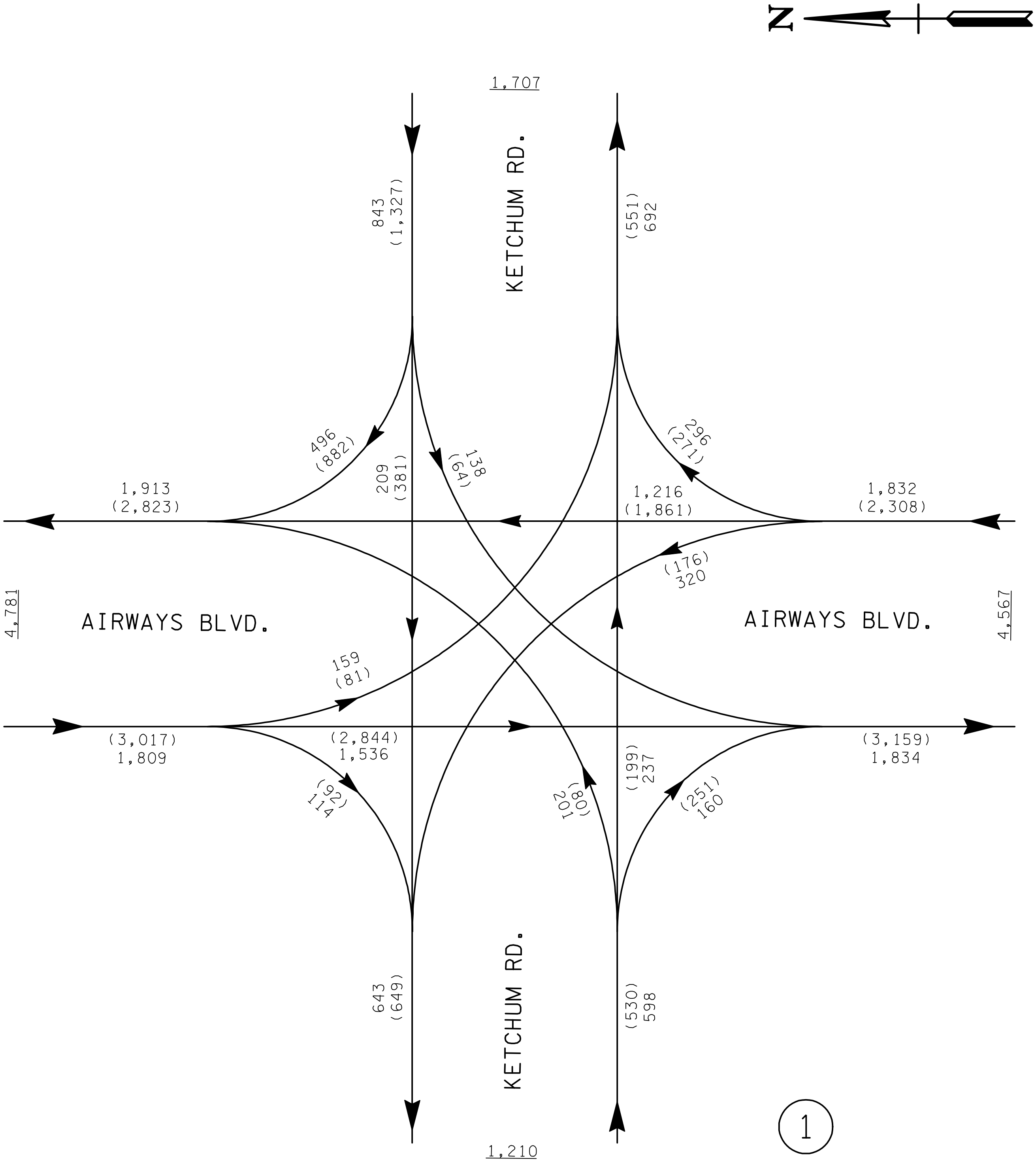


ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.

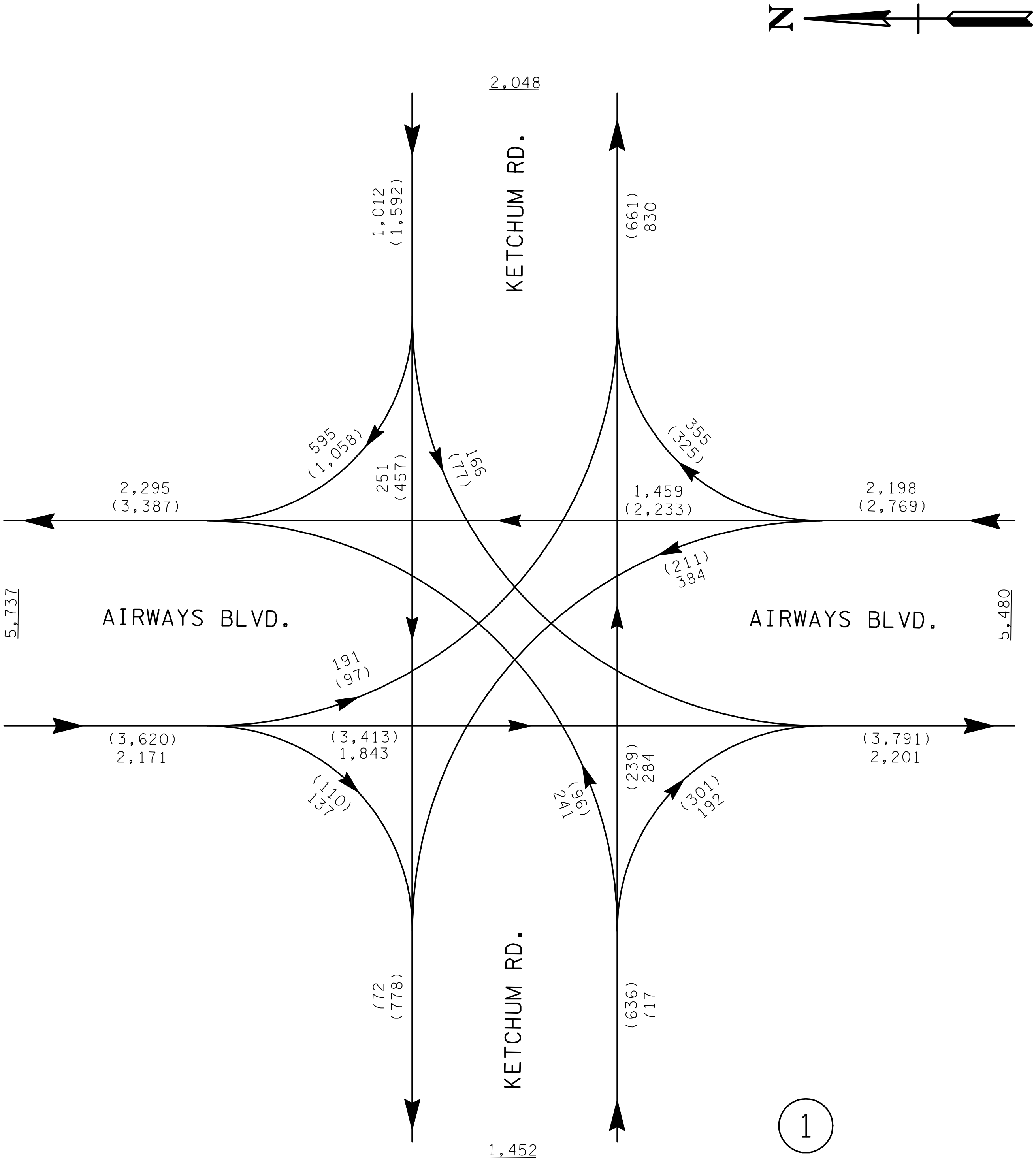


2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

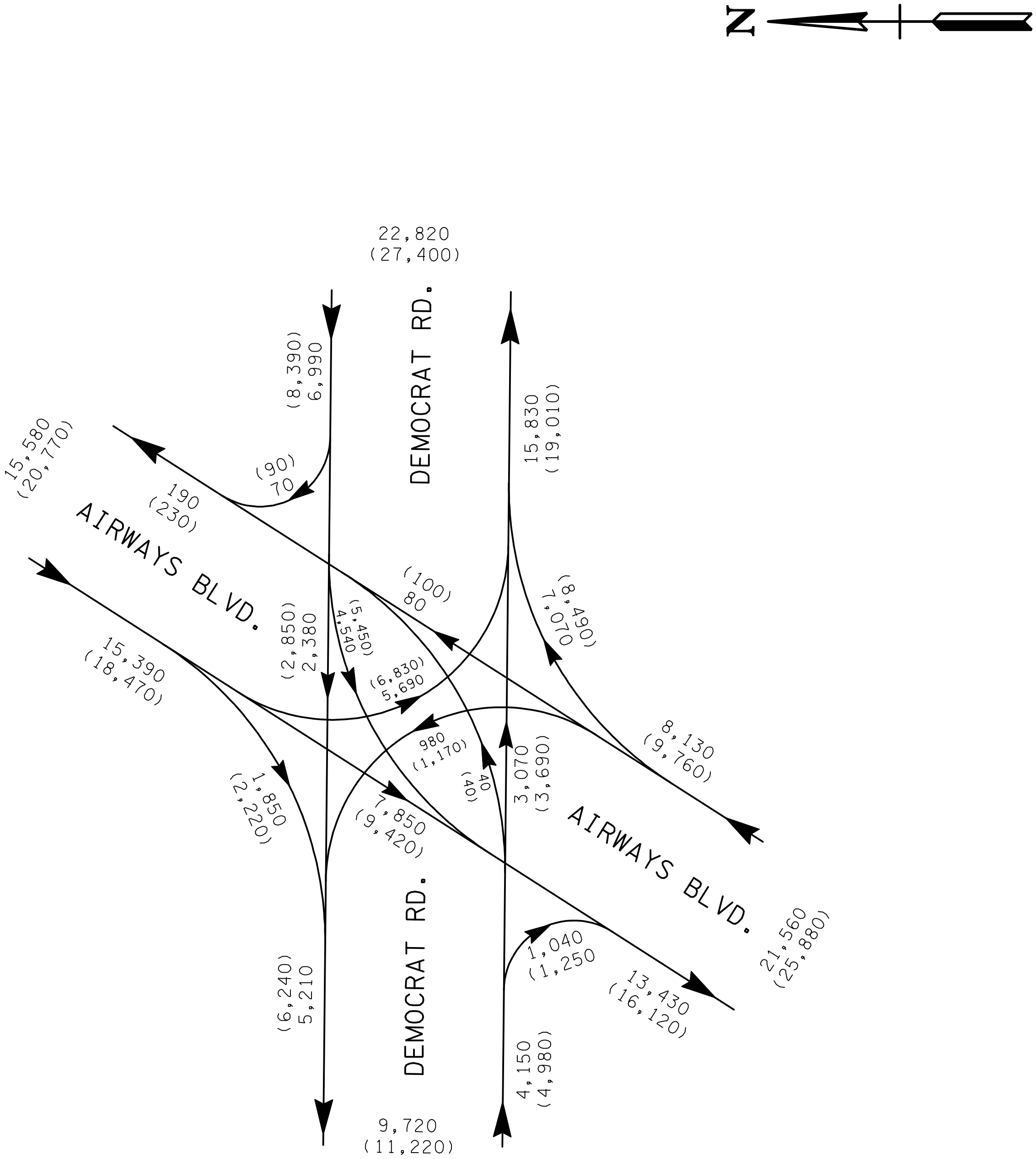


2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



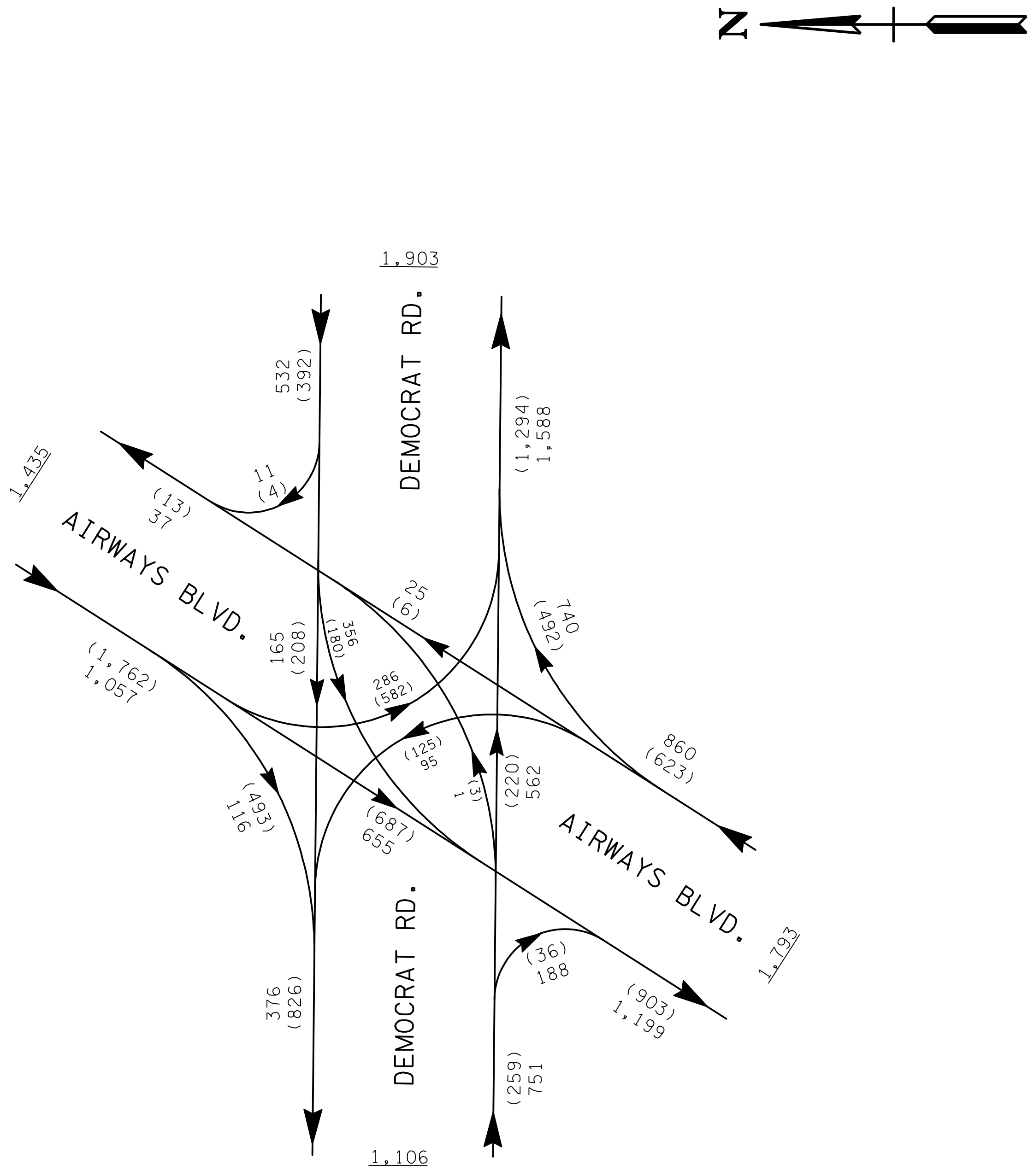
②

ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.



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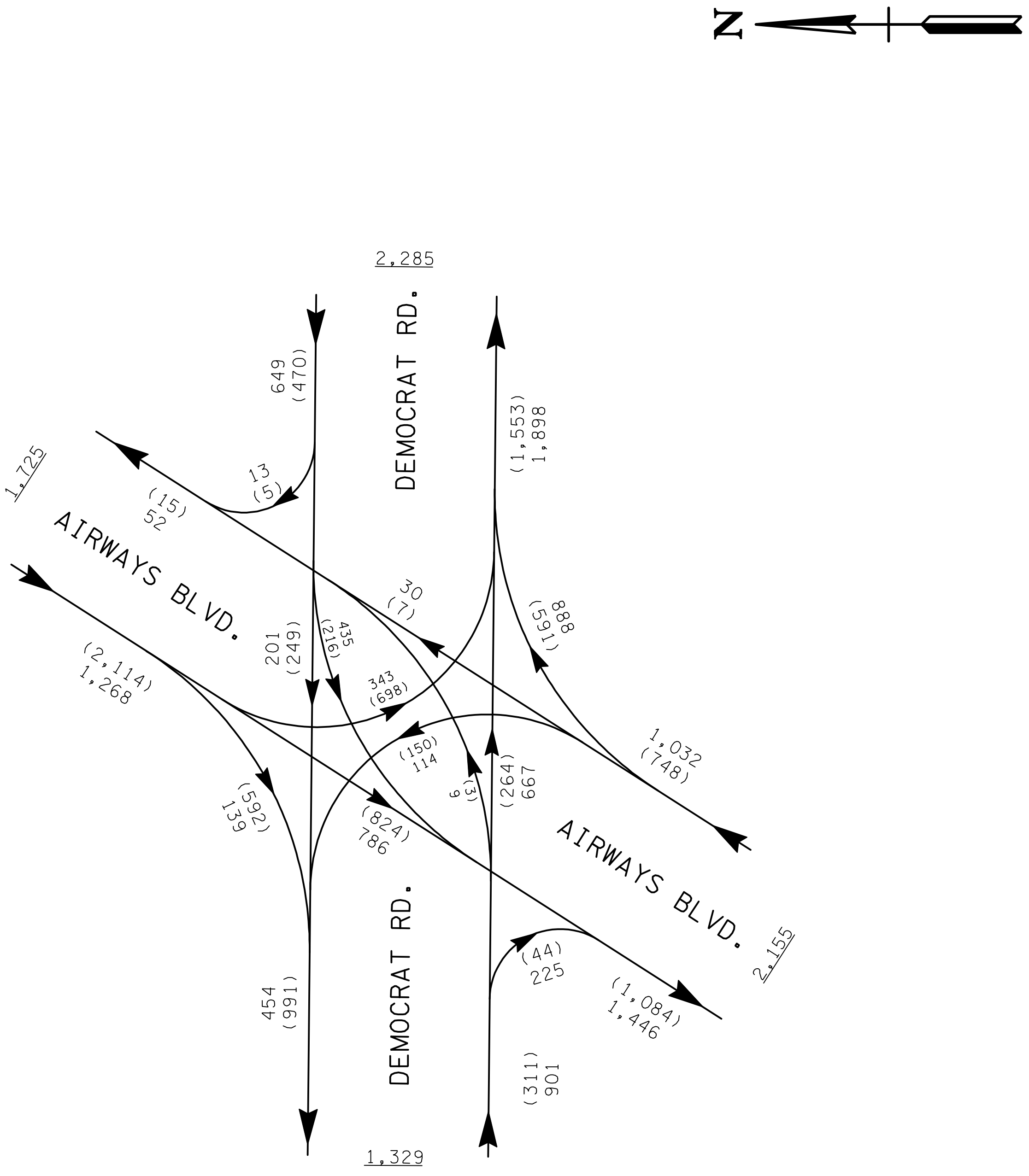
2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



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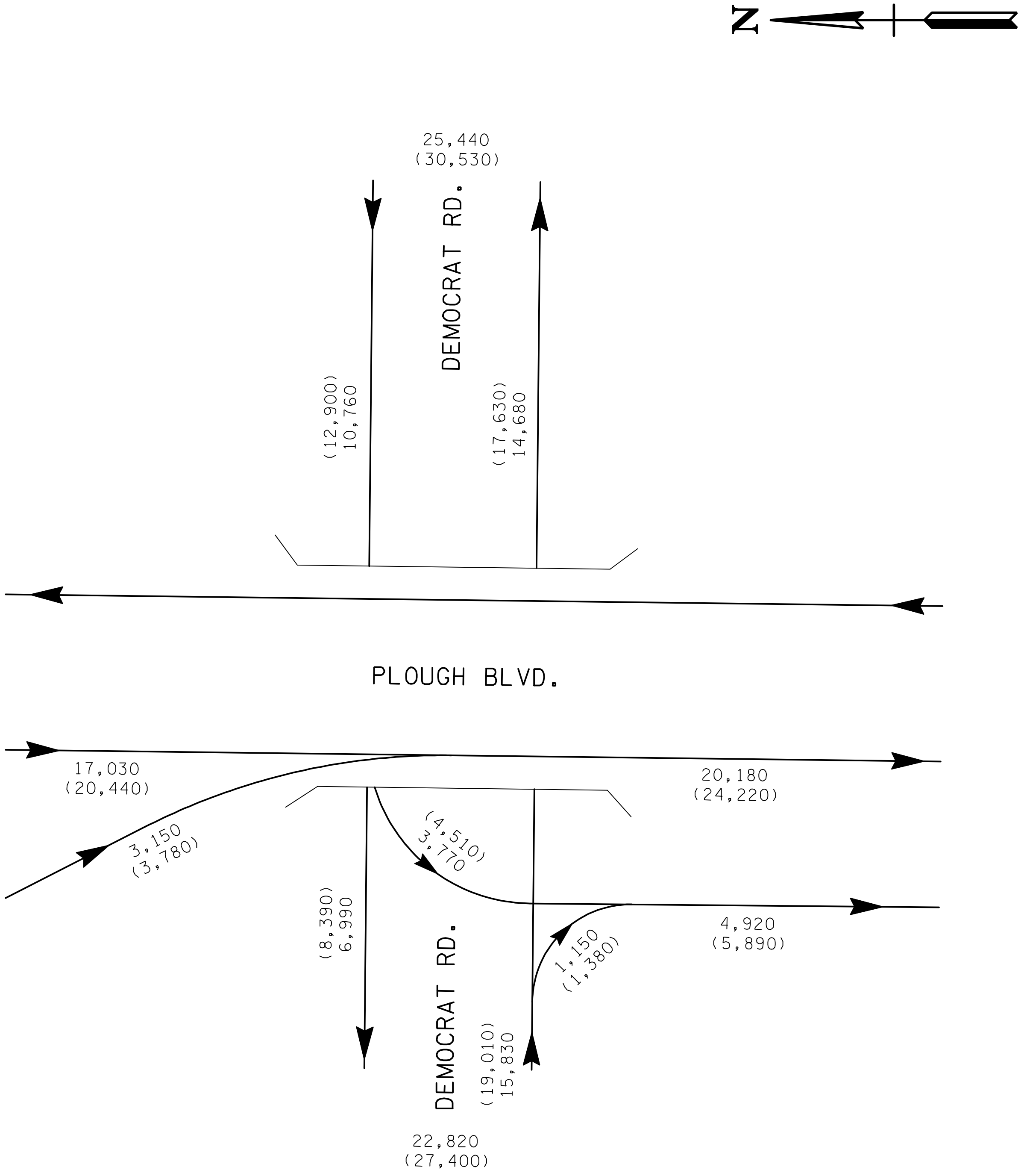
2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



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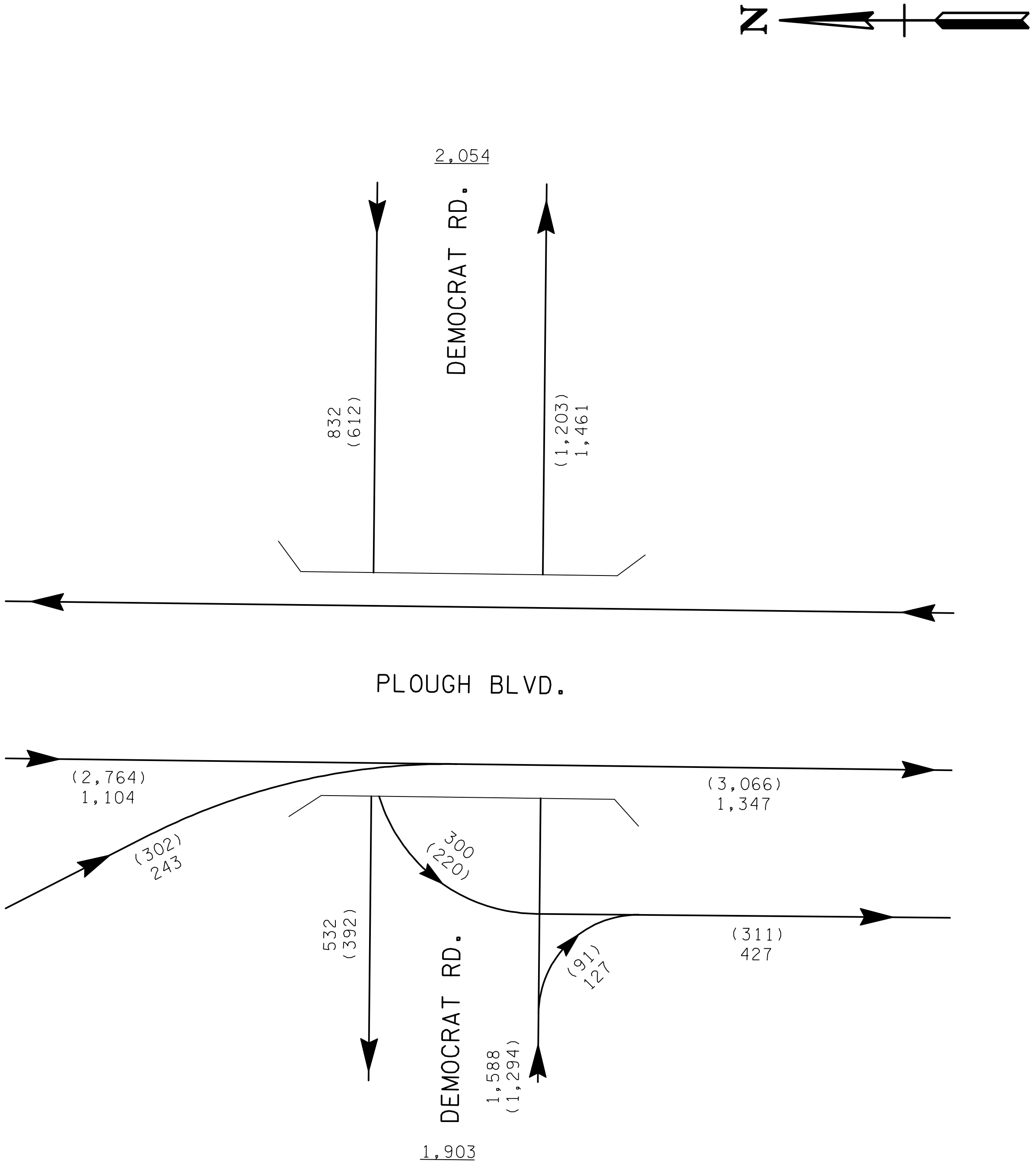
ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.



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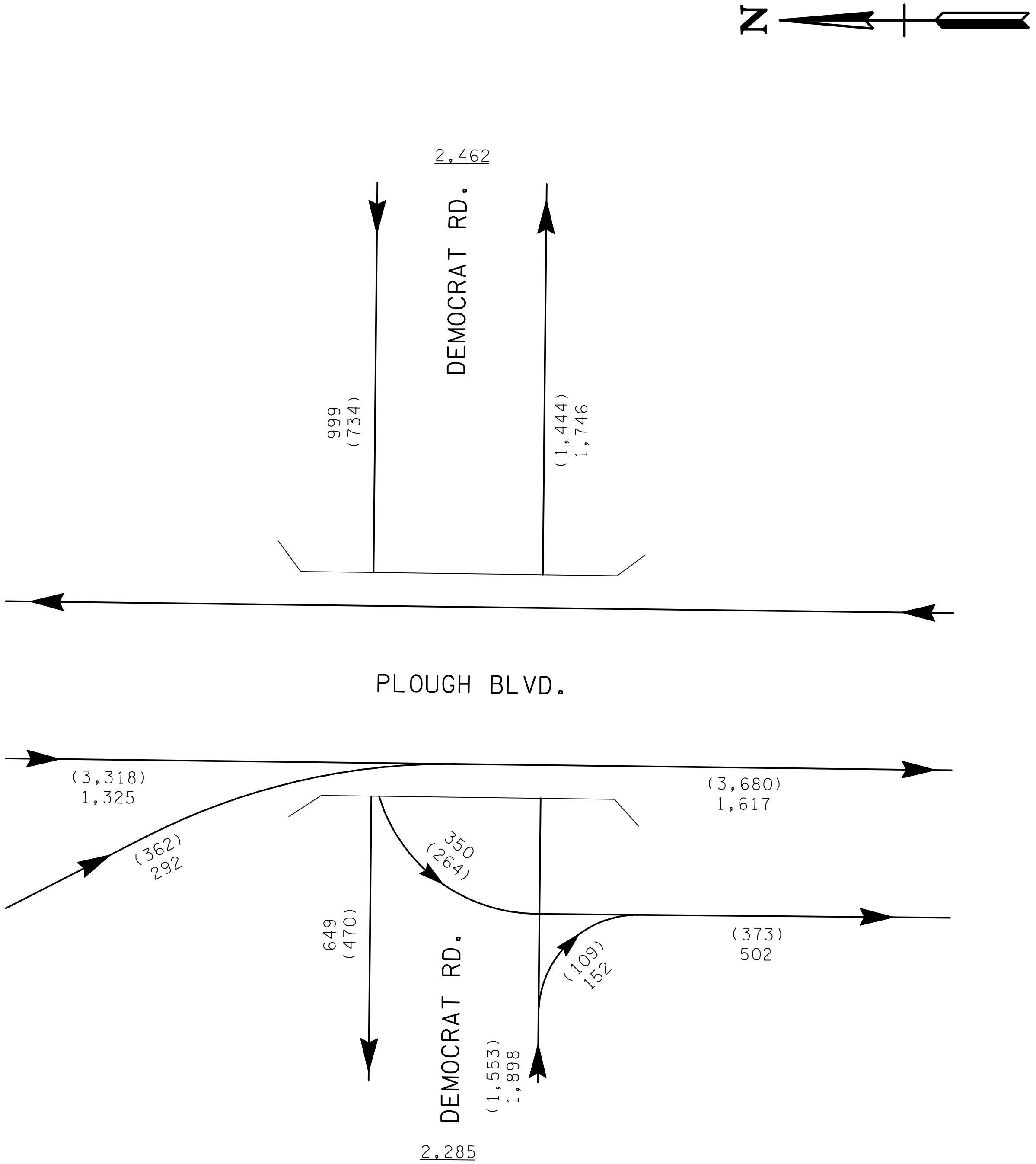
2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



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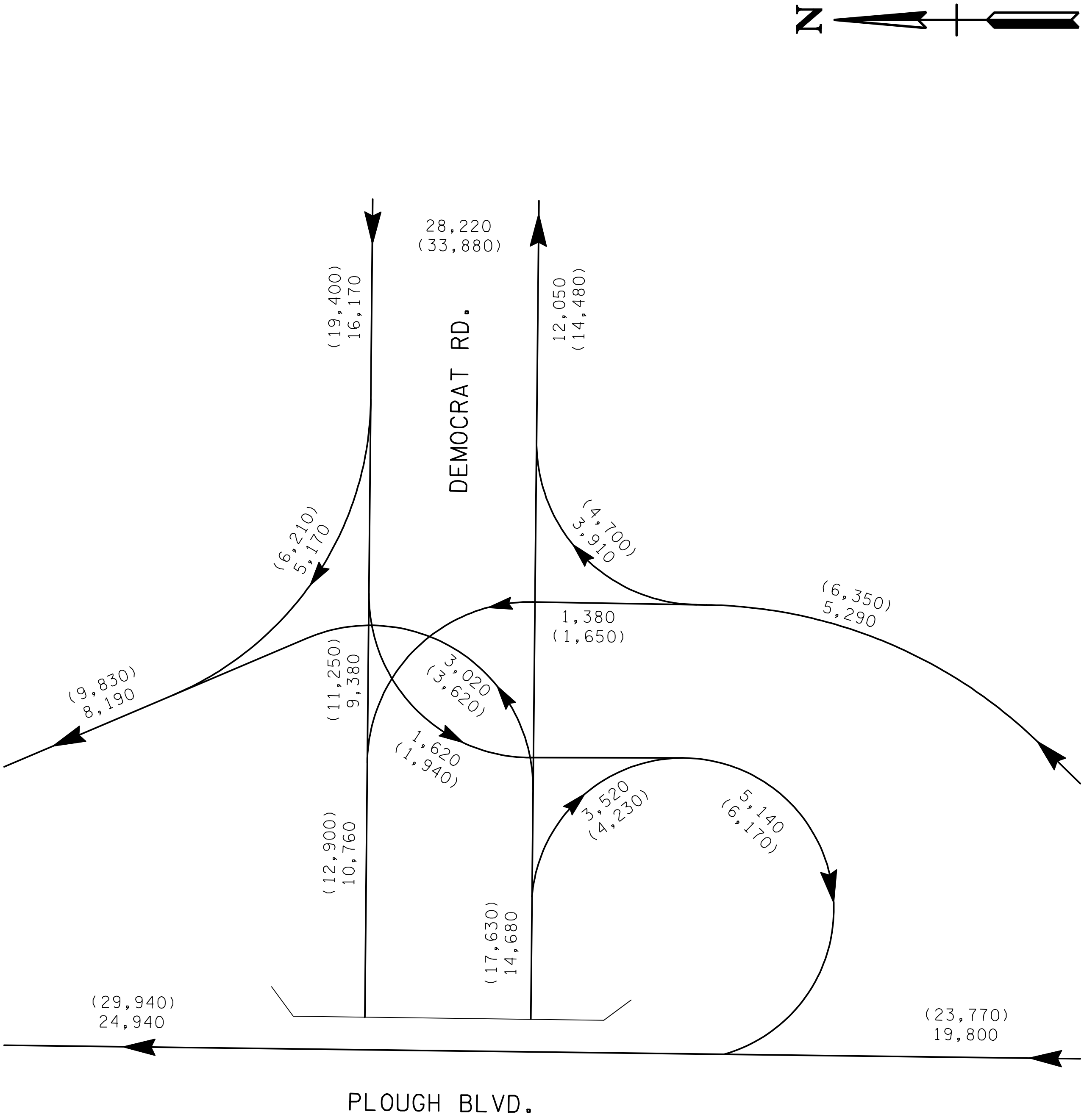
2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



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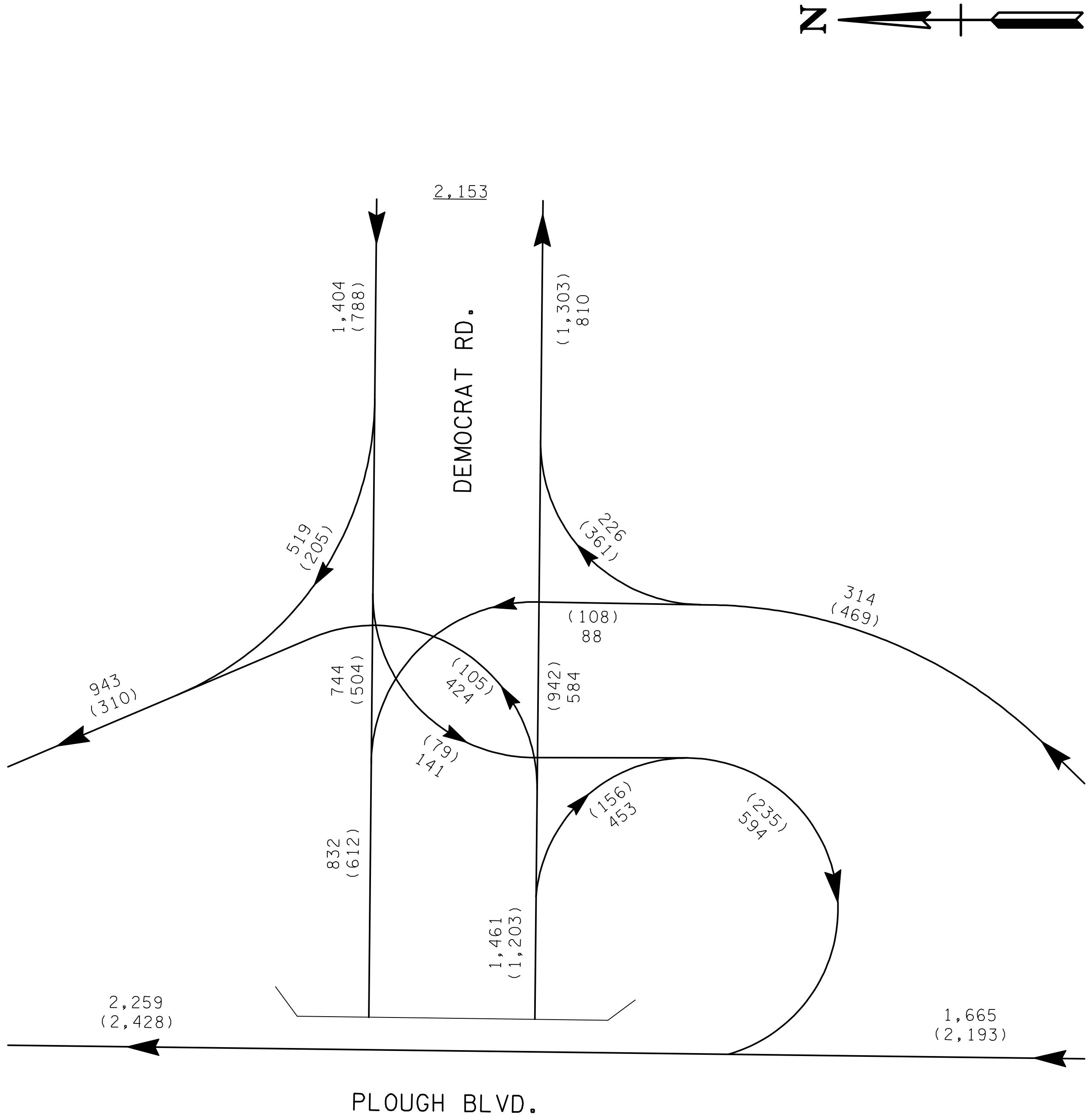
ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.



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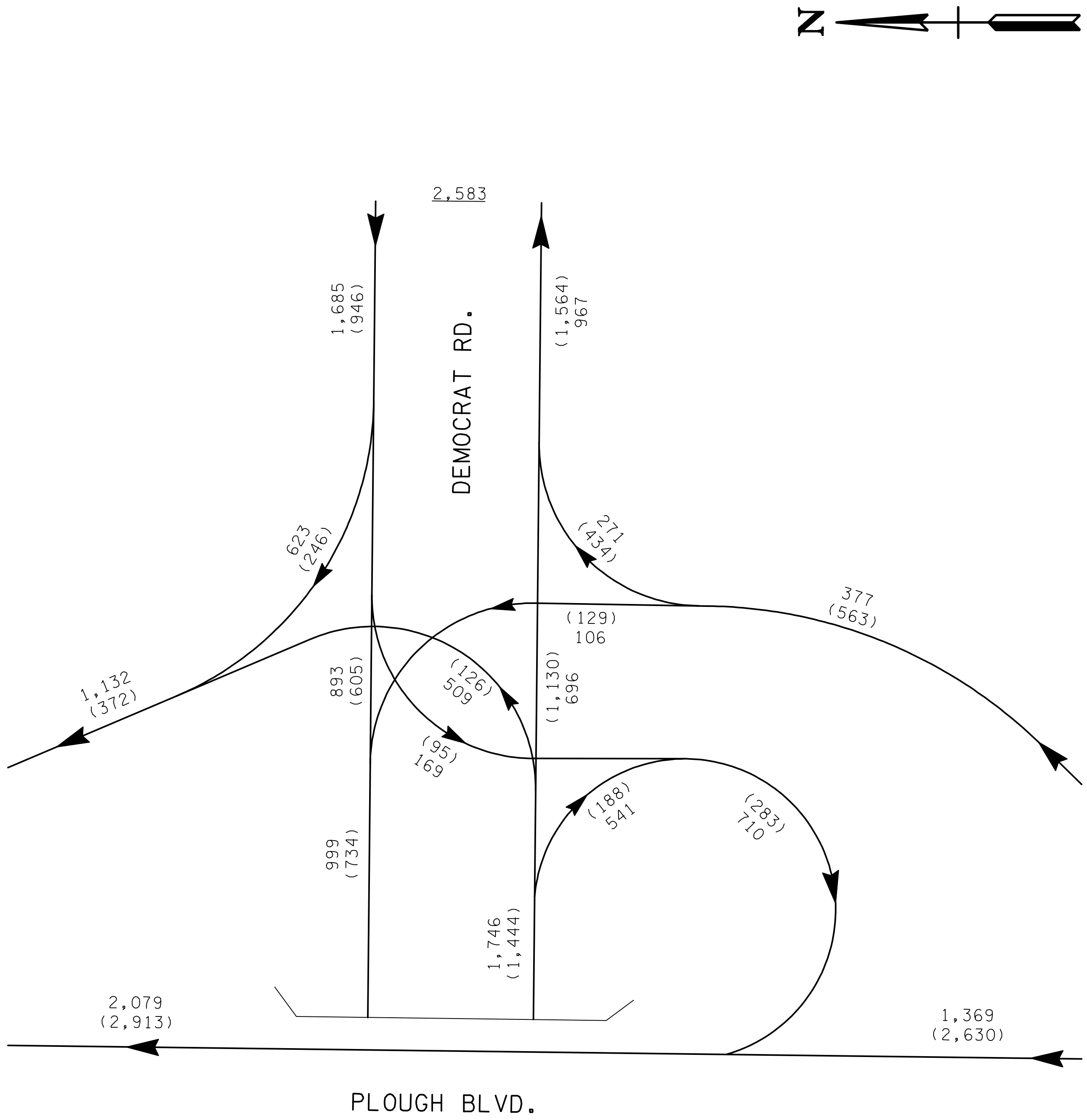
2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



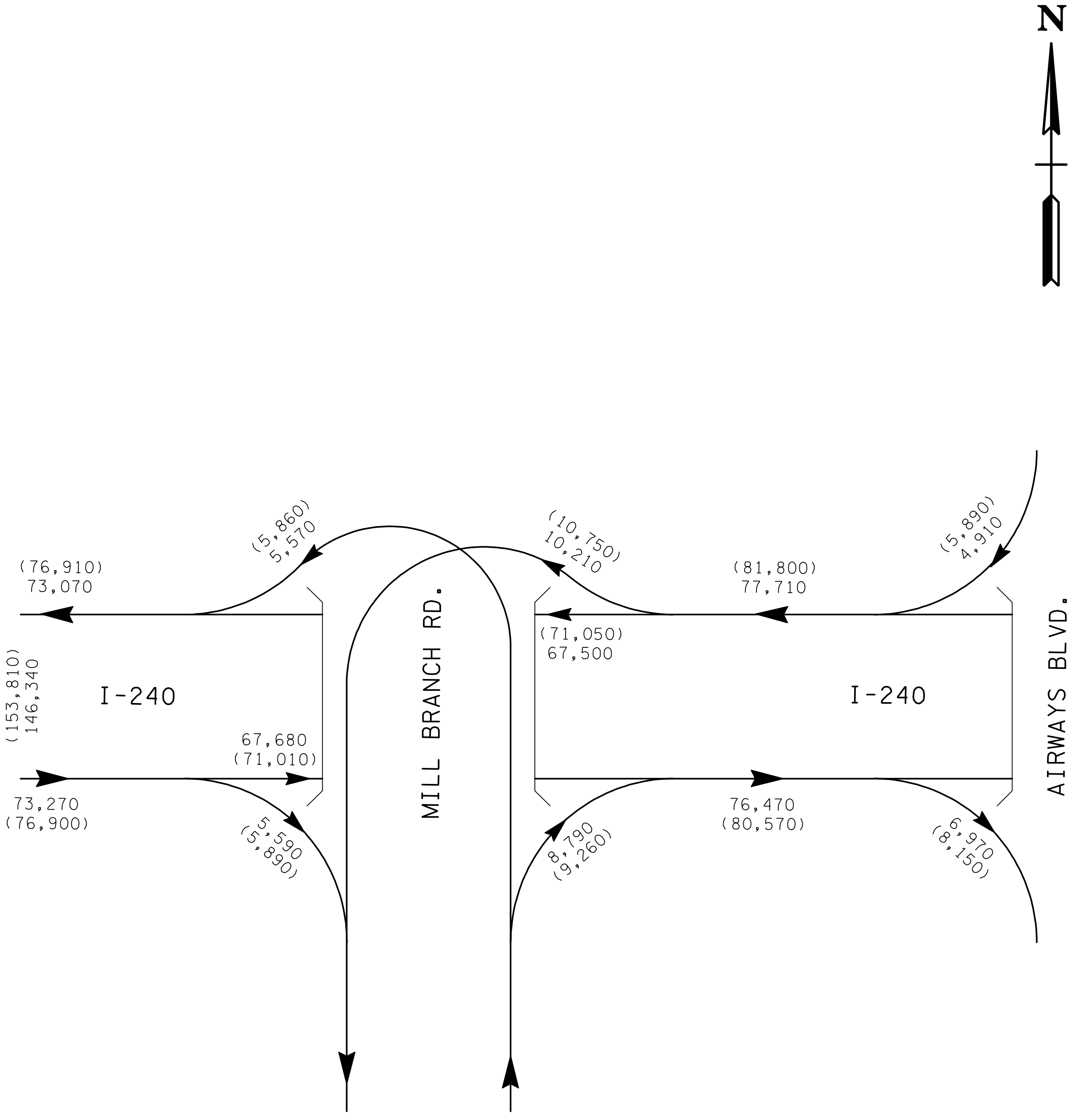
④

2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



☆ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED

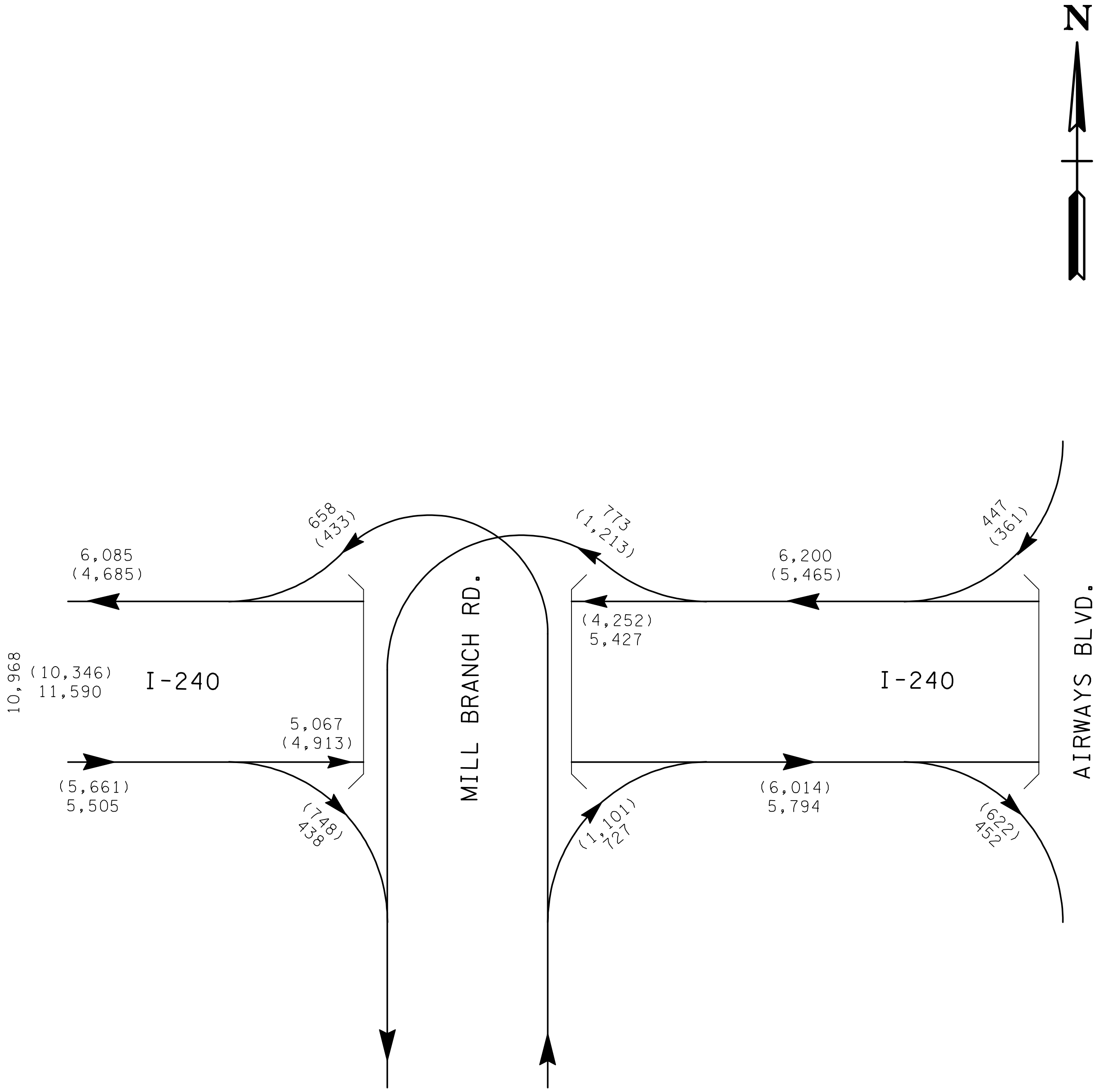
5

ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.



⑤

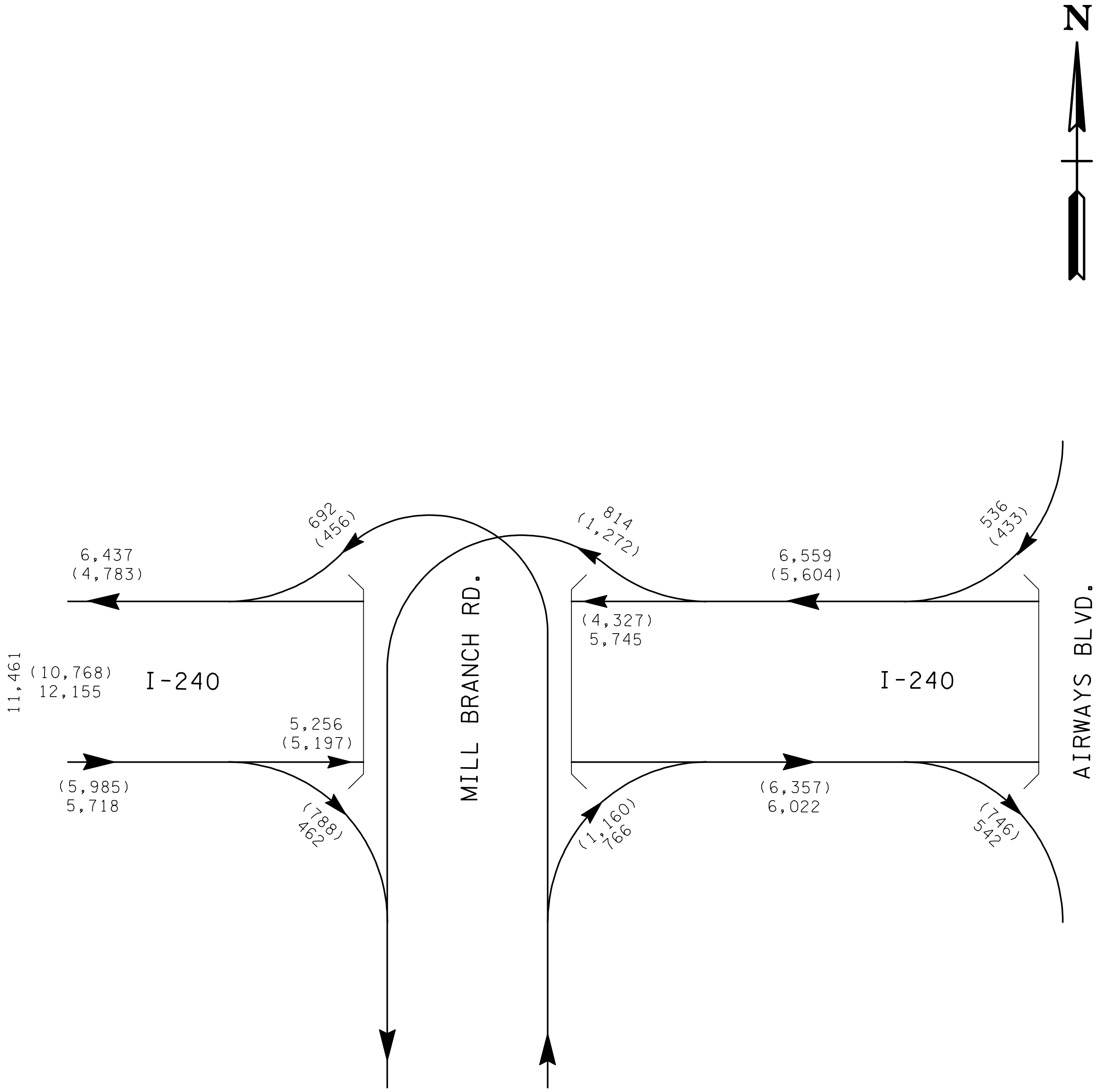
2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

☆ ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED



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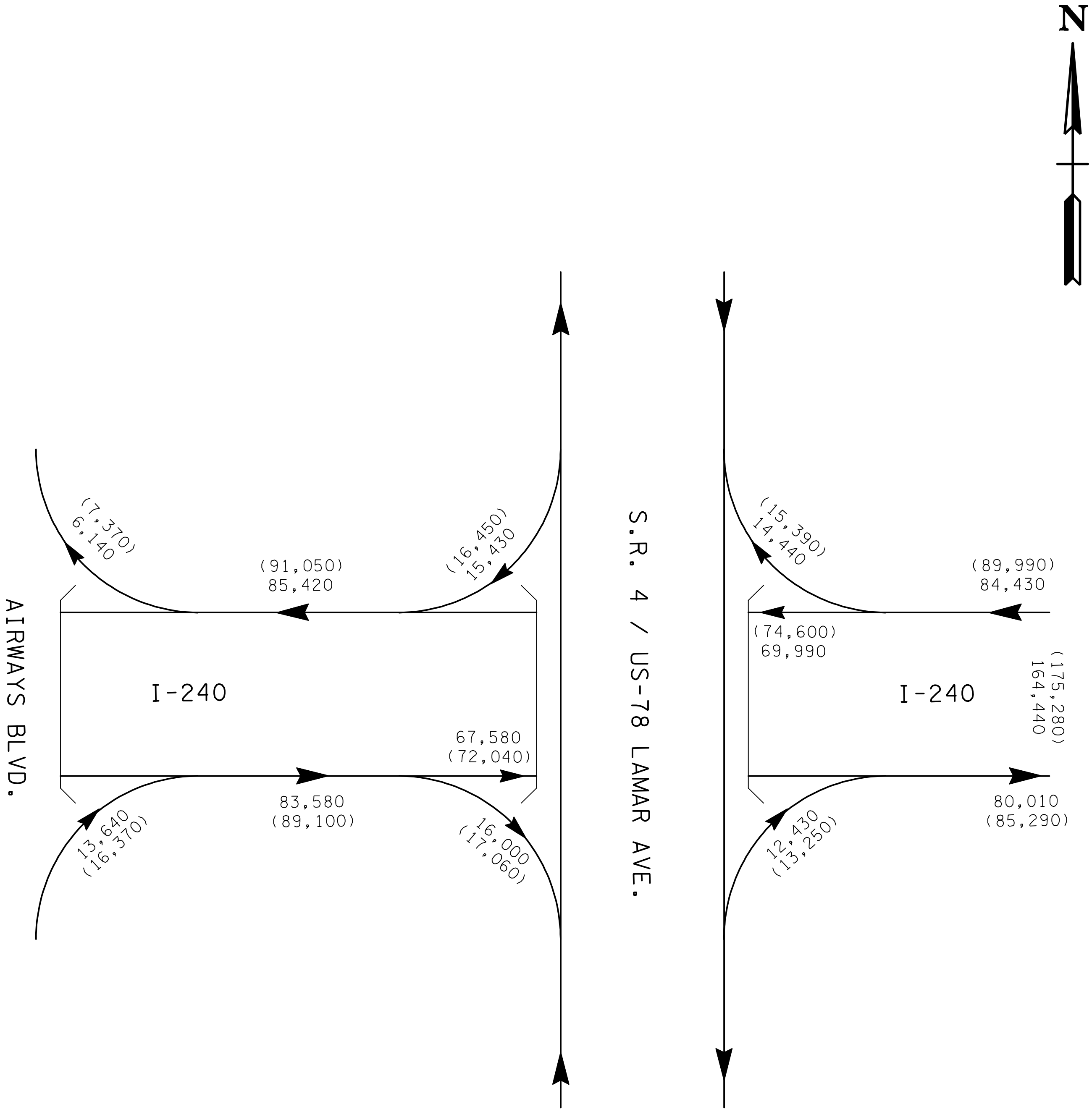
2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

☆ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED



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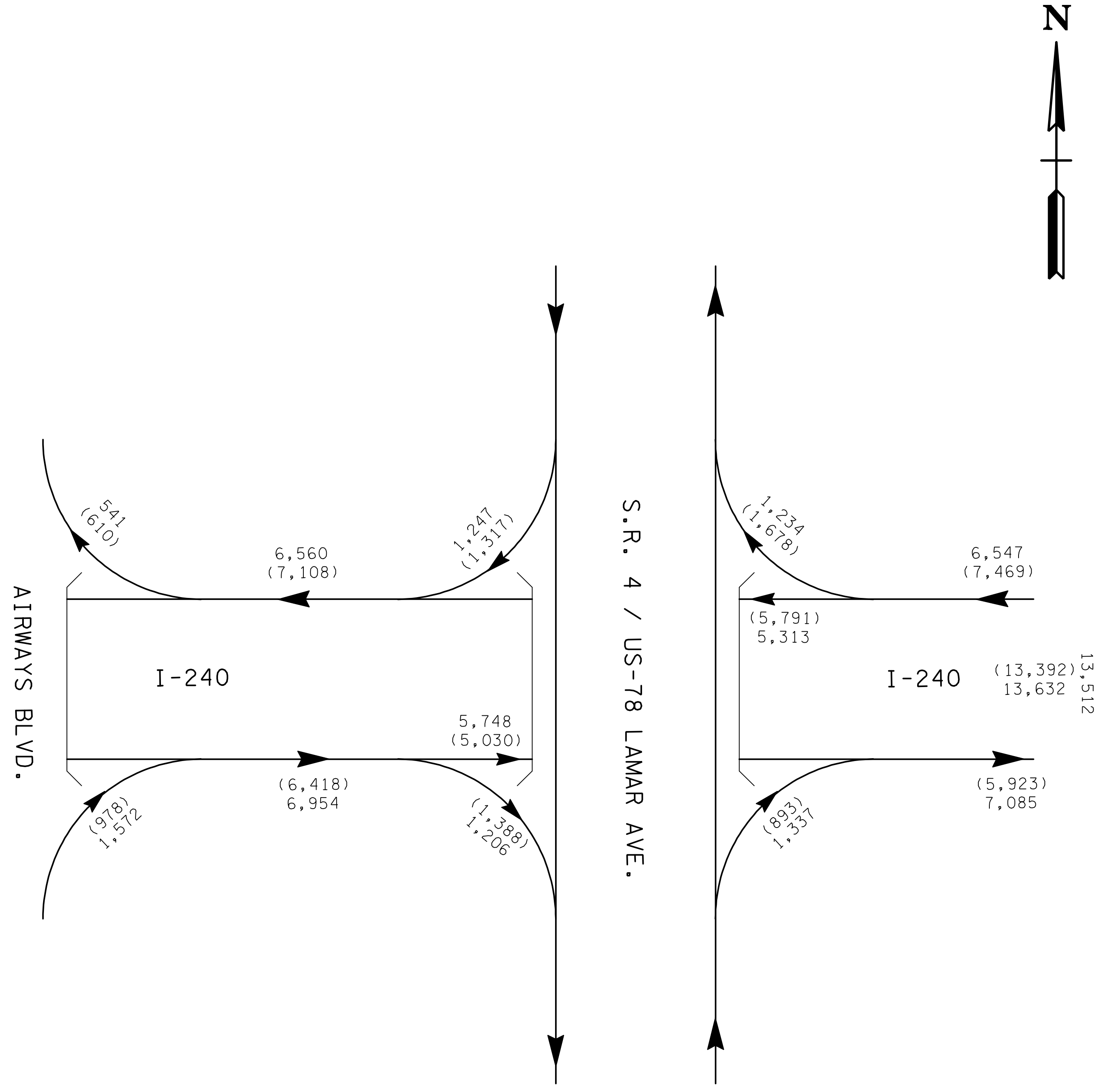
☆ ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED

ADT
EXISTING

AIRWAYS BLVD
@ I-240

2012
(2032)

N.T.S.



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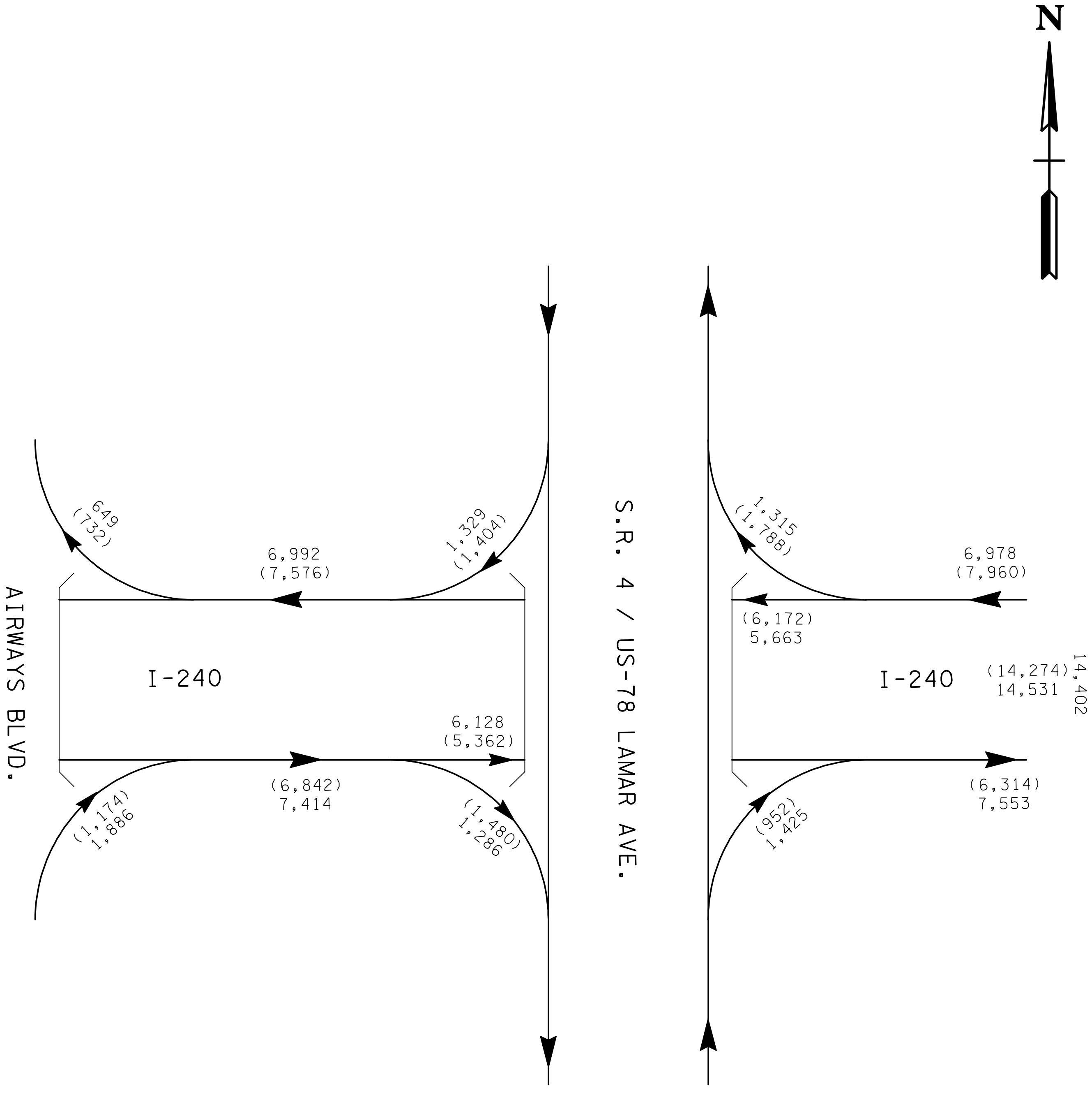
☆ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED

2012 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



⑥

2032 DHV
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

☆ ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED

TDOT
Go.

Tennessee Department of Transportation
Suite 1000, James K. Polk Building
505 Deaderick Street
Nashville, TN 37243-0344
Fax: (615) 532-0353

FACSIMILE TRANSMITTAL SHEET

TO: Tom Clinard

FROM: TONY ARMSTRONG

COMPANY: Clinard Engineering Assoc.

DATE: JANUARY 26, 2007

FAX NUMBER: 615-627-4066

TOTAL NO. OF PAGES INCLUDING COVER: 11

PHONE NUMBER:

YOUR PHONE NUMBER: 741-6741

E-MAIL ADDRESS AT WORK

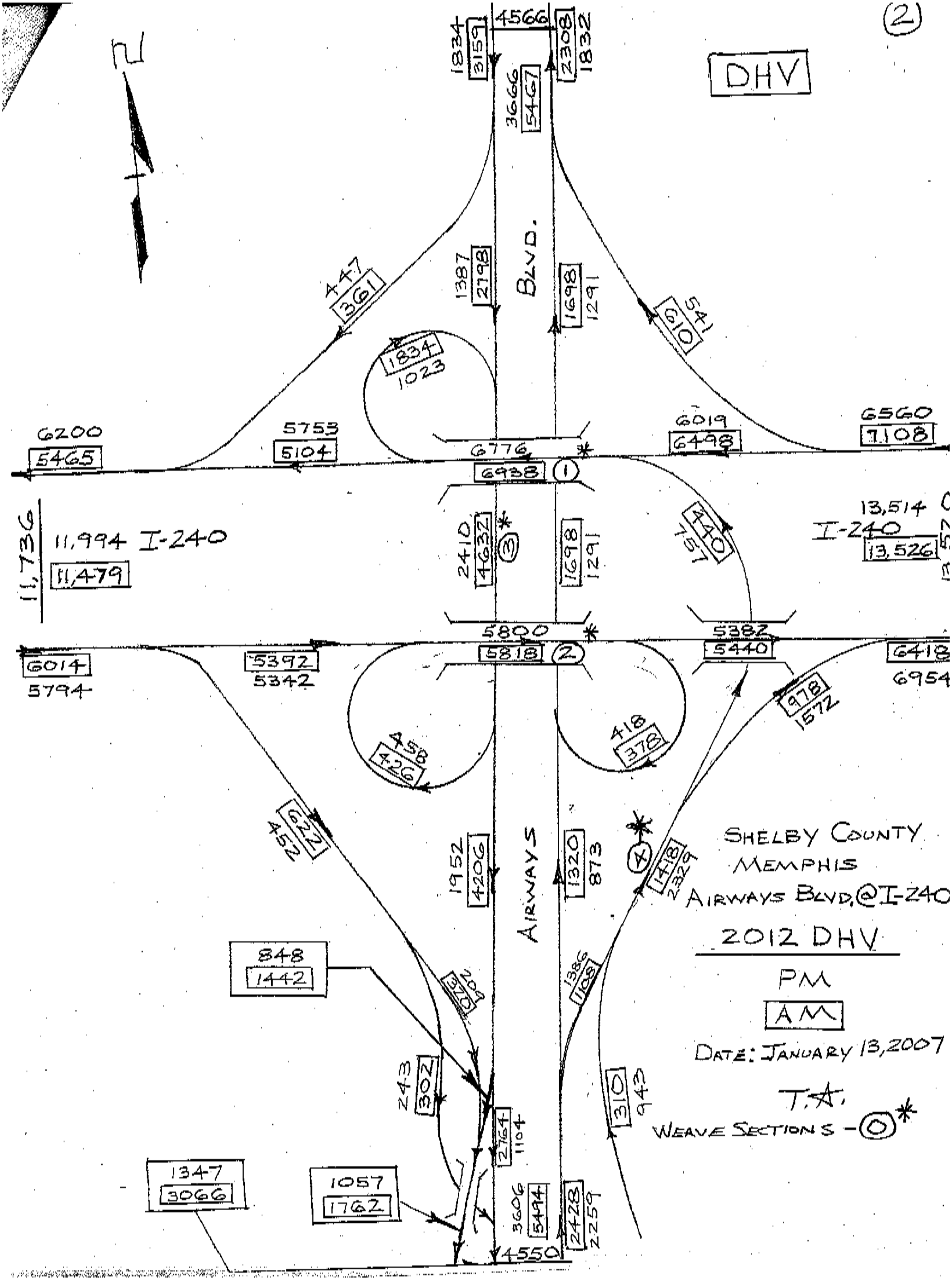
RE: I-240 @ Airways Blvd.

☐ URGENT ☐ FOR REVIEW ☐ PLEASE COMMENT ☐ PLEASE REPLY ☐ PLEASE RECYCLE

Tom,
Find in the attachments the weave sections you requested by e-mail on January 26, 2007.

(2)

DHV



SHELBY COUNTY
MEMPHIS
AIRWAYS BLVD. @ I-240

2012 DHV

PM

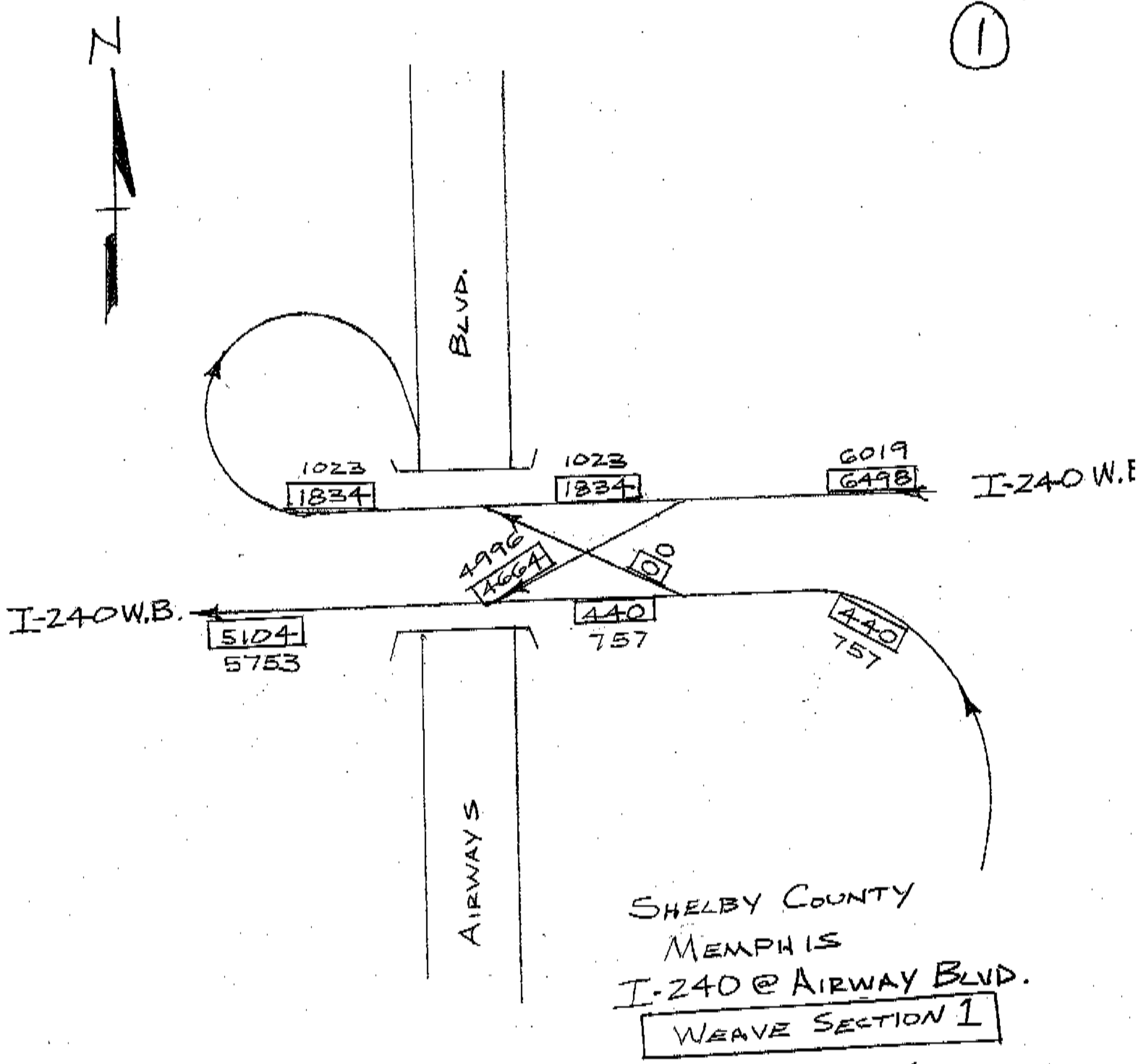
AM

DATE: JANUARY 13, 2007

T.A.

WEAVE SECTIONS - ⓪*

①



SHELBY COUNTY
MEMPHIS
I-240 @ AIRWAY BLVD.
WEAVE SECTION 1

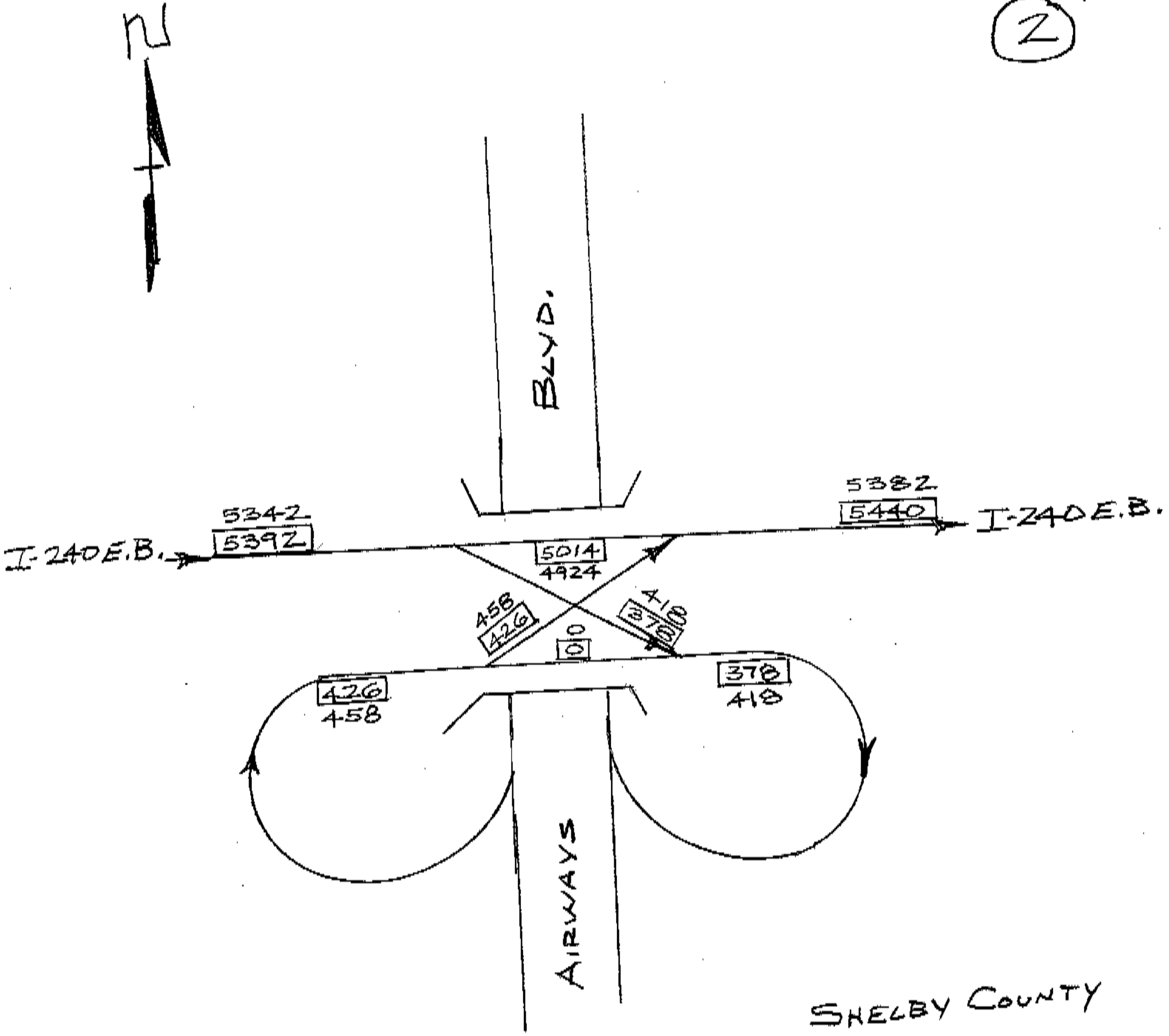
2012 DHV

PM
[✓ AM]

DATE: JANUARY 26, 2007

T.A.

② *



SHELBY COUNTY

MEMPHIS

I-240 @ AIRWAYS BLVD.

WEAVE SECTION 2

2012 DHV

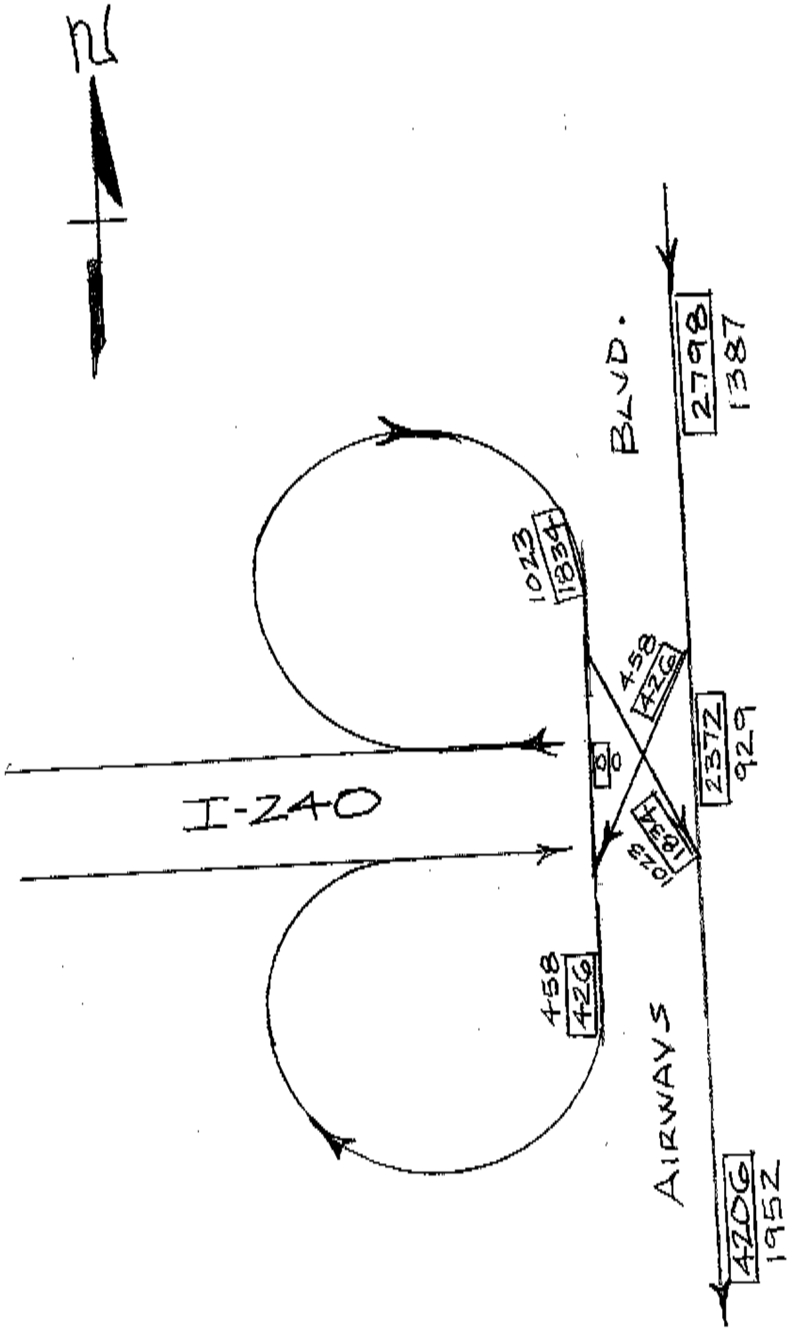
PM

[✓ AM]

DATE: JANUARY 26, 2007

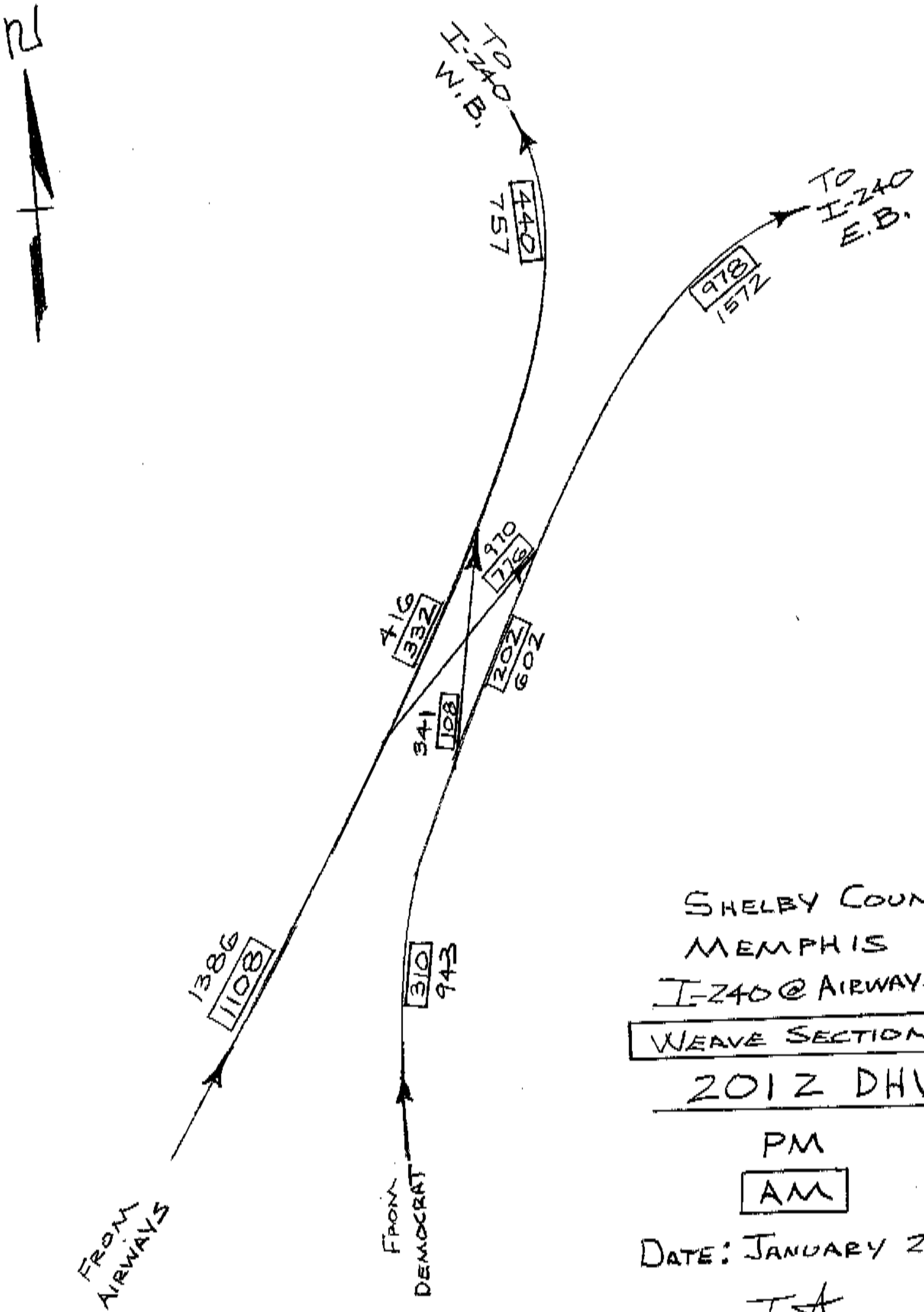
T.A.

③*



SHELBY COUNTY
MEMPHIS
I-240@ AIRWAYS BLVD.
WEAVE SECTION 3
2012 DHV
PM
[✓ AM]
DATE: JANUARY 26, 2007
T.A.

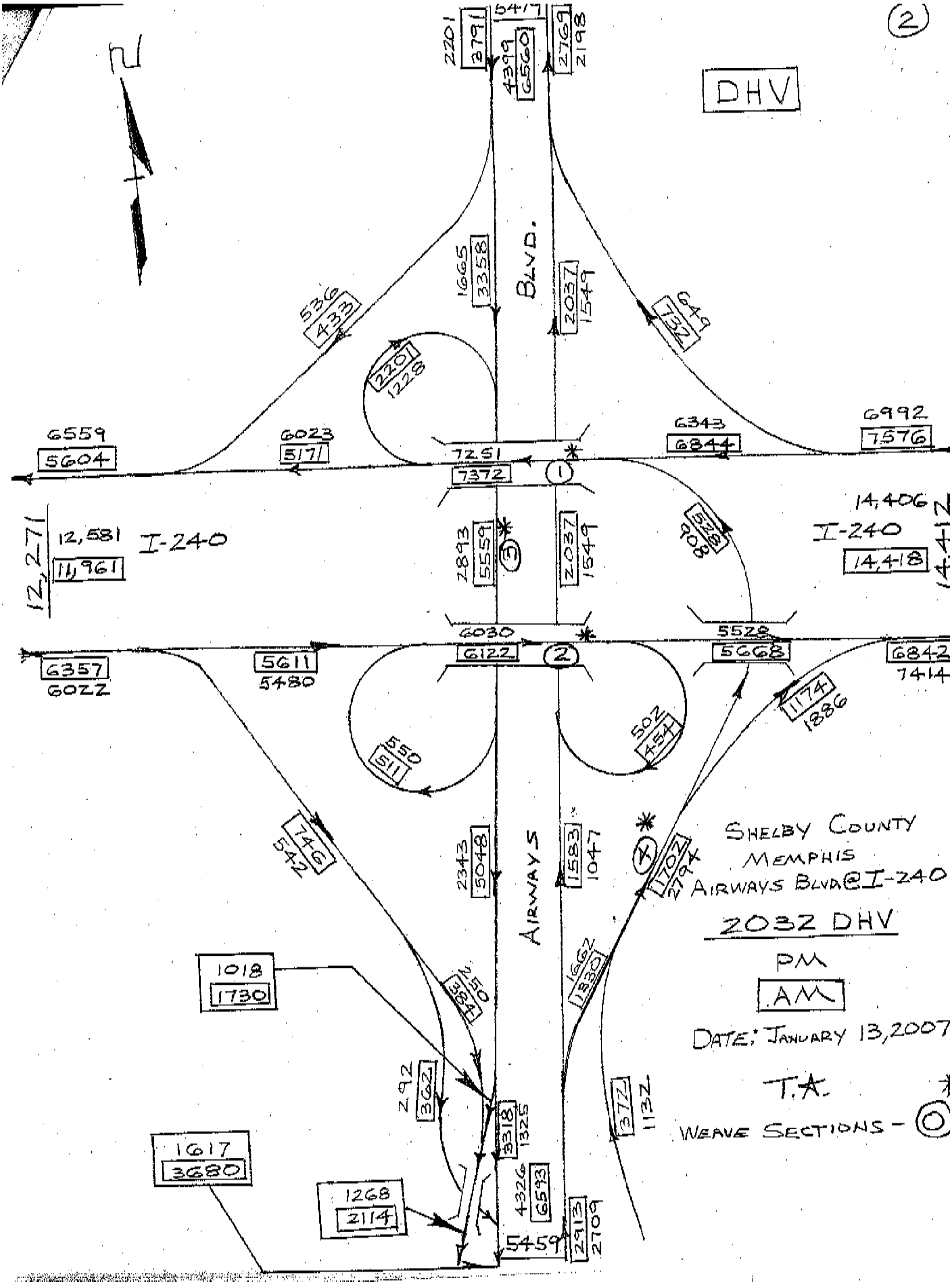
④*



SHELBY COUNTY
MEMPHIS
I-240 @ AIRWAYS BLVD.
WEAVE SECTION 4
2012 DHV
PM
[✓ AM]

DATE: JANUARY 26, 2007
T.A.

(2)



SHELBY COUNTY
MEMPHIS
AIRWAYS BLVD@I-240

2032 DHV

PM

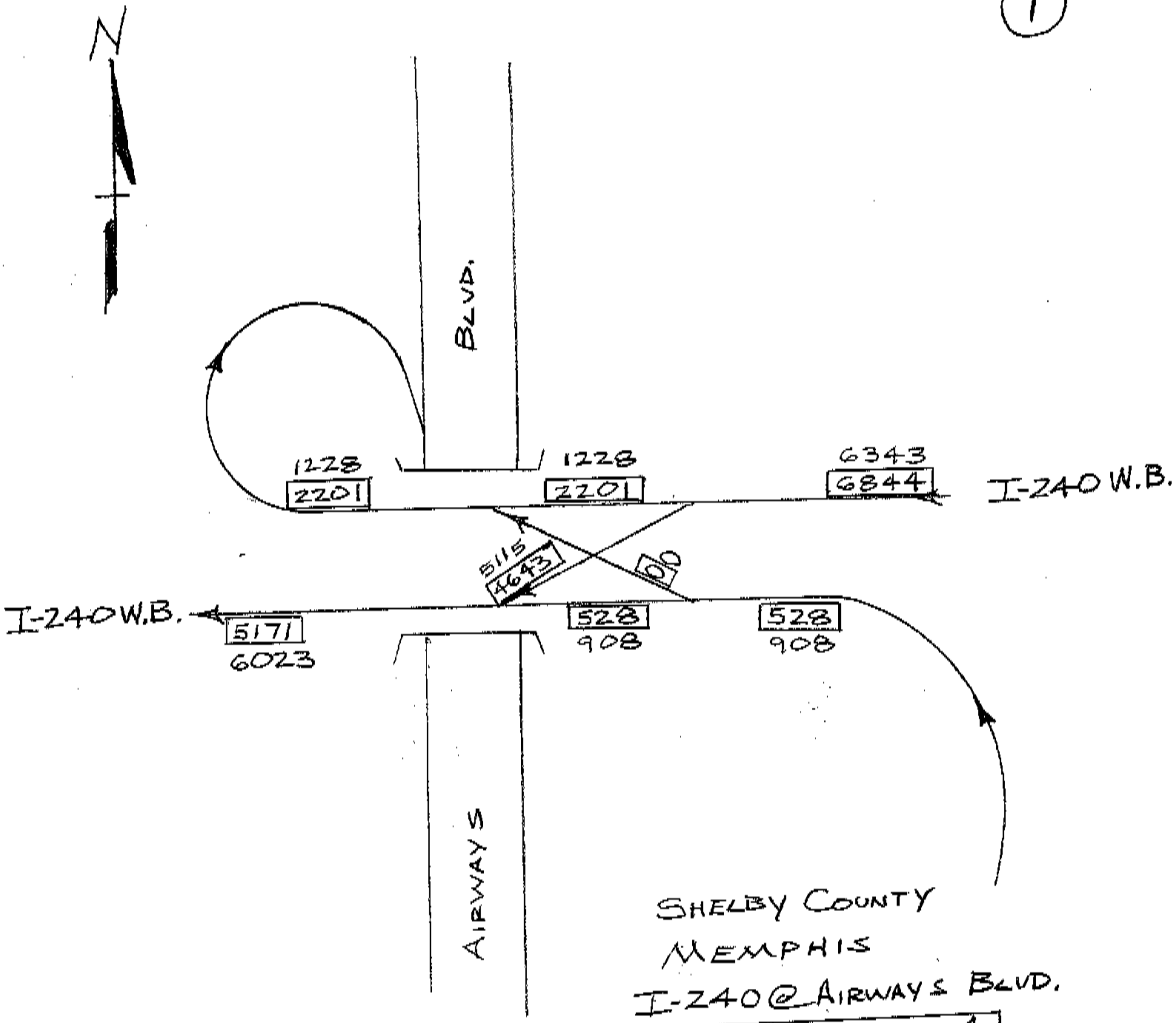
AM

DATE: JANUARY 13,2007

T.A.

WEAVE SECTIONS - ○

①*



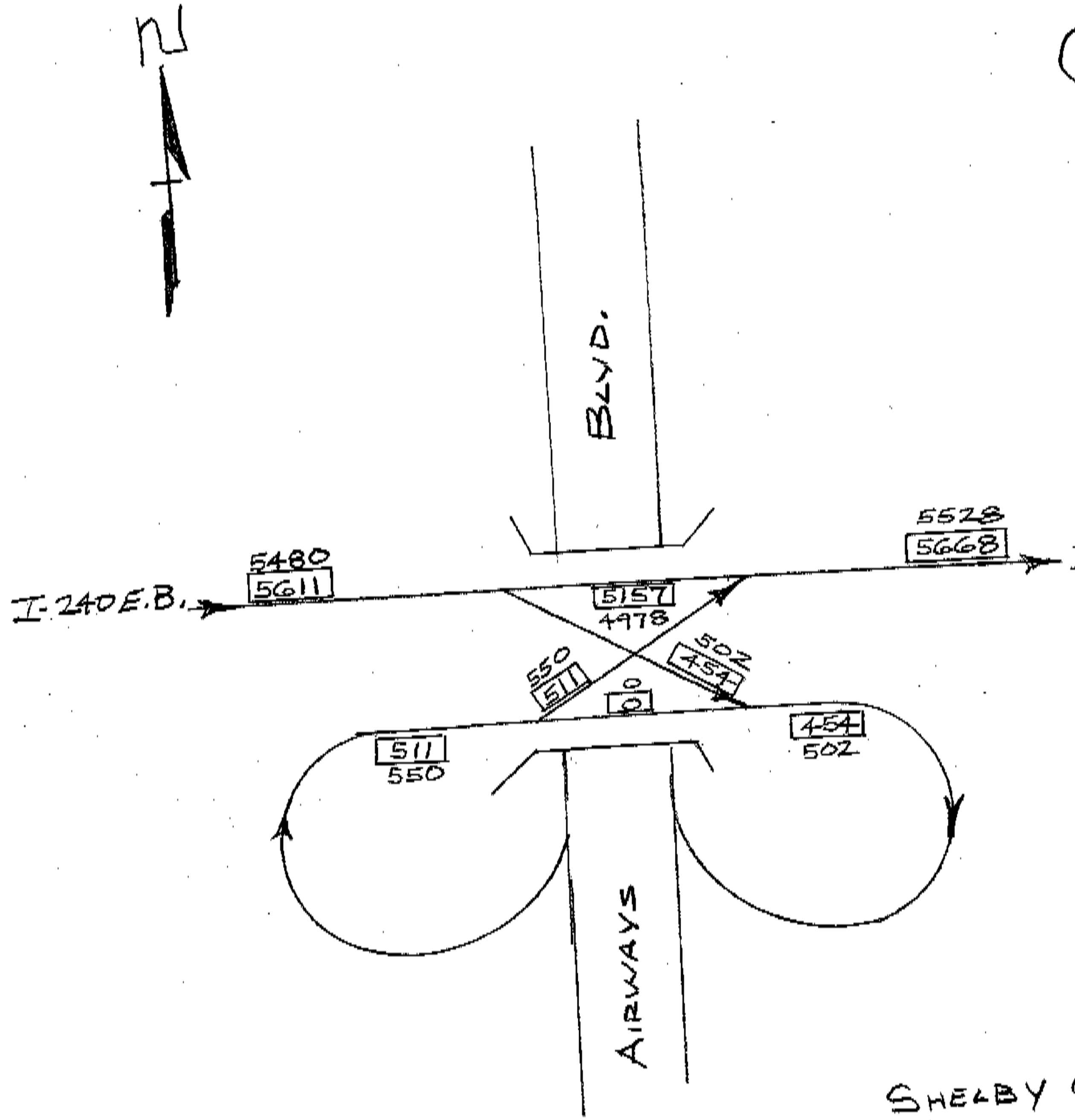
SHELBY COUNTY
MEMPHIS
I-240 @ AIRWAYS BLVD.
WEAVE SECTION 1

2032 DHV
PM
[✓ AM]

DATE: JANUARY 26, 2007

T.A.

②



SHELBY COUNTY
MEMPHIS
I-240 @ AIRWAYS BLV

WEAVE SECTION 2

2032 DHV

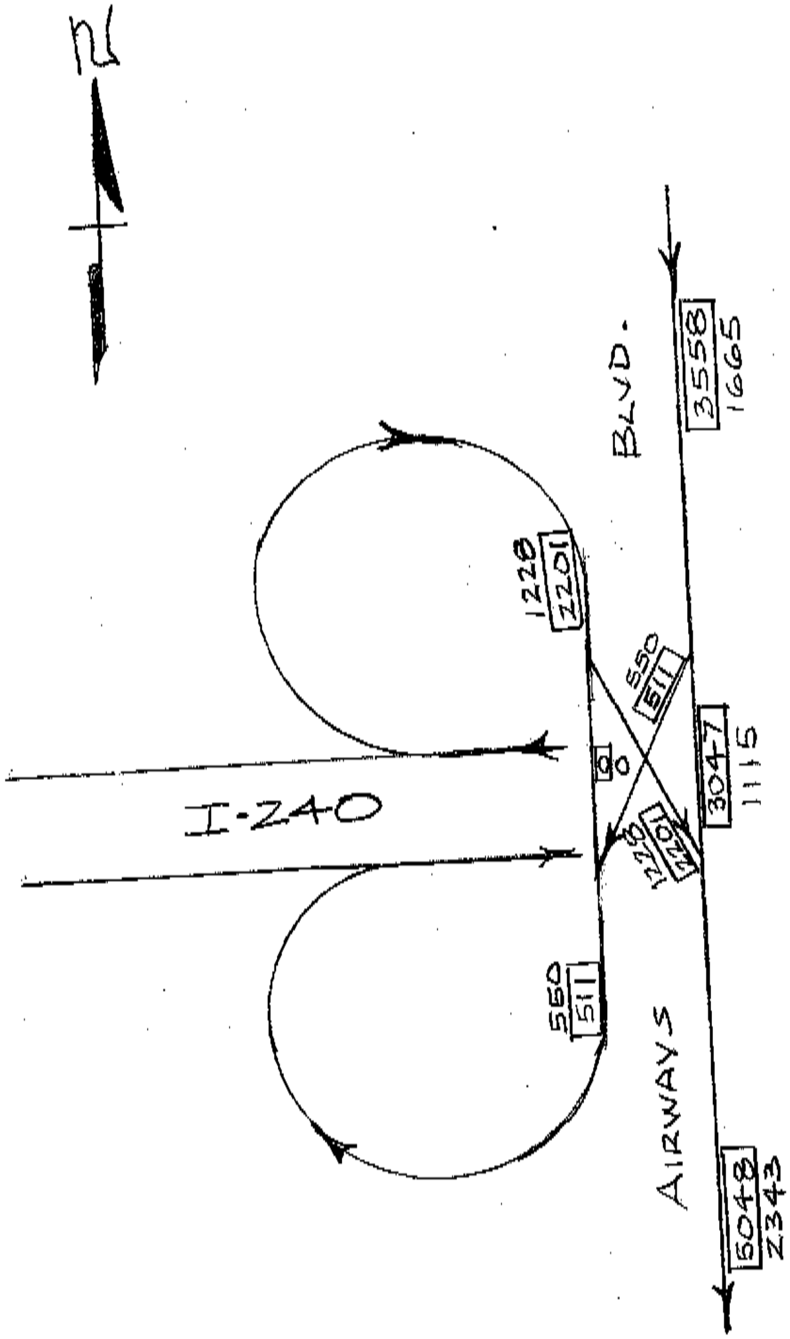
PM

AM

DATE: JANUARY 26,20

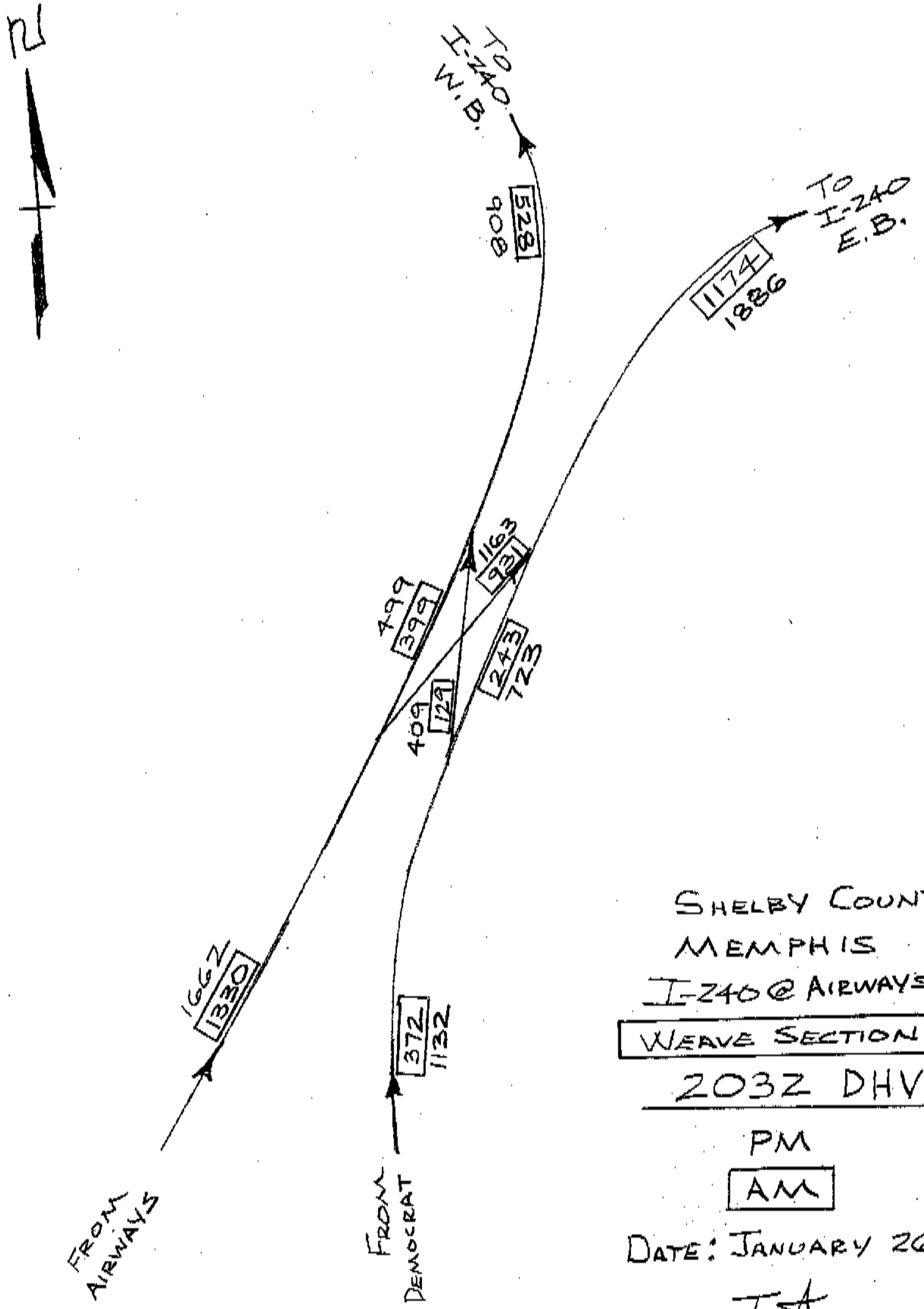
T. A.

③*

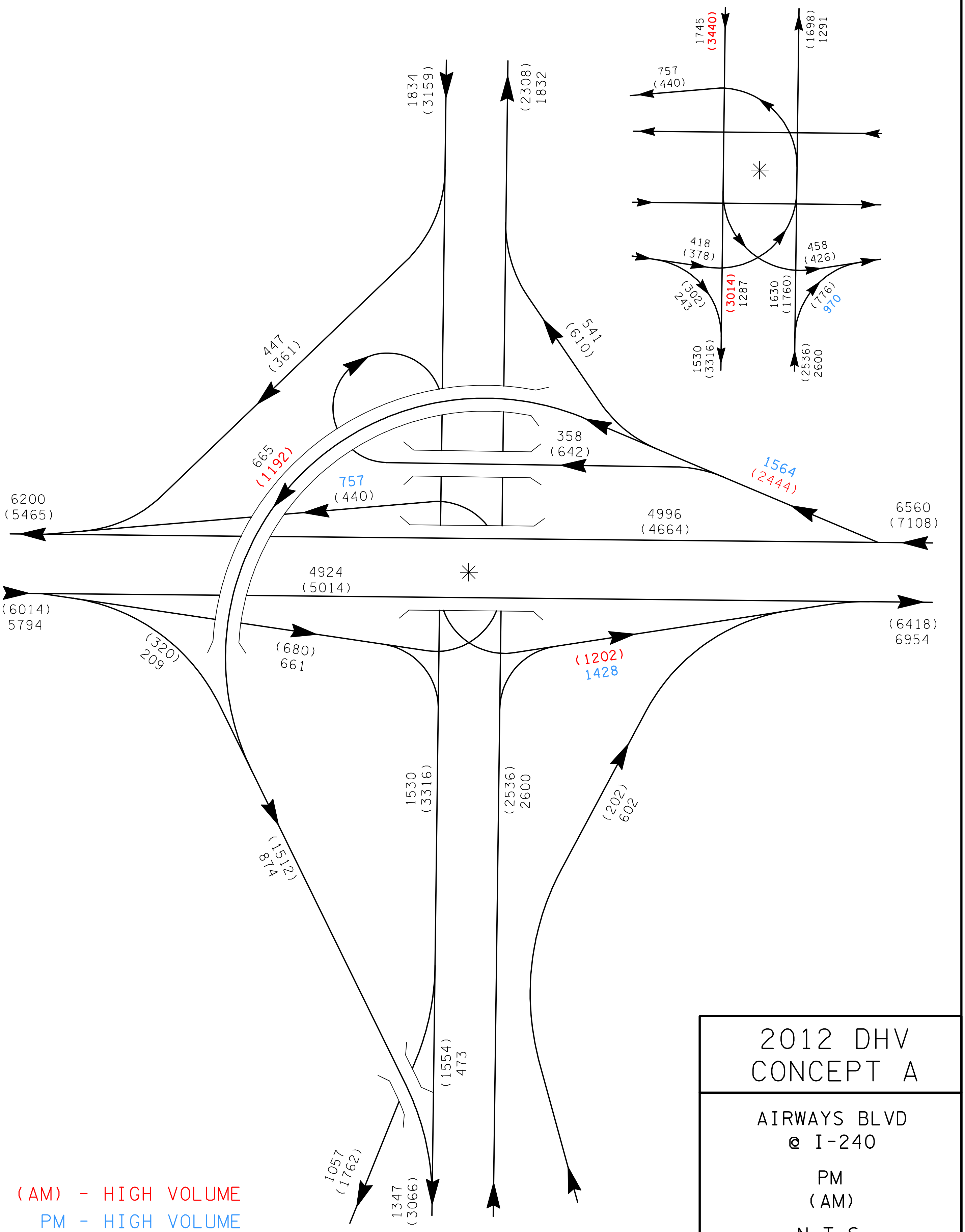


SHELBY COUNTY
MEMPHIS
I-240 @ AIRWAYS BLVD.
WEAVE SECTION 3
2032 DHV
PM
[✓ AM]
DATE: JANUARY 26, 2007
T.A.

④*



SHELBY COUNTY
MEMPHIS
I-240 @ AIRWAYS BLVD.
WEAVE SECTION 4
2032 DHV
PM
[✓ AM]
DATE: JANUARY 26, 2007
T.A.



(AM) - HIGH VOLUME

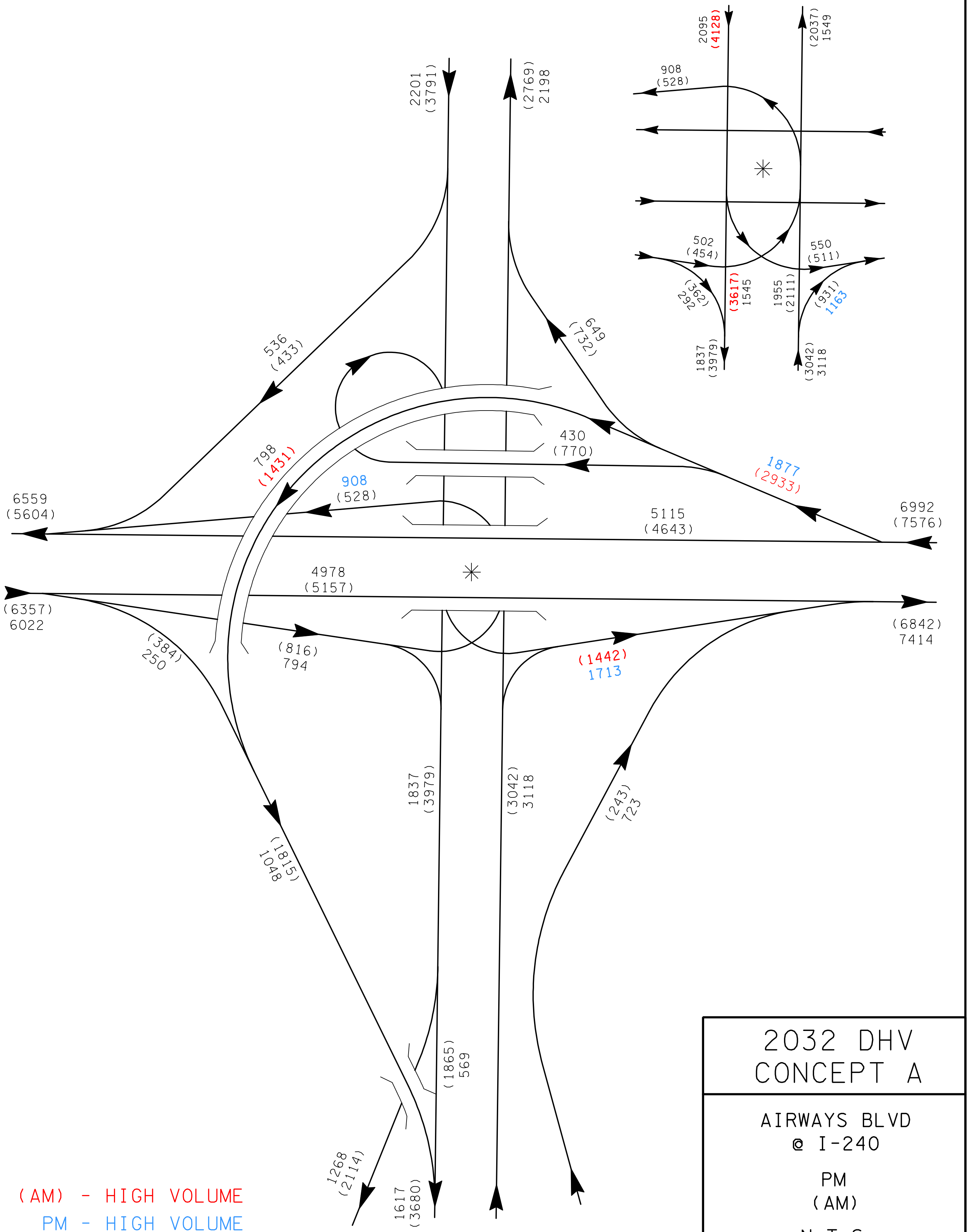
PM - HIGH VOLUME

2012 DHV
CONCEPT A

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



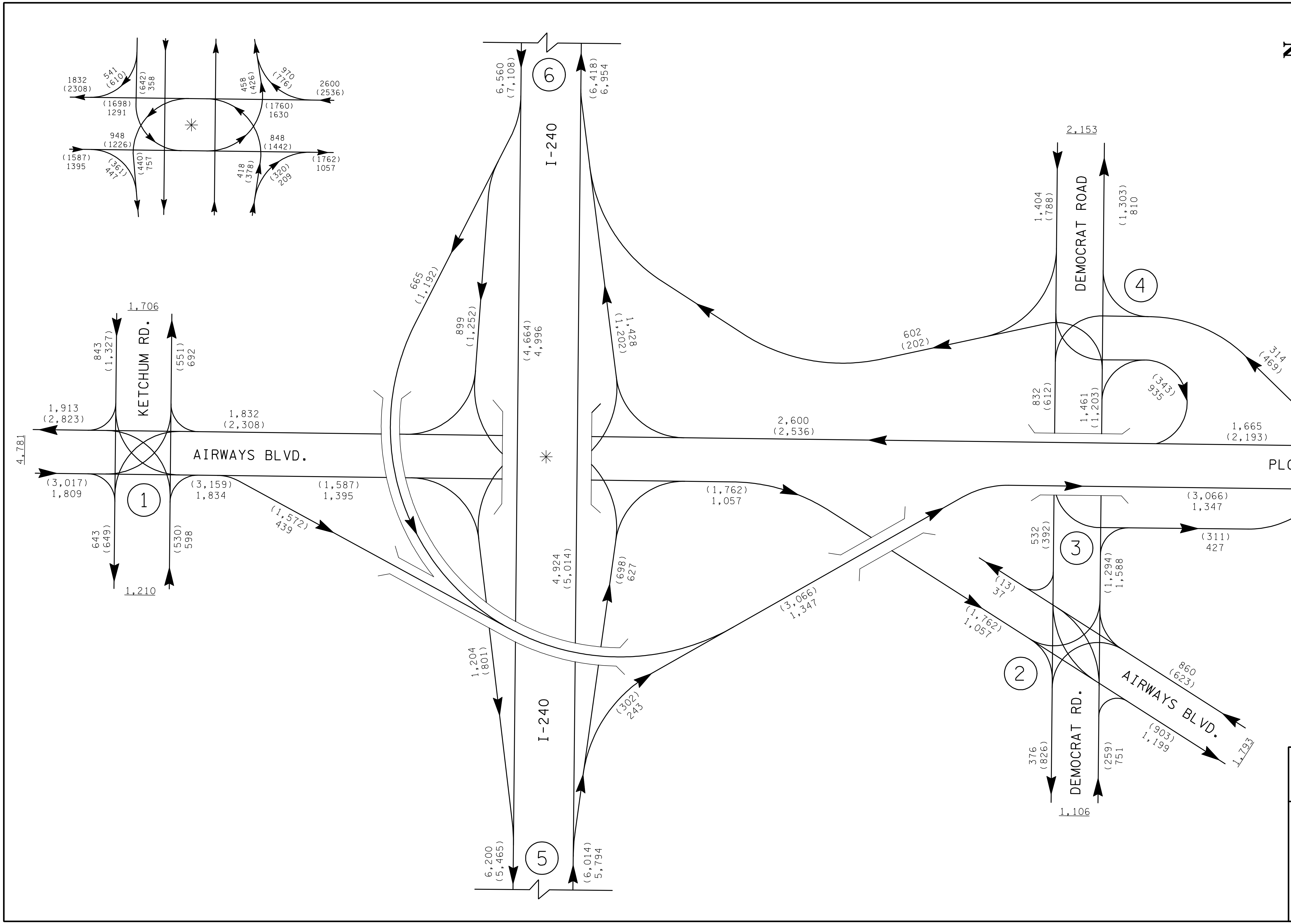
(AM) - HIGH VOLUME
PM - HIGH VOLUME

2032 DHV
CONCEPT A

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

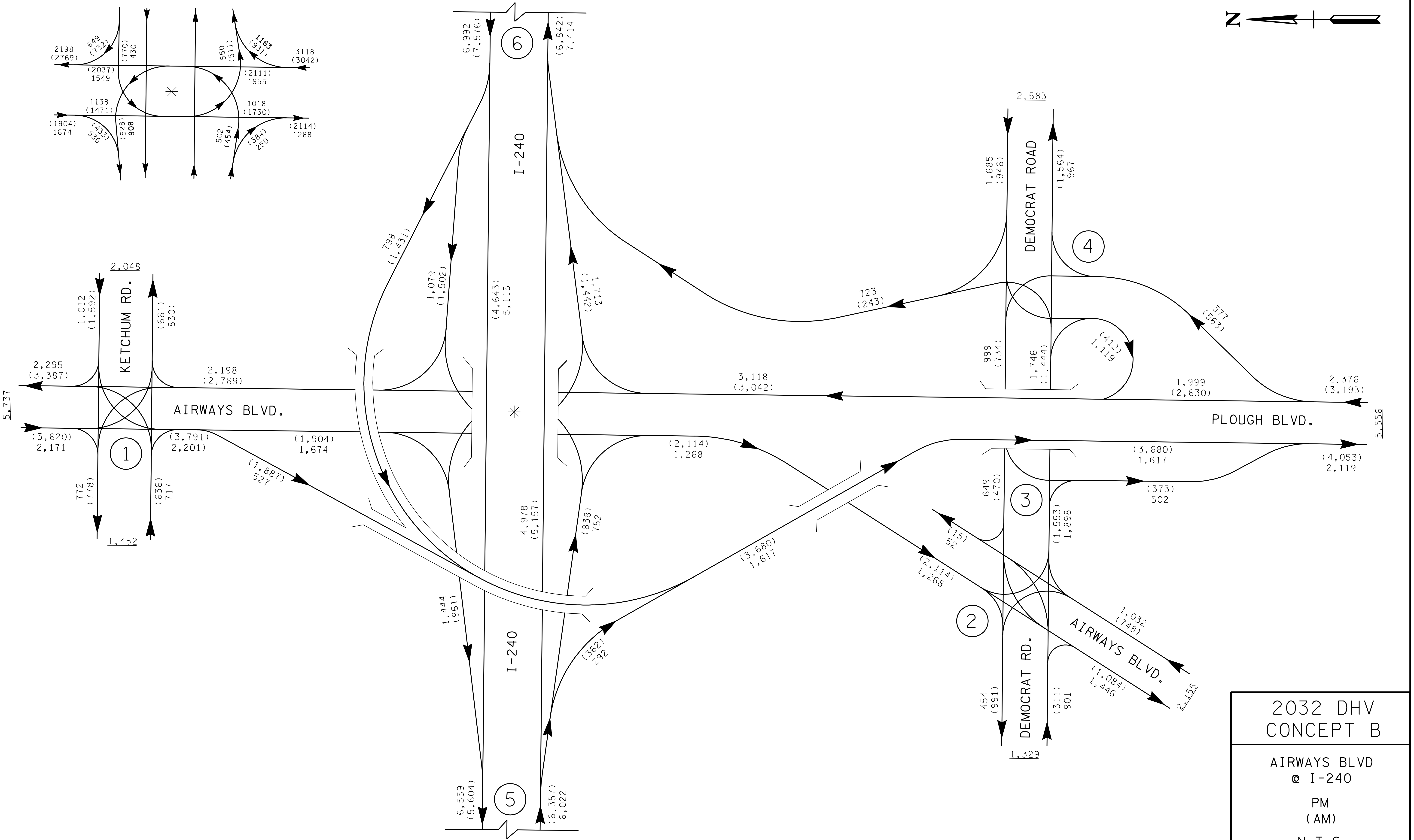


2012 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

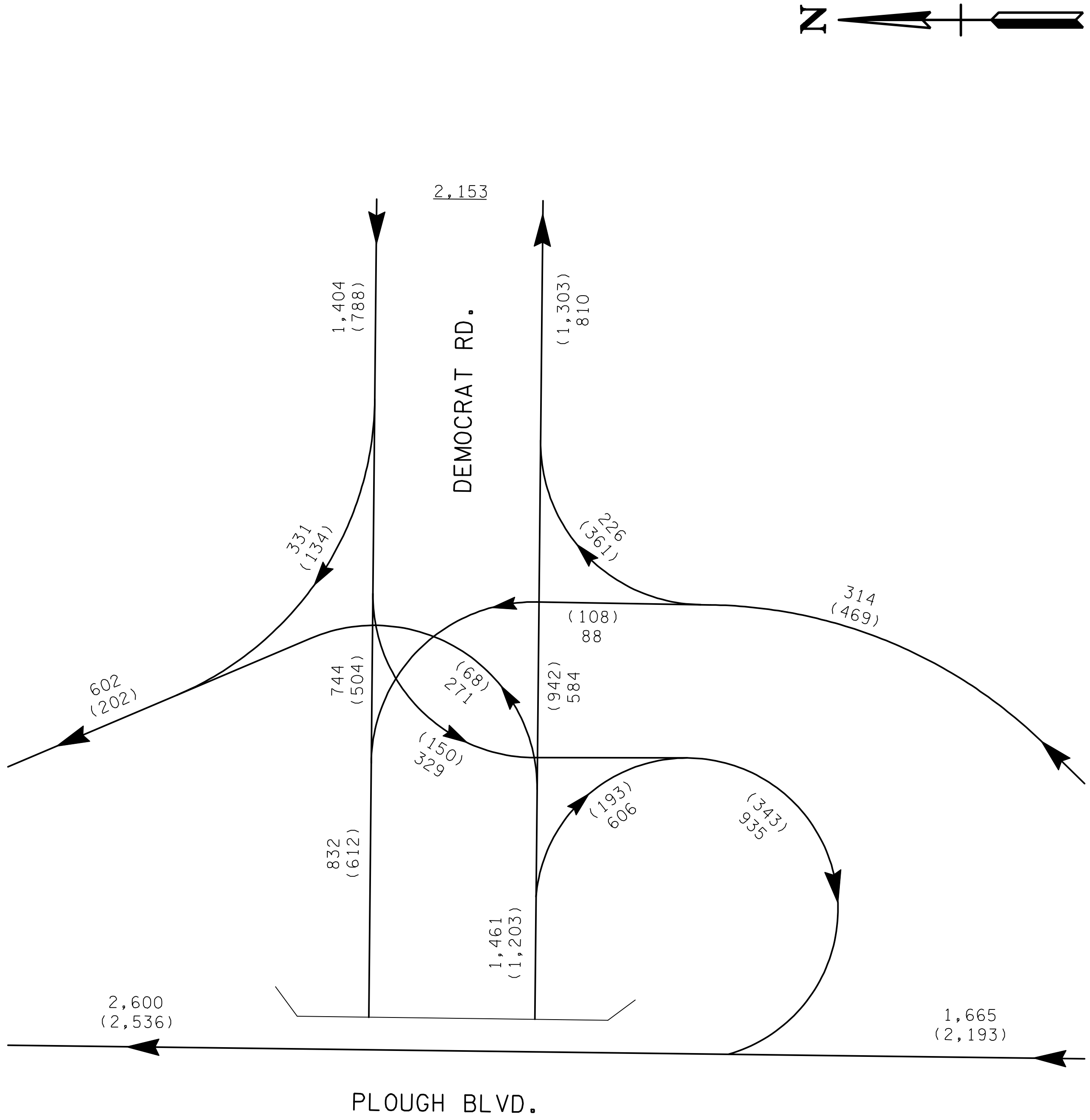


2032 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



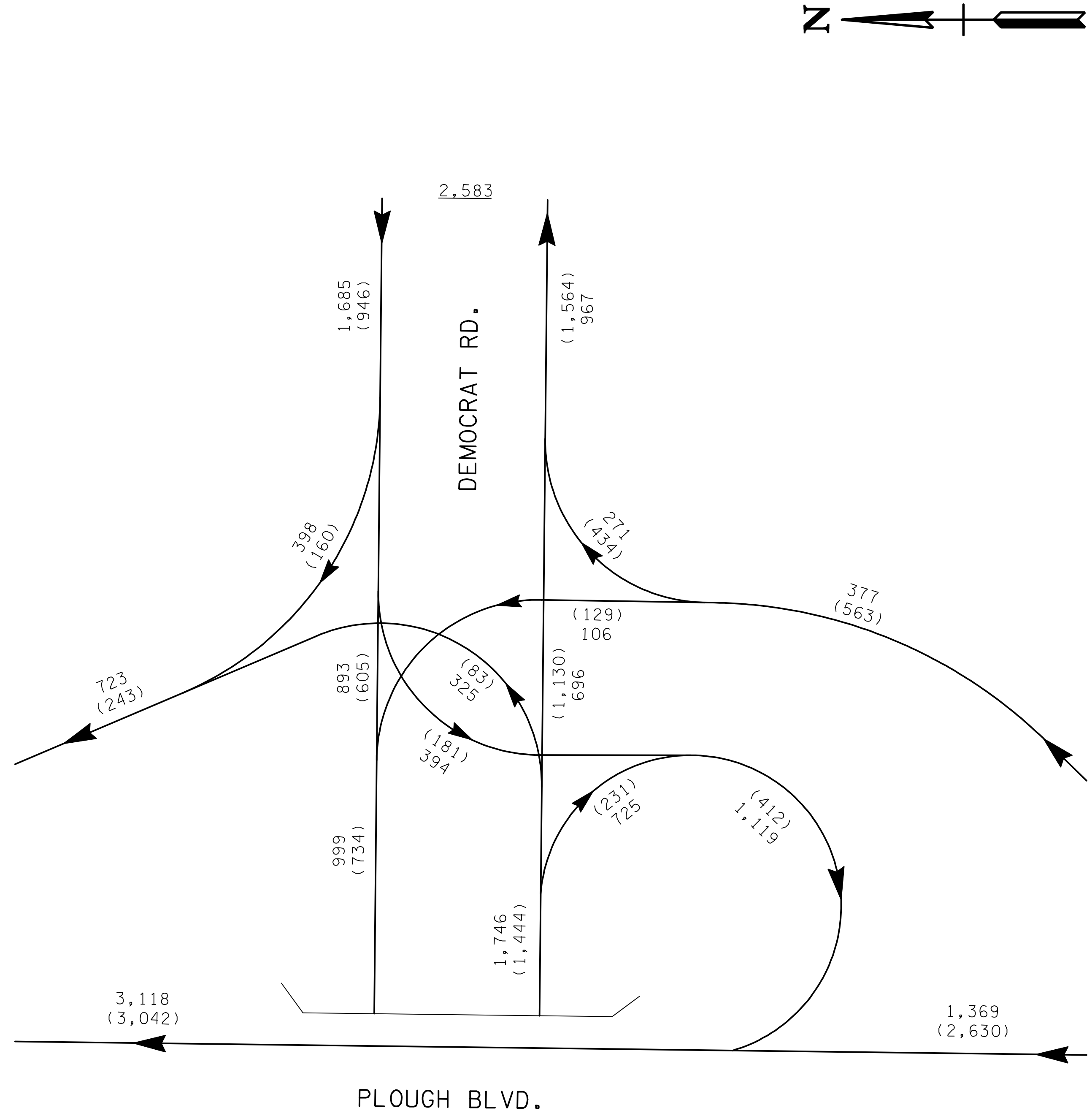
④

2012 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



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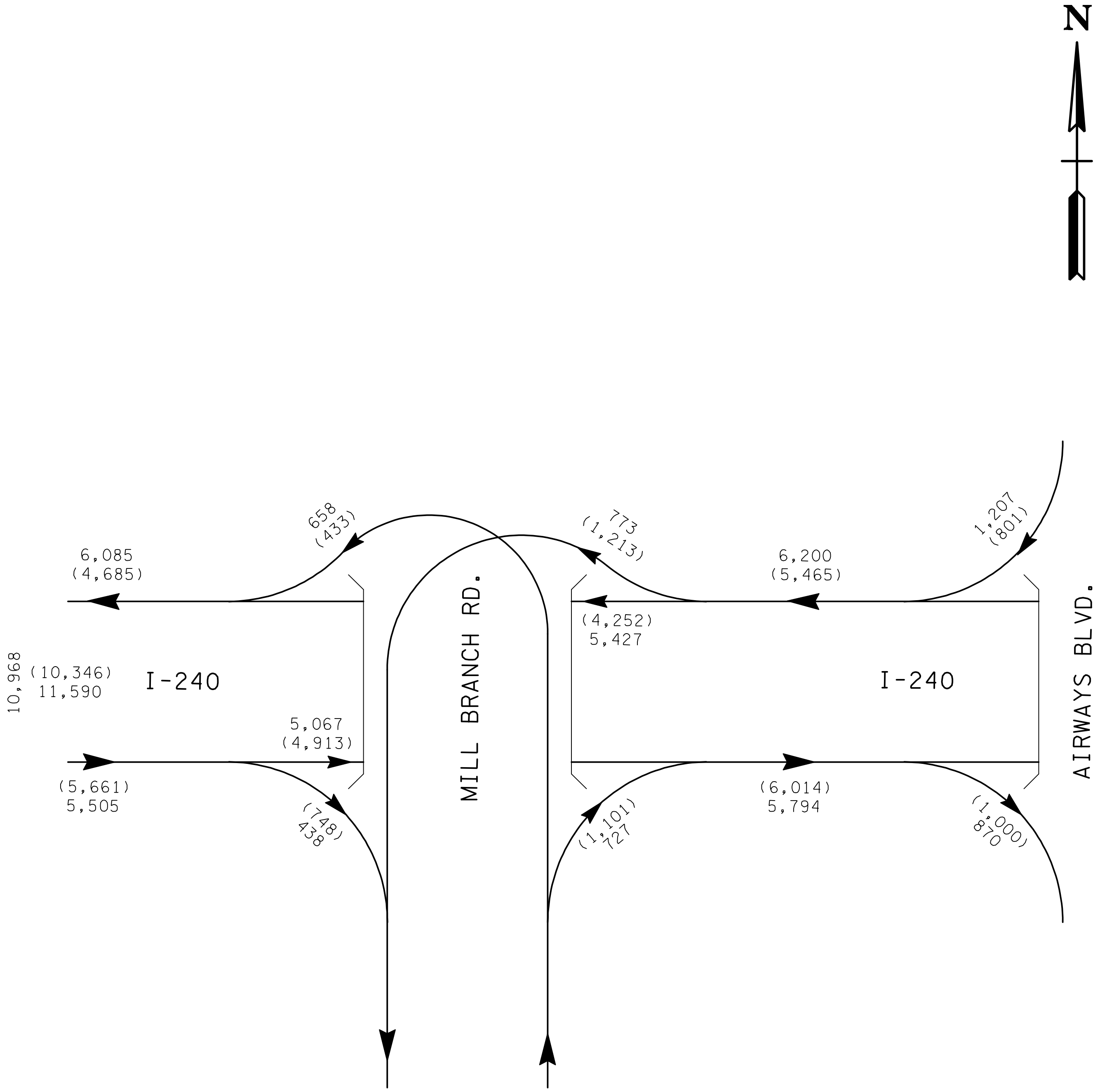
2032 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



⑤

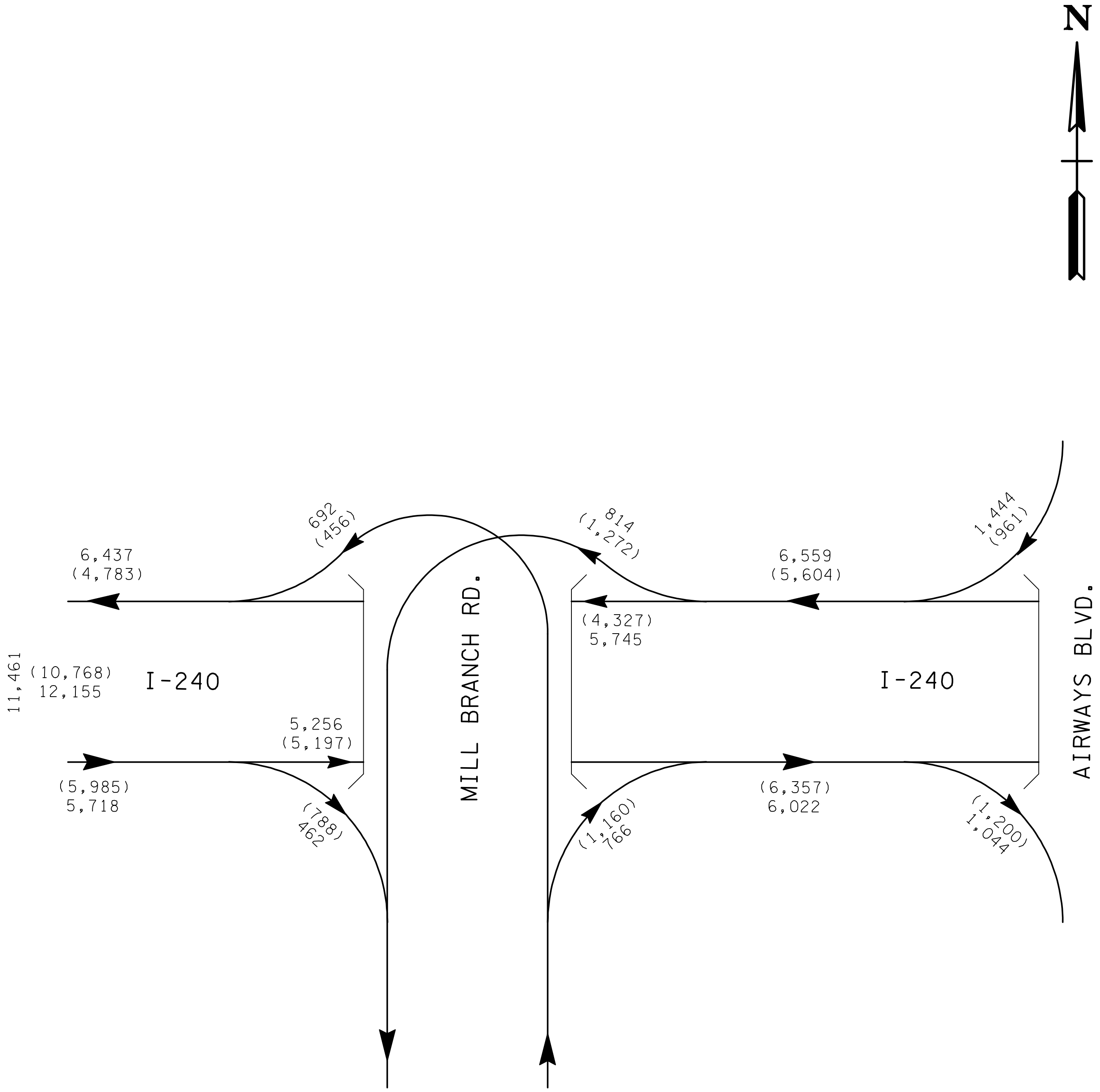
☆ ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED

2012 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



⑤

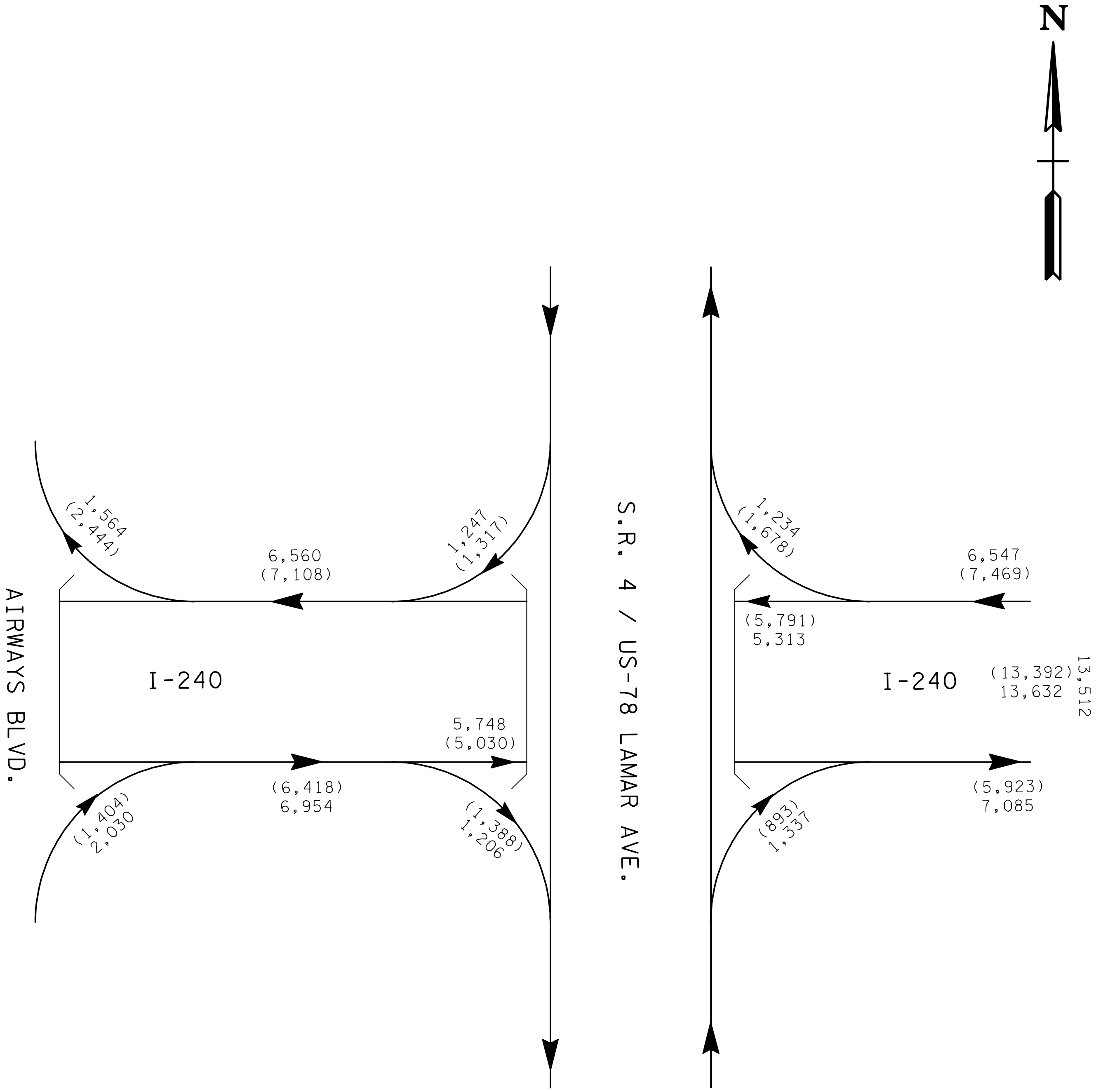
2032 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

☆ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED



⑥

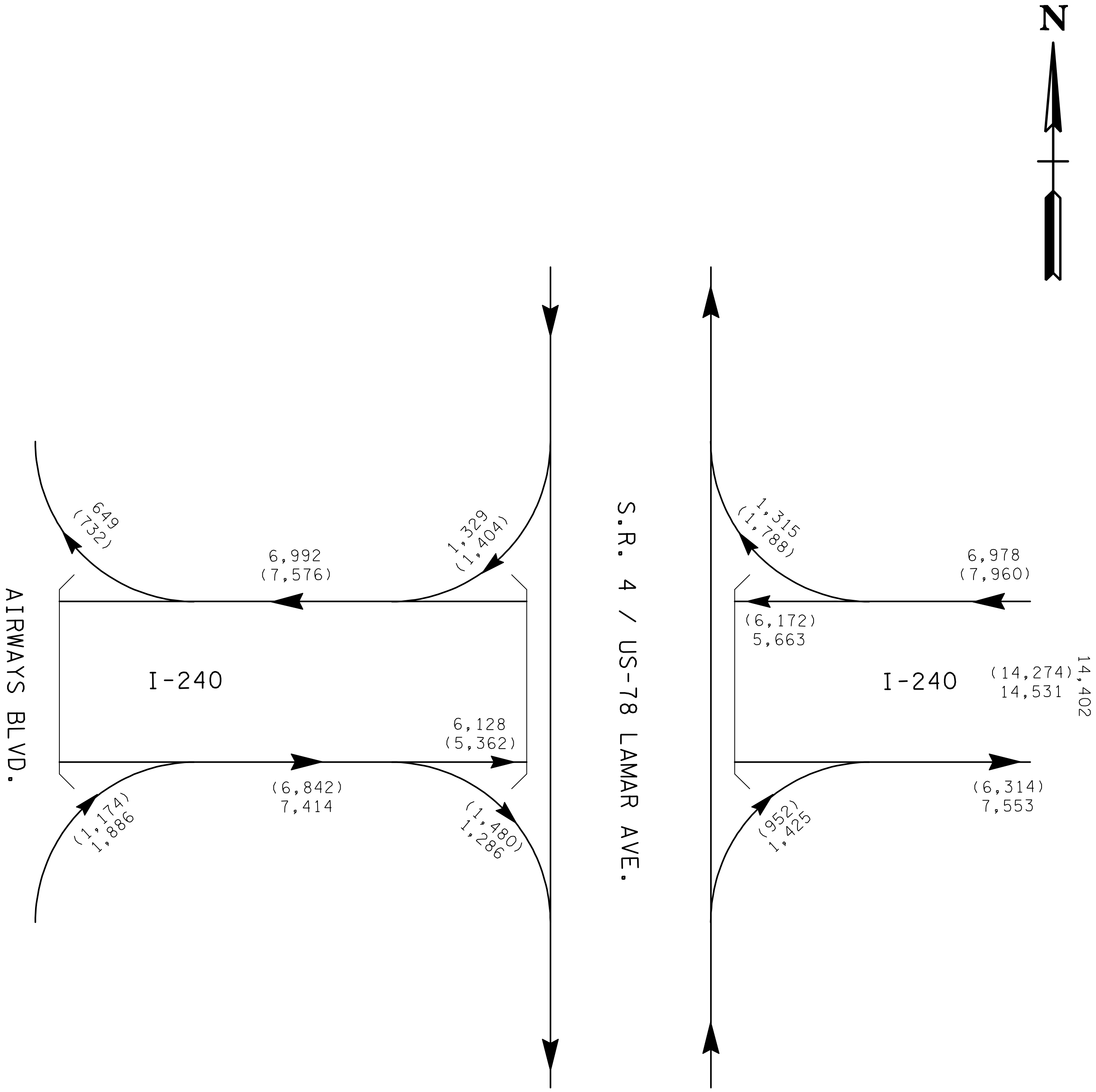
2012 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

☆ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED



⑥

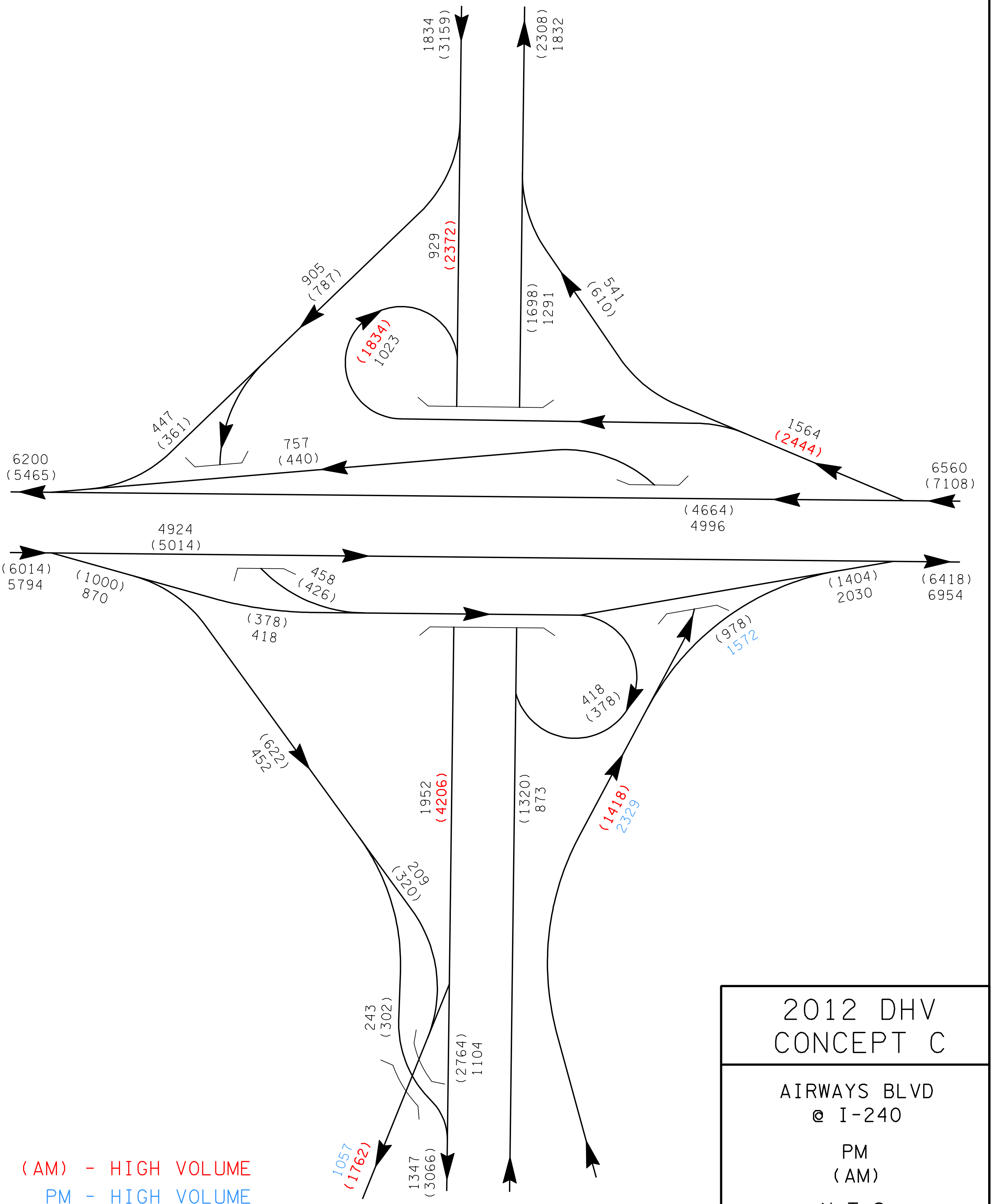
2032 DHV
CONCEPT B

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

☆ ONLY INTERCHANGE RAMPS
CONNECTED TO I-240 ARE SHOWN
AND HAVE BEEN ANALYZED



(AM) - HIGH VOLUME

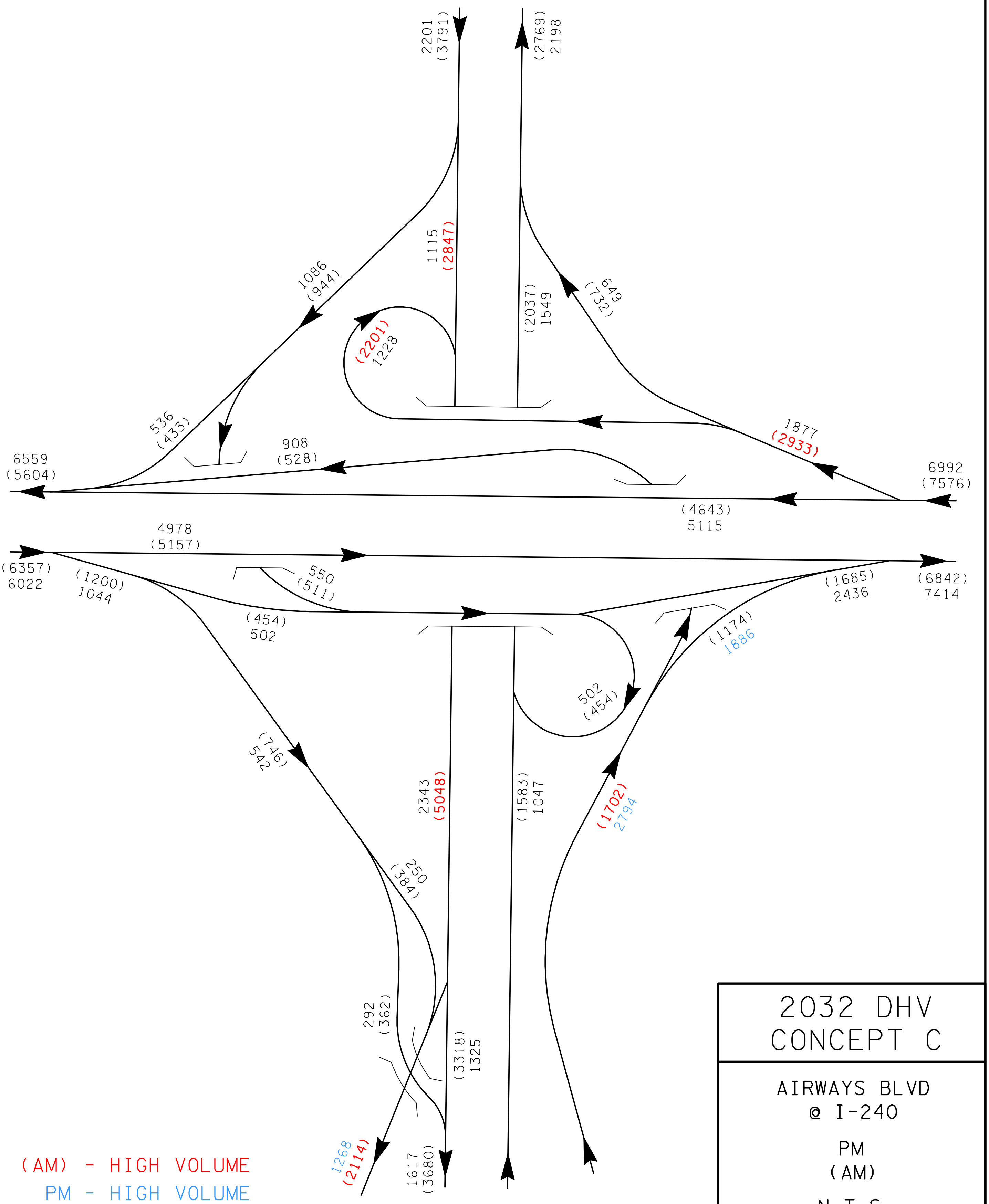
PM - HIGH VOLUME

2012 DHV
CONCEPT C

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



(AM) - HIGH VOLUME

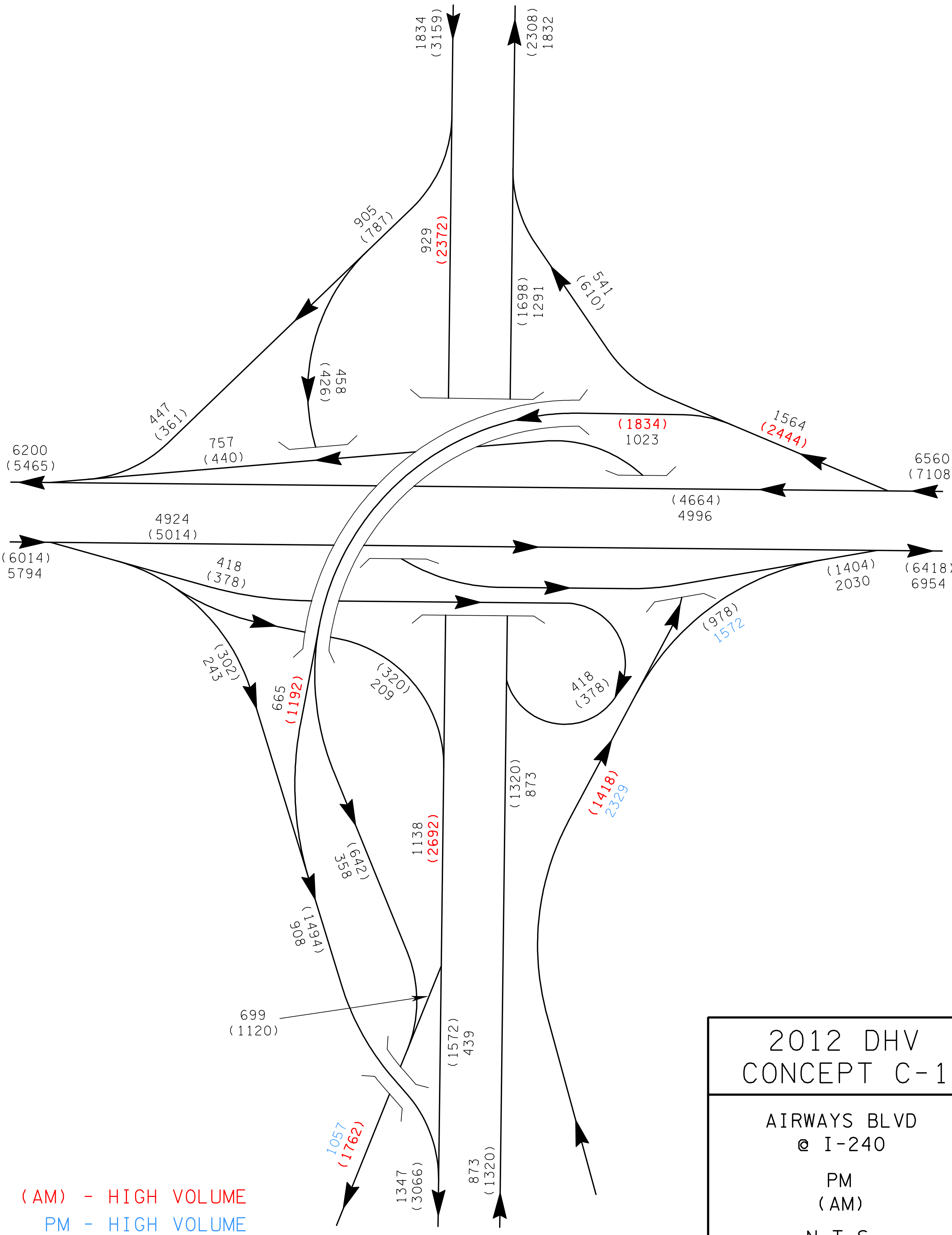
PM - HIGH VOLUME

2032 DHV
CONCEPT C

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



(AM) - HIGH VOLUME

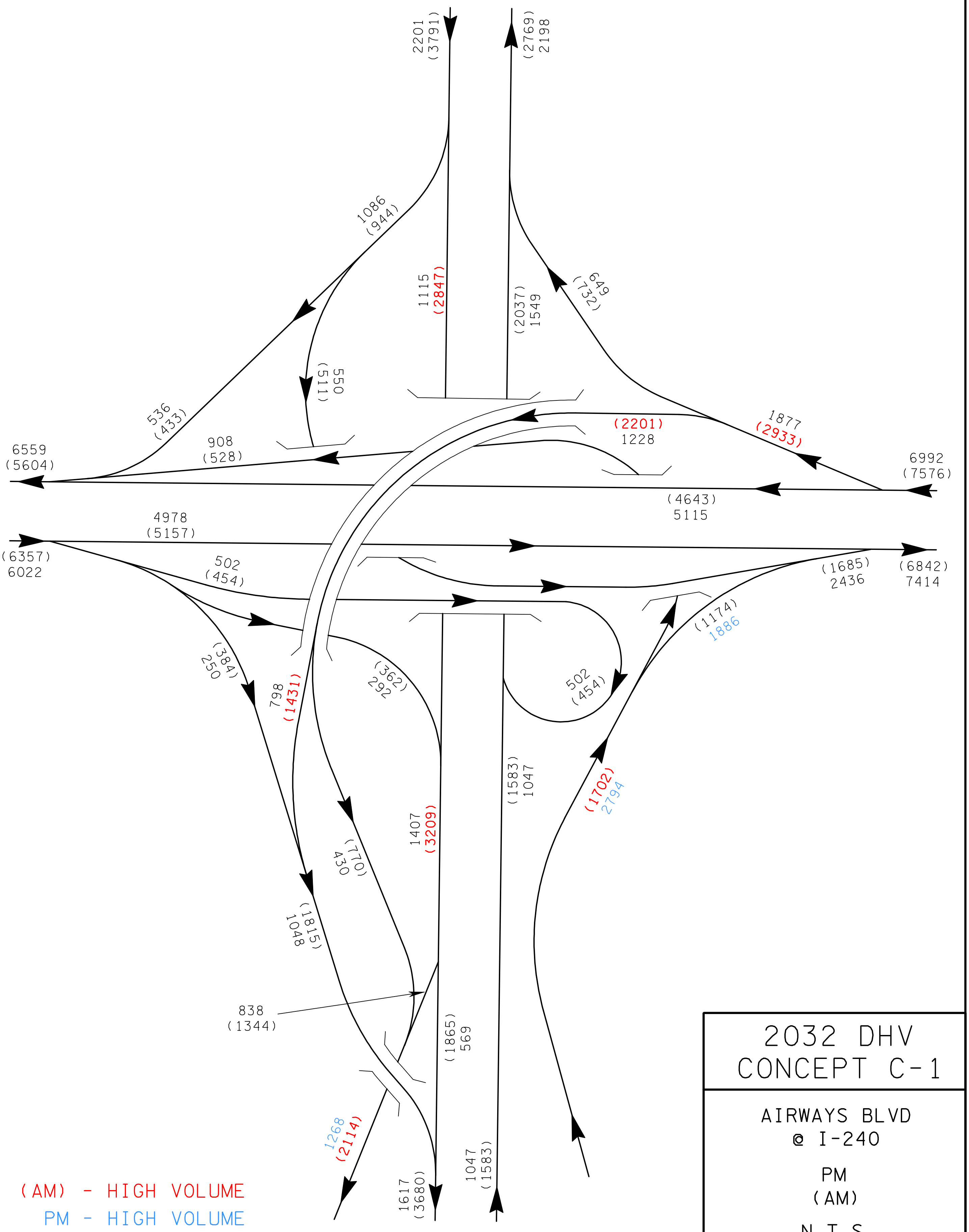
PM - HIGH VOLUME

2012 DHV
CONCEPT C-1

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



2032 DHV
CONCEPT C-1

AIRWAYS BLVD
@ I-240

PM
(AM)

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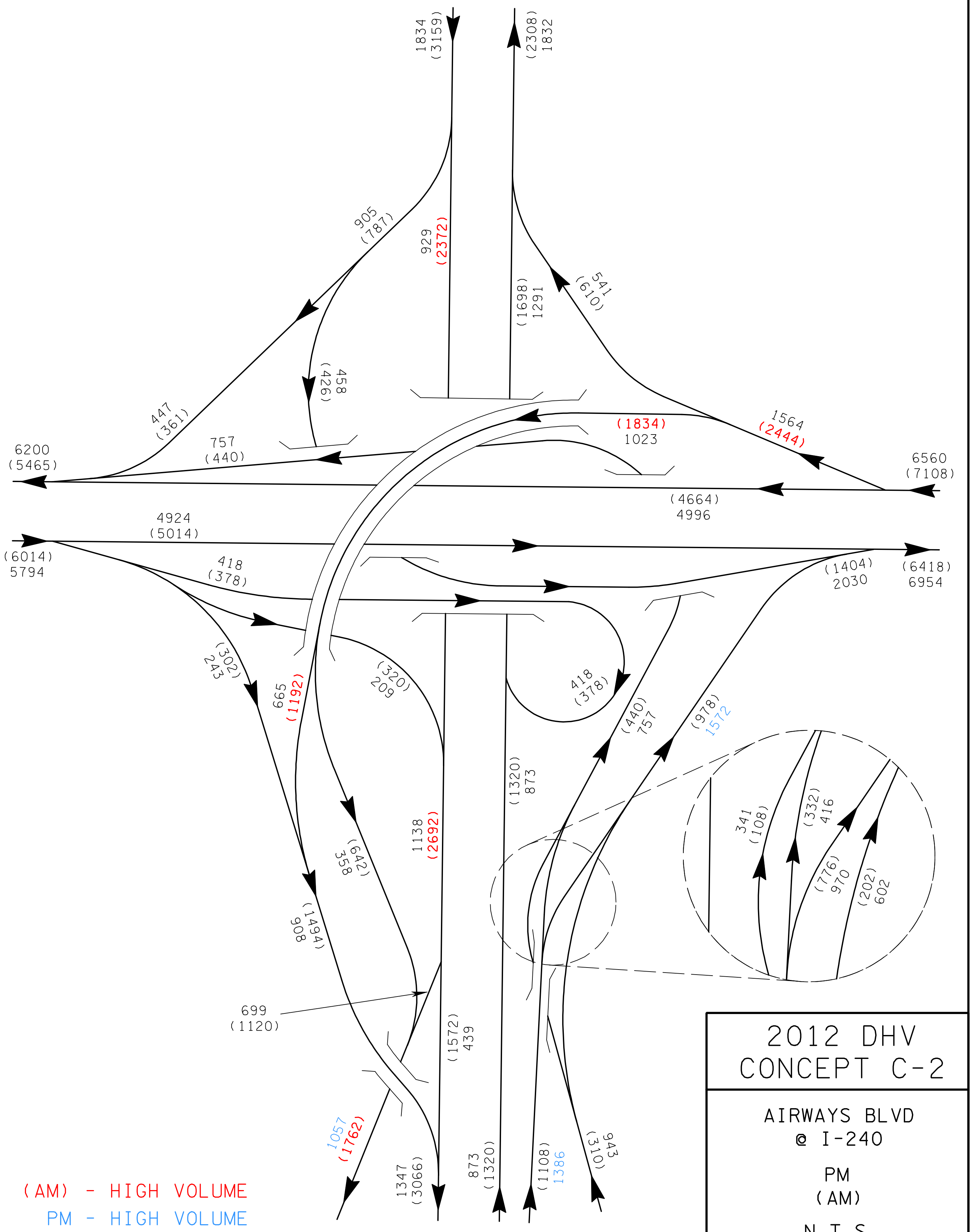

2012 DHV
CONCEPT C-2

AIRWAYS BLVD
@ I-240

PM
(AM)

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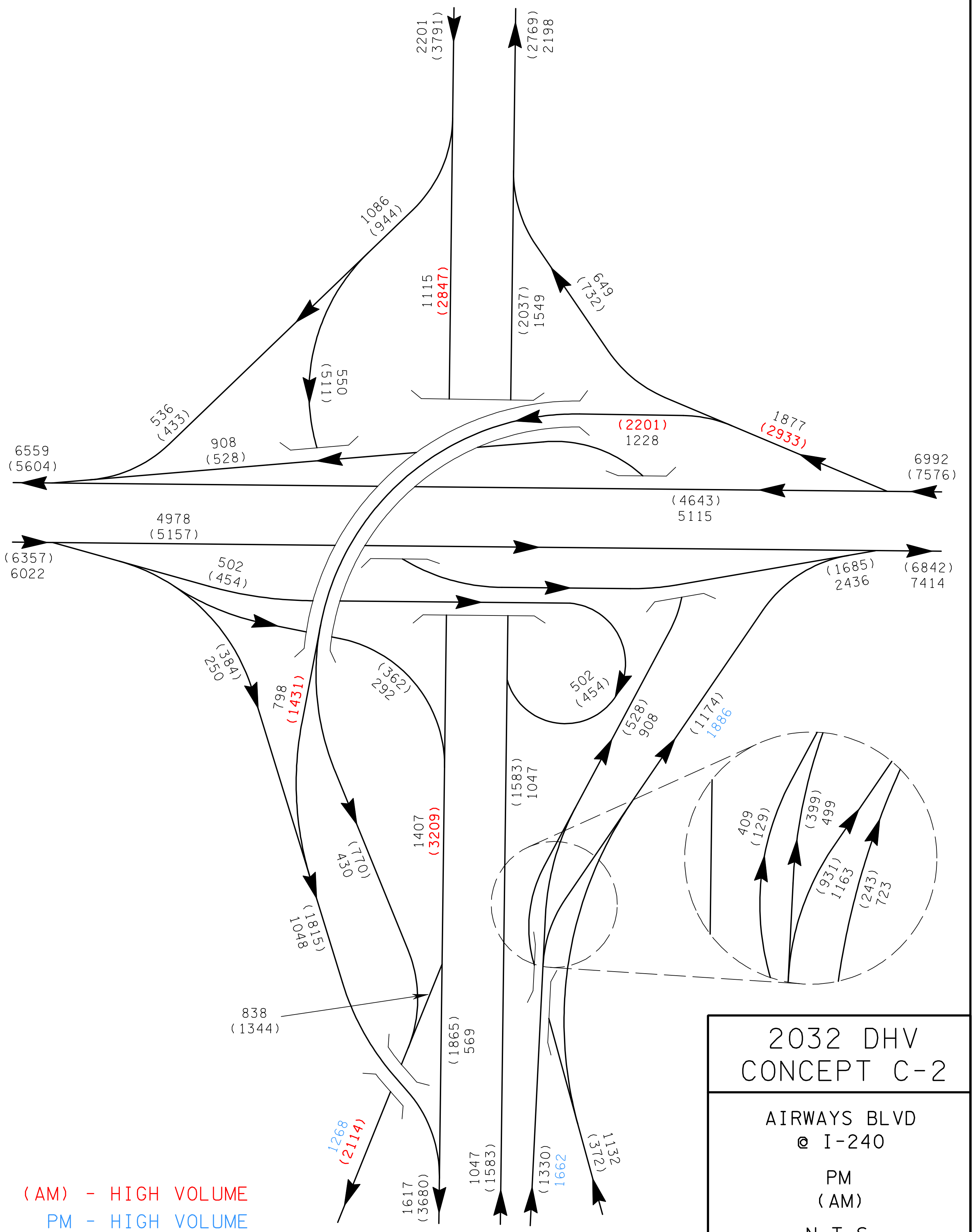


(AM) - HIGH VOLUME
PM - HIGH VOLUME

2032 DHV
CONCEPT C-2

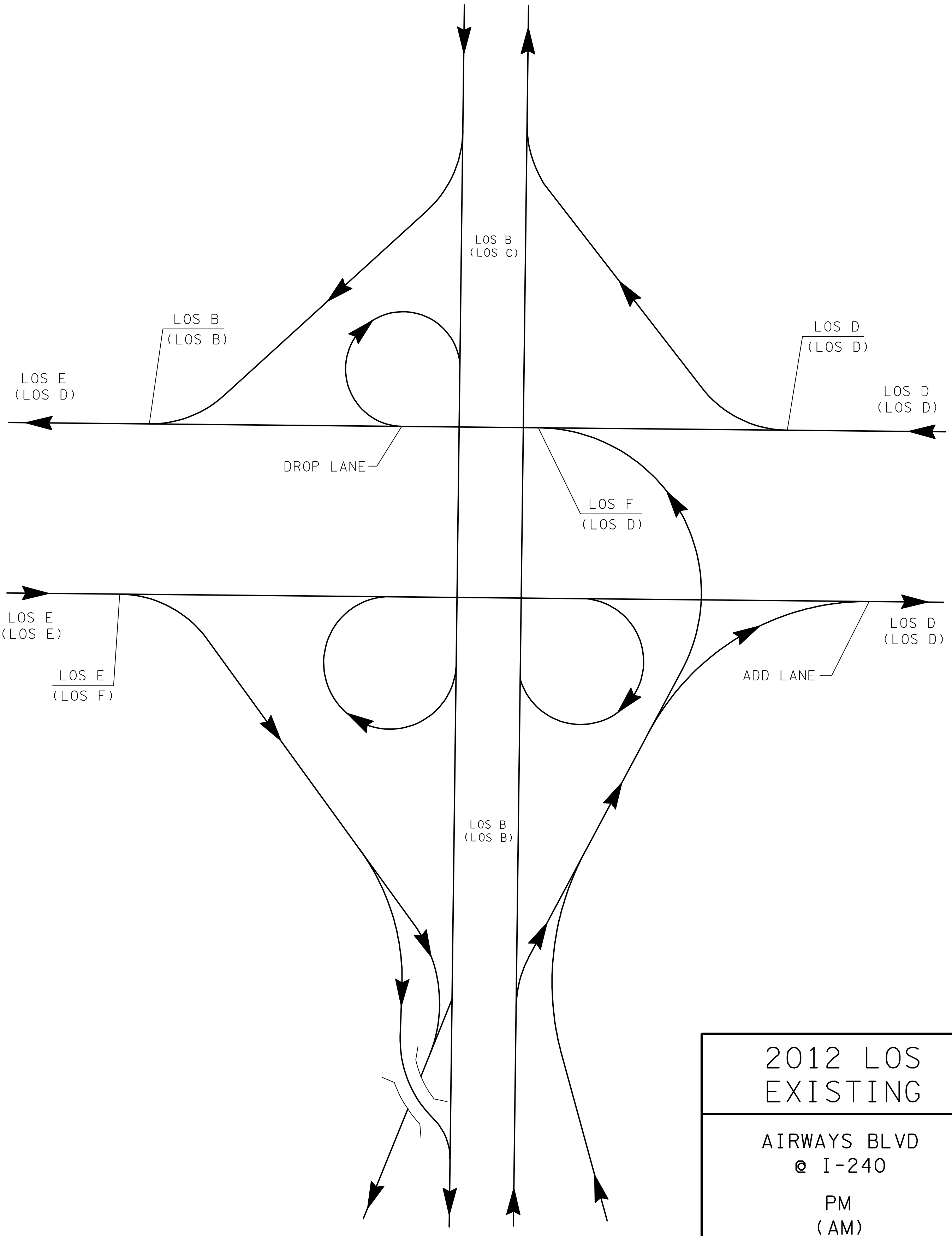
AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

APPENDIX B

LEVEL OF SERVICE DIAGRAMS: EXISTING AND PROPOSED

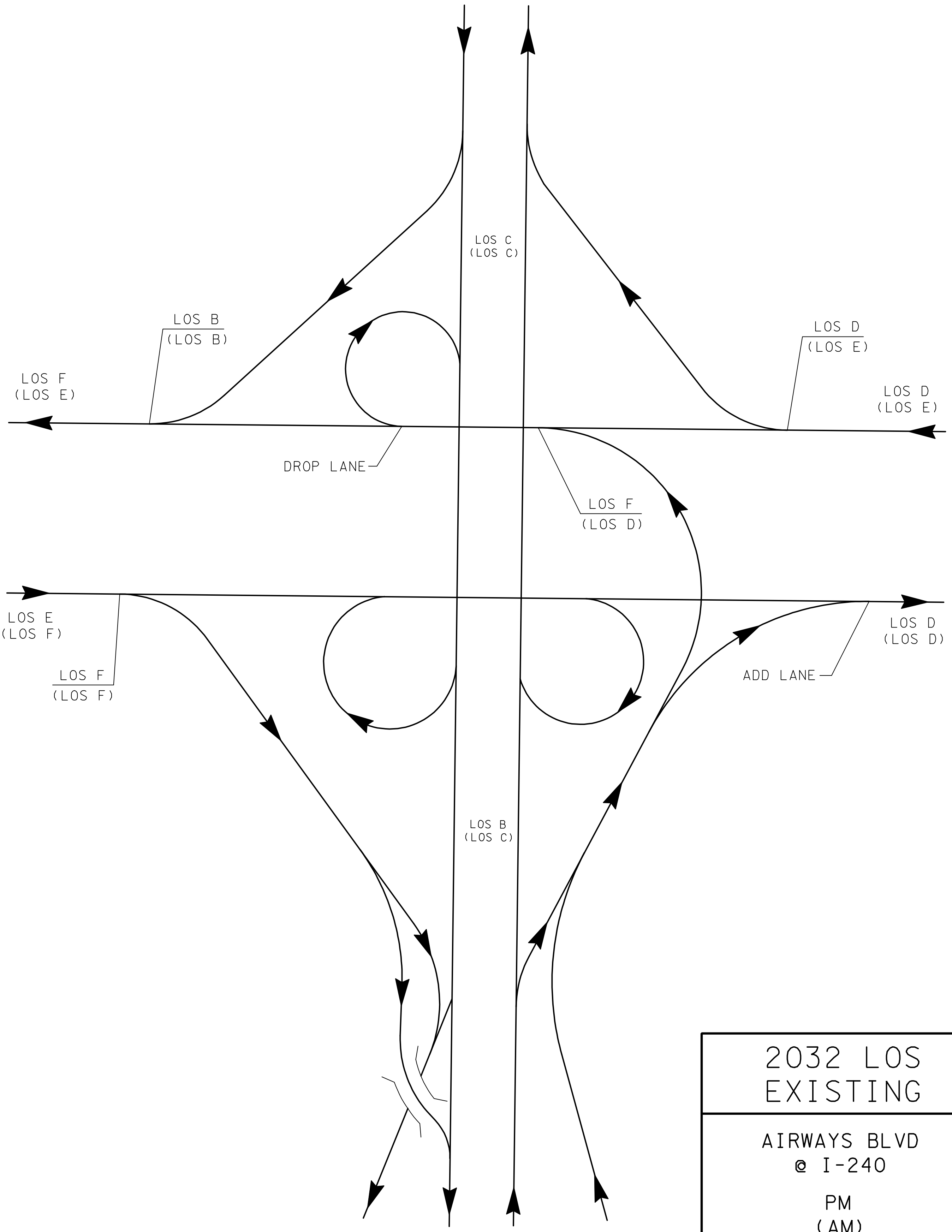


2012 LOS
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

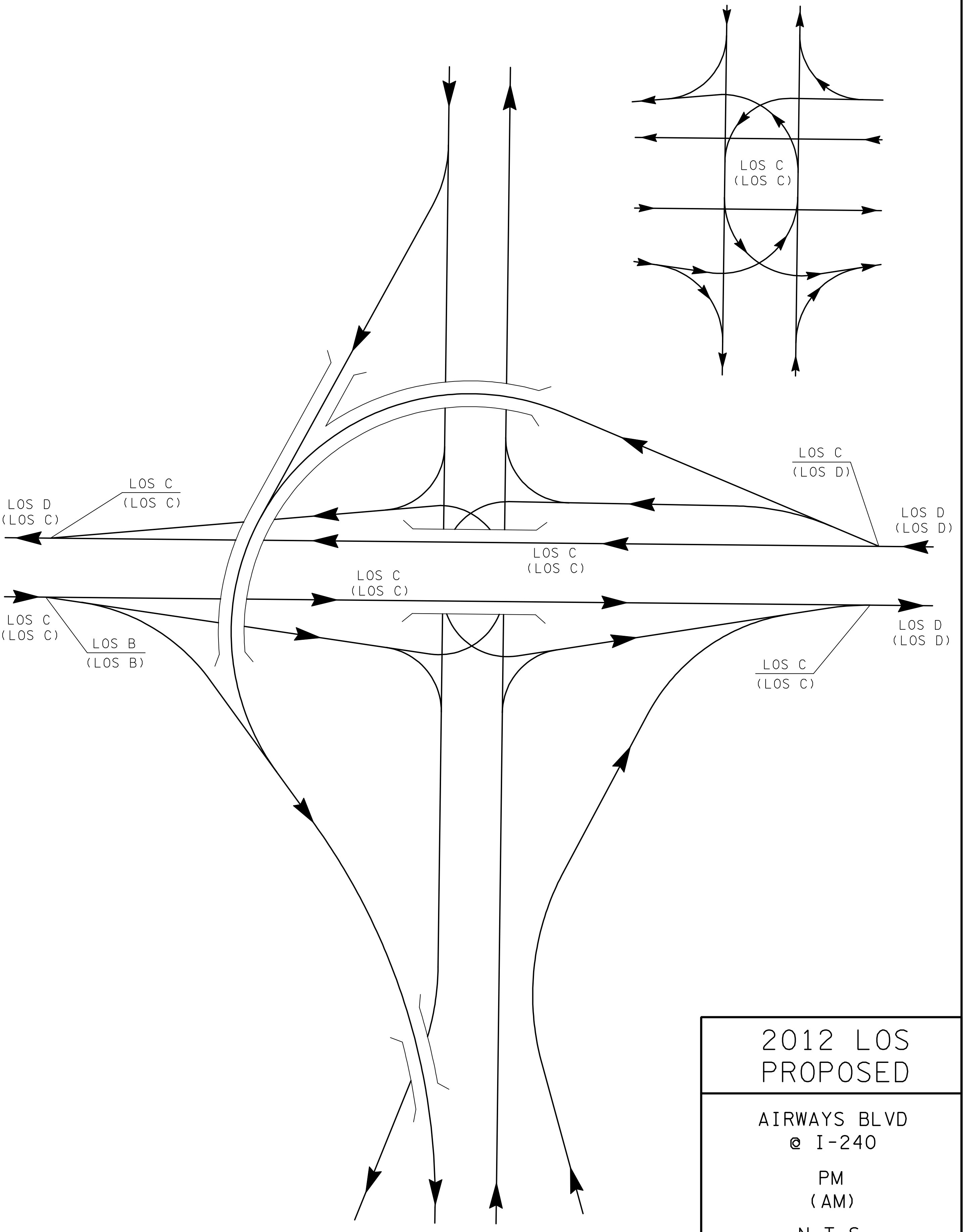


2032 LOS
EXISTING

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

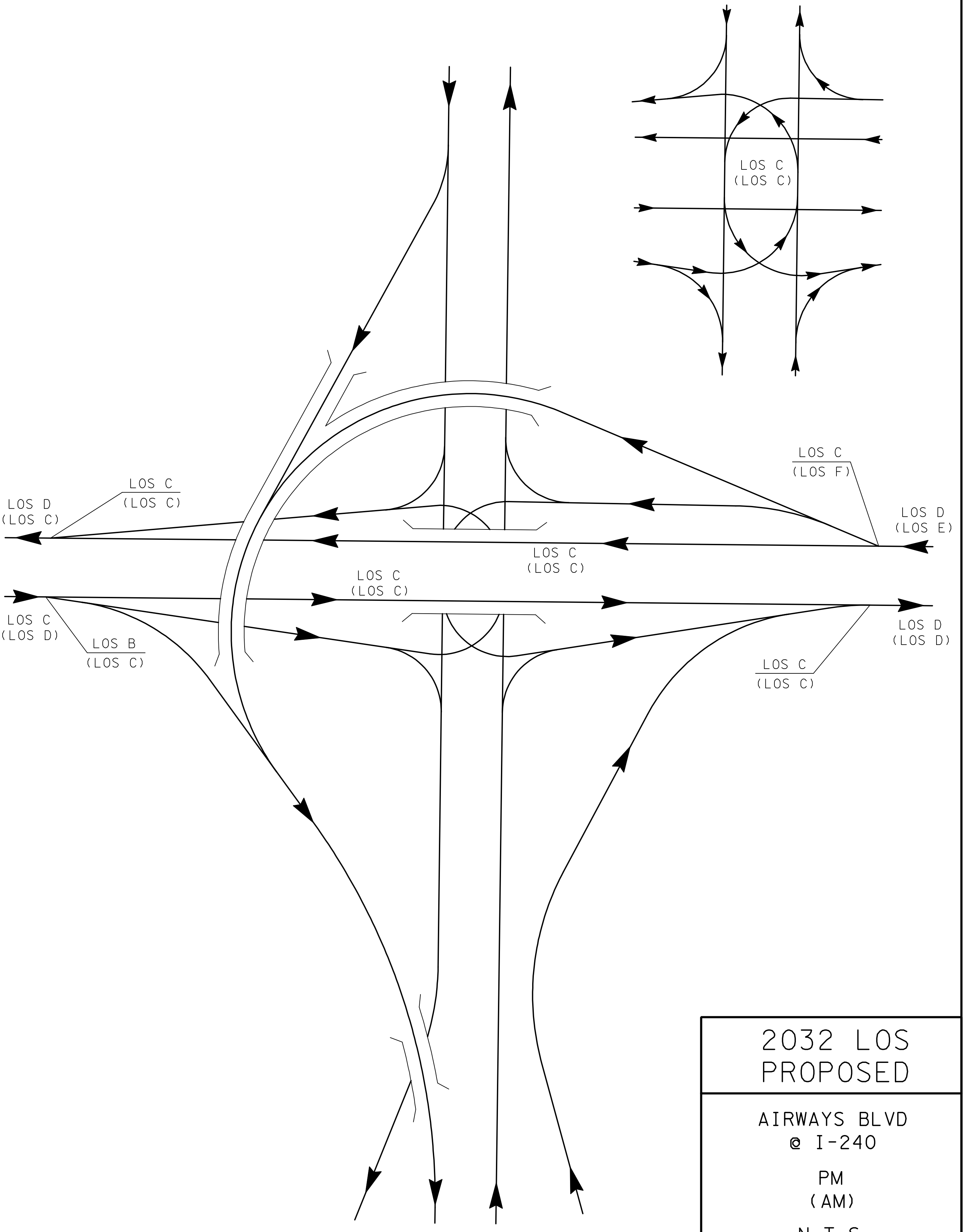


2012 LOS
PROPOSED

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.



2032 LOS PROPOSED

AIRWAYS BLVD
@ I-240

PM
(AM)

N.T.S.

APPENDIX C

COST ESTIMATES

COST DATA SHEET

PROJECT: I-240 & Airways Boulevard Interchange Modification Study
LOCATION: Shelby County, Memphis, Tennessee
LENGTH: --
CROSS SECTION: N.A.

RIGHT-OF-WAY

Land, Improvements & Damages	(# Acres	0.65)	$207,000	
Incidentals	(# Tracts	2)	$20,000	
Relocation Payments	(Residences	0)	$0	
	(Businesses	0)	$0	
	(Non-Profits	0)		
Total Right-Of-Way Cost				**$227,000**

UTILITY RELOCATION

Reimbursable	$142,000	
Non-Reimbursable	$0	
Total Utility Adjustment Cost		**$142,000**

CONSTRUCTION

Clear and Grubbing		$113,000	
Earthwork		$1,290,000	
Pavement Removal / Median Barrier		$697,000	
Drainage	(Erosion Control = $375,000)	$1,625,000	
Structures		$13,802,000	
Railroad Crossing		$0	
Paving		$3,428,000	
Retaining Walls		$2,725,000	
Maintenance of Traffic		$1,350,000	
Topsoil		$211,000	
Seeding		$432,000	
Sodding		$195,000	
Signing		$650,000	
Signalization		$75,000	
Fence		$5,000	
Guardrail		$63,000	
Rip-rap or Slope Protection		$38,000	
Other Construction Items (8.5%)		$1,096,000	
Mobilization		$1,014,000	
10% Engineering and Contigencies		$2,881,000	
Total Construction Cost			**$31,690,000**
Preliminary Engineering (10% of Constr.)			**$2,881,000**

TOTAL ESTIMATED COST $34,940,000

6/13/2007

I-240 & Airways Boulevard Interchange Modification Study
Cost Estimate
CEA Project No. 04020.11

	Area (ac)	Cost/Acre	Total Cost
Clearing & Grubbing	75.65	$1,500	**$113,475**

Earthwork	Length (ft)	Factor	Total (yd^3)	Cost / yd^3	
	1,900	15.5	29,450		
	900	60	54,000		
	1,800	16.3	29,340		
	500	36	18,000		
	800	6.2	4,960		
		Total:	135,750		
		Total Earthwork Cost:		$9.5	**$1,289,625**

	Length	Cost/lf	
Pavement Removal	22,380	$9	**$201,420**

	Length	Cost/lf	
Concrete Median Barrier	8,260	$60	**$495,600**

Drainage	**$1,250,000**
Erosion Control	**$375,000**

Structures

Bridges	Width	Length	Area	Cost/sf		
Over Single Point Intersection	150	240	36,000	$75		$2,700,000
Fly-Over Structure	-	-	57,822	$100		$5,782,200
New Structure over Nonconnah Creek	60	445	26,700	$75		$2,002,500
New Structure over SB Airways	60	286	17,160	$75		$1,287,000
Widen Existing Structure on Airways	30	530	15,900	$75		$1,192,500
Bridge Rail		0	ft	$100.00	per ft.	$0

Demolition	Width	Length	Area	Cost/sf	
EB I-240 Structure #1	60	200	12,000	$15	$180,000
EB I-240 Structure #2	54	105	5,670	$15	$85,050
WB I-240 Structure	94	200	18,800	$15	$282,000
EB Ramp to SB Airways/Plough (over Nonconnah)	30	430	12,900	$15	$193,500
Structure over Airways	30	215	6,450	$15	$96,750
			Total Demolition Cost:		**$837,300**
			Total Structure Cost:		**$13,801,500**

Fence

Length	Cost	
500	$10	**$5,000**

Paving

	Length	Cost		
Mainline I-240	6,800	$200		$1,360,000
Fly-over Ramp	3,000	$145		$435,000
Single Point Ramps	7,500	$115		$862,500
Ramp to EB I-240	2,500	$100		$250,000
Plough	2,000	$80		$160,000
Airways	3,000	$120		$360,000
			Total Paving Cost:	**$3,427,500**

Retaining Walls

Retaining Wall	Height	Length	Area	Cost/sf	
EB I-240	10	1,245	12,450	$65	$809,250
WB I-240	10	1,015	10,150	$65	$659,750
WB to Fly-Over Ramp	15	785	11,775	$85	$1,000,875
SB to Fly-Over Ramp	5	215	1,075	$50	$53,750
South of Nonconnah	10	310	3,100	$65	$201,500
			Total Retaining Wall Cost:		**$2,725,125**

Maintenance of Traffic **$1,350,000**

Topsoil

Length	Factor	Total	Cost per	
6,000	6.778	40,668	$4.00	**$162,672**
3,600	3.389	12,200	$4.00	**$48,802**

Seeding

Length	Factor	Total	Cost per	
3,600	7.500	0	$16.00	**$432,000**

Sodding

Length	Factor	Total	Cost per	
6,000	6.500	0	$5.00	**$195,000**

Signing **$650,000**

Signalization **$75,000**

Guardrail

Number of Terminals	Cost	
14	$1,500	$21,000

Length of rail	3,200	ft	$13	$41,600
			Total Guardrail:	**$62,600**

Rip-Rap

Length		Cost	
2,500	Tons	$15	**$37,500**

Right-of-Way

			Cost/acre	Cost			
Total acreage	0.7	acres	$150,000	$97,500			
Slope Easmt.	0.0	acres	$15,000	$0			
Const. Easmt.	0.0	acres	$10,000	$0			
			Total	$97,500	Factor	146%	$142,350
No. of Tracts	2	Cost/tract	$10,000				$20,000
Relocate 0 Businesses			0	@	$100,000		$0
Relocate 0 Residences			0	@	$10,000		$0
Parking Lot Damages					$65,000		$65,000

Total Right-of-Way Cost: **$227,350**

Utilities

Reimbursable

	Length (ft)		Cost/ft	Total Cost
8" Water	1,300		$30	$39,000
6" Gas	1,300		$40	$52,000
			Cost/each	
Electric	15	Poles	$2,000	$30,000
Telephone	15	Poles	$1,400	$21,000

Total Reimbursable **$142,000**

Non-Reimbursable

	Length (ft)		Cost/ft	Total Cost
6" Water	0		$22	$0
6" Gas	0		$40	$0
			Cost/each	
Electric	0	Poles	$2,000	$0
Telephone	0	Poles	$1,400	$0

Total Non-Reimbursable **$0**

Total Utility Cost: **$142,000**

APPENDIX D

FUNCTIONAL PLANS

TENNESSEE D.O.T.
DESIGN DIVISION
FILE NO.

Index Of Sheets

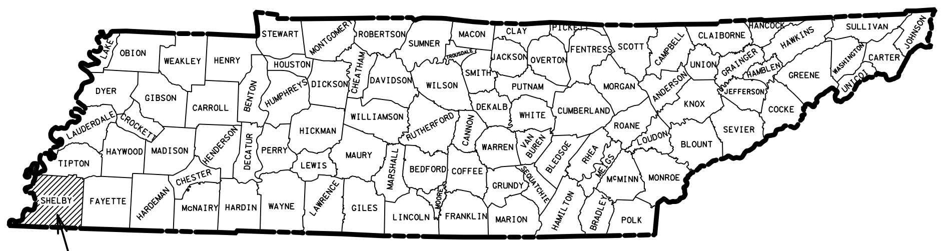
STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING

TENN.	YEAR	SHEET NO.
	2008	1
FED. AID PROJ. NO.		
STATE PROJ. NO.		

SHELBY COUNTY

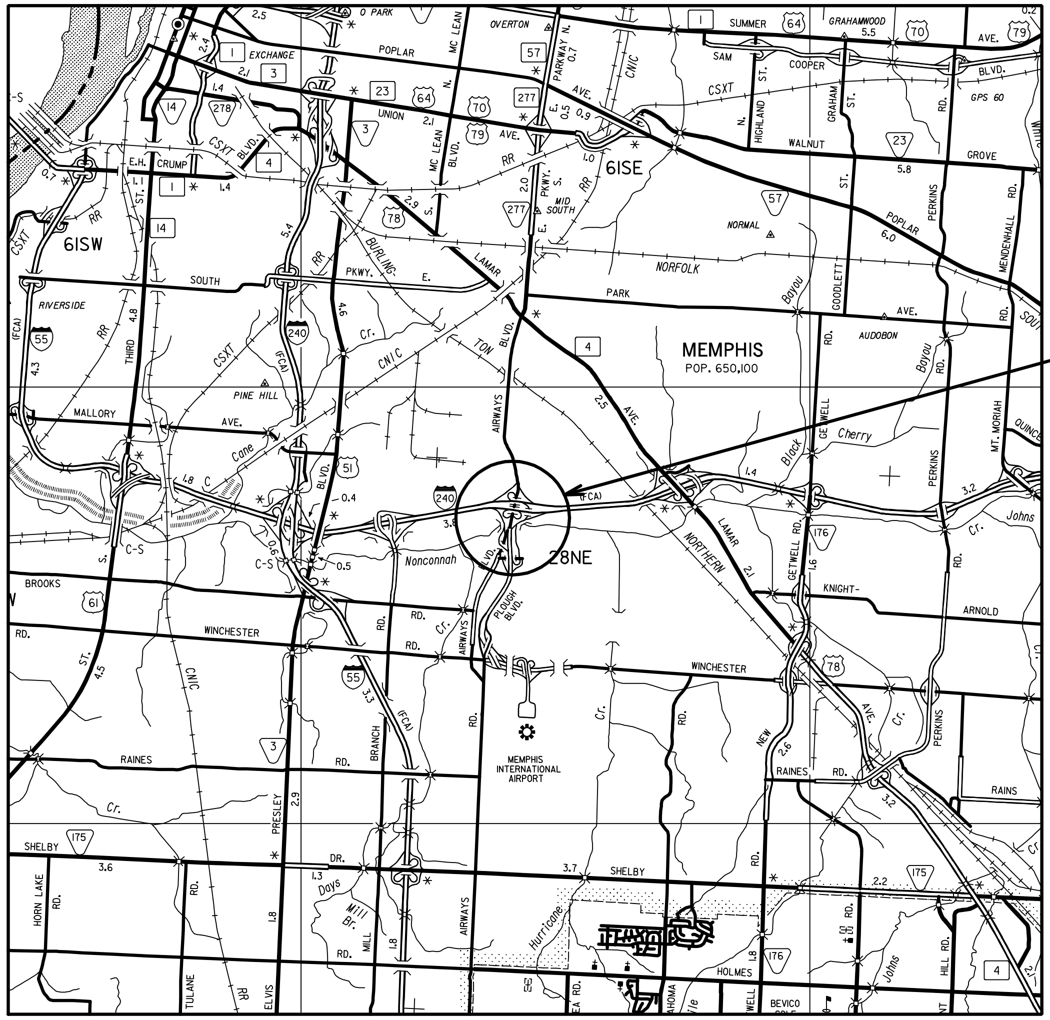
INTERSTATE 240
& AIRWAYS BLVD.
INTERCHANGE MODIFICATION STUDY

STATE HIGHWAY NO. 240 F.A.H.S. NO. 240



PROJECT LOCATION

NOTE: SIGNAGE INCLUDED IN THESE PLANS IS ONLY A VISUAL AID AND IS NOT INTENDED AS AN ACTUAL SIGNING PLAN.



SCALE: 1"= 1 MILE

PROJECT LOCATION

TRAFFIC DATA	
INTERSTATE 240	
ADT (2012)	161,590
ADT (2032)	171,260
DHV (2032)	13,701
D	52 - 48
T (ADT)	11 %
T (DHV)	7 %
V	55 MPH

TRAFFIC DATA	
AIRWAYS BLVD.	
ADT (2012)	47,840
ADT (2032)	57,420
DHV (2032)	5,742
D	54 - 46
T (ADT)	6 %
T (DHV)	4 %
V	45 MPH

APPROVED:

CHIEF ENGINEER

DATE:

APPROVED:

COMMISSIONER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED:

DIVISION ADMINISTRATOR DATE

SPECIAL NOTES

PROPOSALS MAY BE REJECTED BY THE COMMISSIONER IF ANY OF THE UNIT PRICES CONTAINED THEREIN ARE OBVIOUSLY UNBALANCED, EITHER EXCESSIVE OR BELOW THE REASONABLE COST ANALYSIS VALUE.

THIS PROJECT TO BE CONSTRUCTED UNDER THE STANDARD SPECIFICATIONS OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION DATED MARCH 1, 2006 AND ADDITIONAL SPECIFICATIONS AND SPECIAL PROVISIONS CONTAINED IN THE PLANS AND IN THE PROPOSAL CONTRACT.

DESIGNER CLINARD ENGINEERING ASSOCIATES, LLC. CHECKED BY THOMAS M. CLINARD, PE

P.E. NO.

PIN NO.

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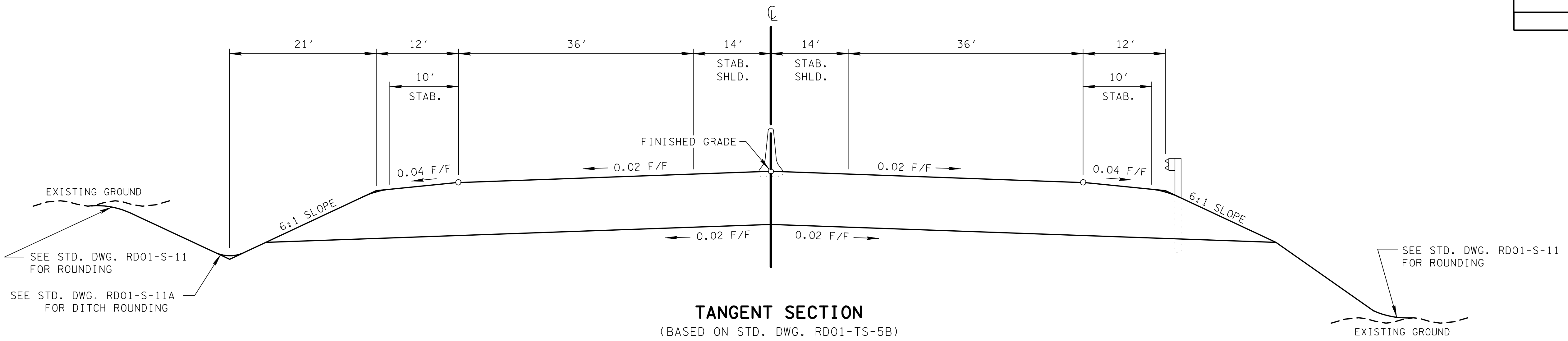
TENNESSEE D.O.T.
DESIGN DIVISION
FILE NO.

TYPE	YEAR	PROJECT NO.	SHEET NO.
IMS	2008		2



TANGENT SECTION
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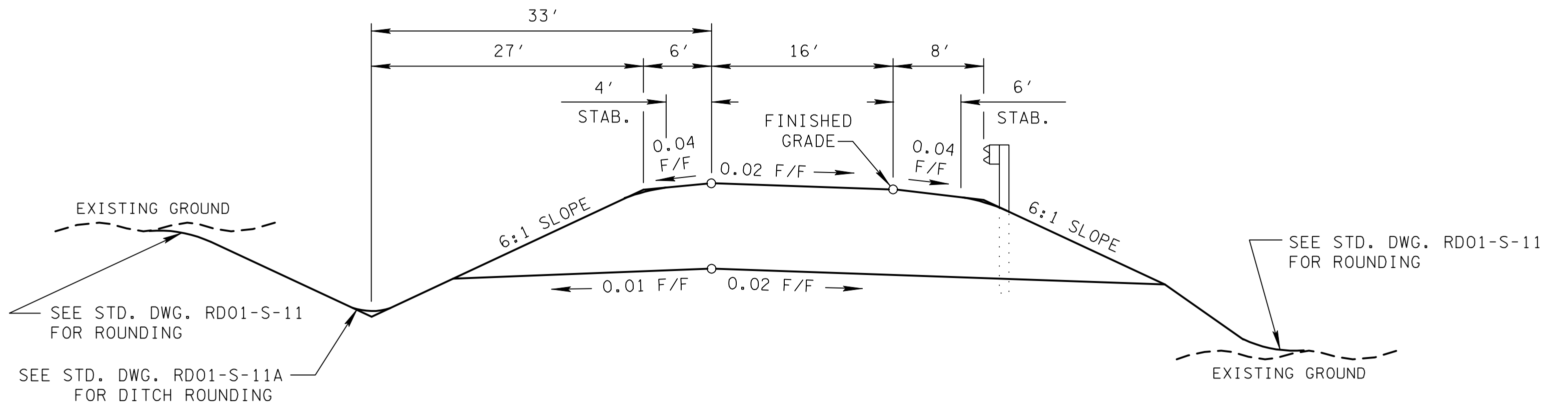
INTERSTATE 240 MAINLINE



TANGENT SECTION
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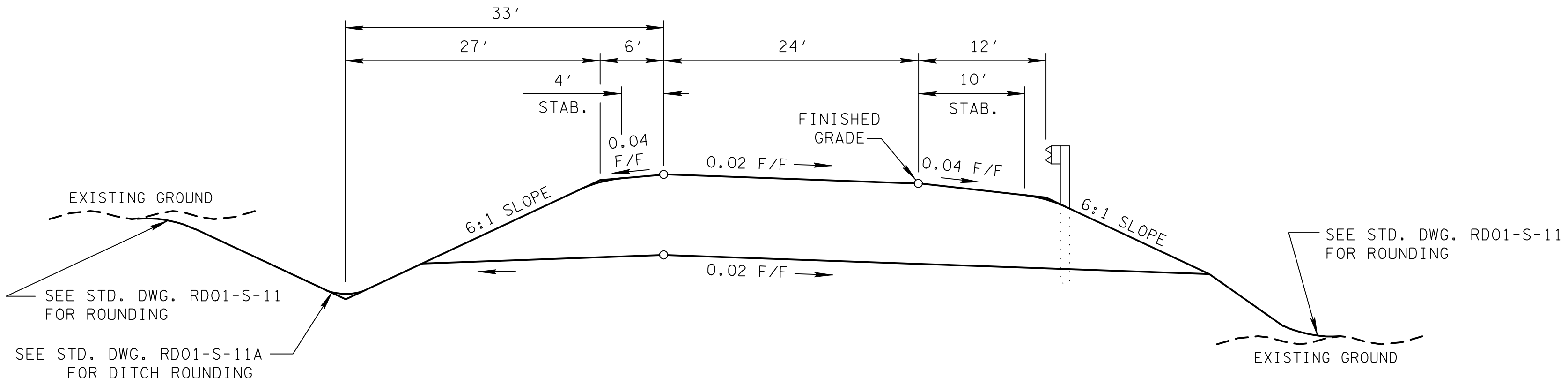
EASTBOUND I-240 ENTRANCE RAMP FROM NORTHBOUND PLOUGH BLVD
WESTBOUND I-240 EXIT RAMP TO SOUTHBOUND PLOUGH BLVD



TANGENT SECTION
(BASED ON STD. DWG. RD01-TS-4)
SINGLE POINT INTERCHANGE RAMPS
SOUTHBOUND AIRWAYS BLVD TO PLOUGH BLVD RAMP

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

TYPICAL SECTIONS

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TENNESSEE D.O.T.
DESIGN DIVISION
FILE NO.

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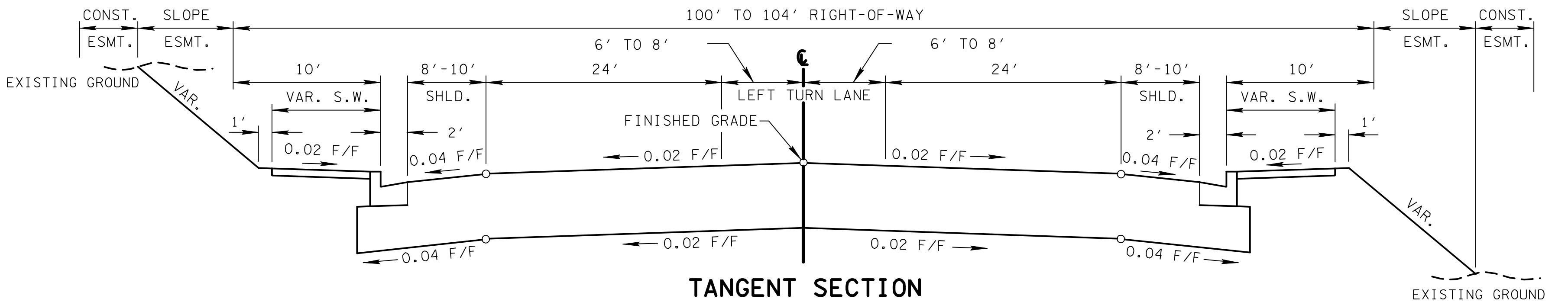

TANGENT SECTION
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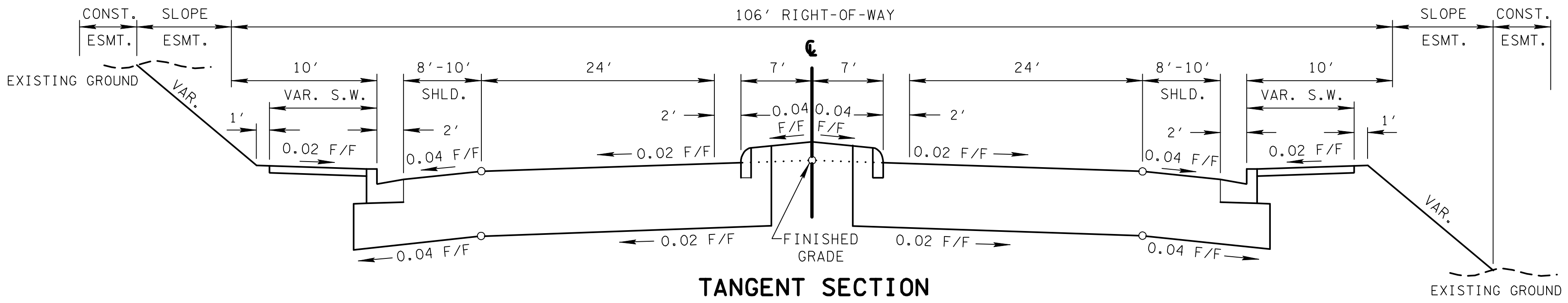
AIRWAYS BOULEVARD



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AIRWAYS BOULEVARD

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STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

TYPICAL SECTIONS

TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

TYPE	YEAR	PROJECT NO.	SHEET NO.
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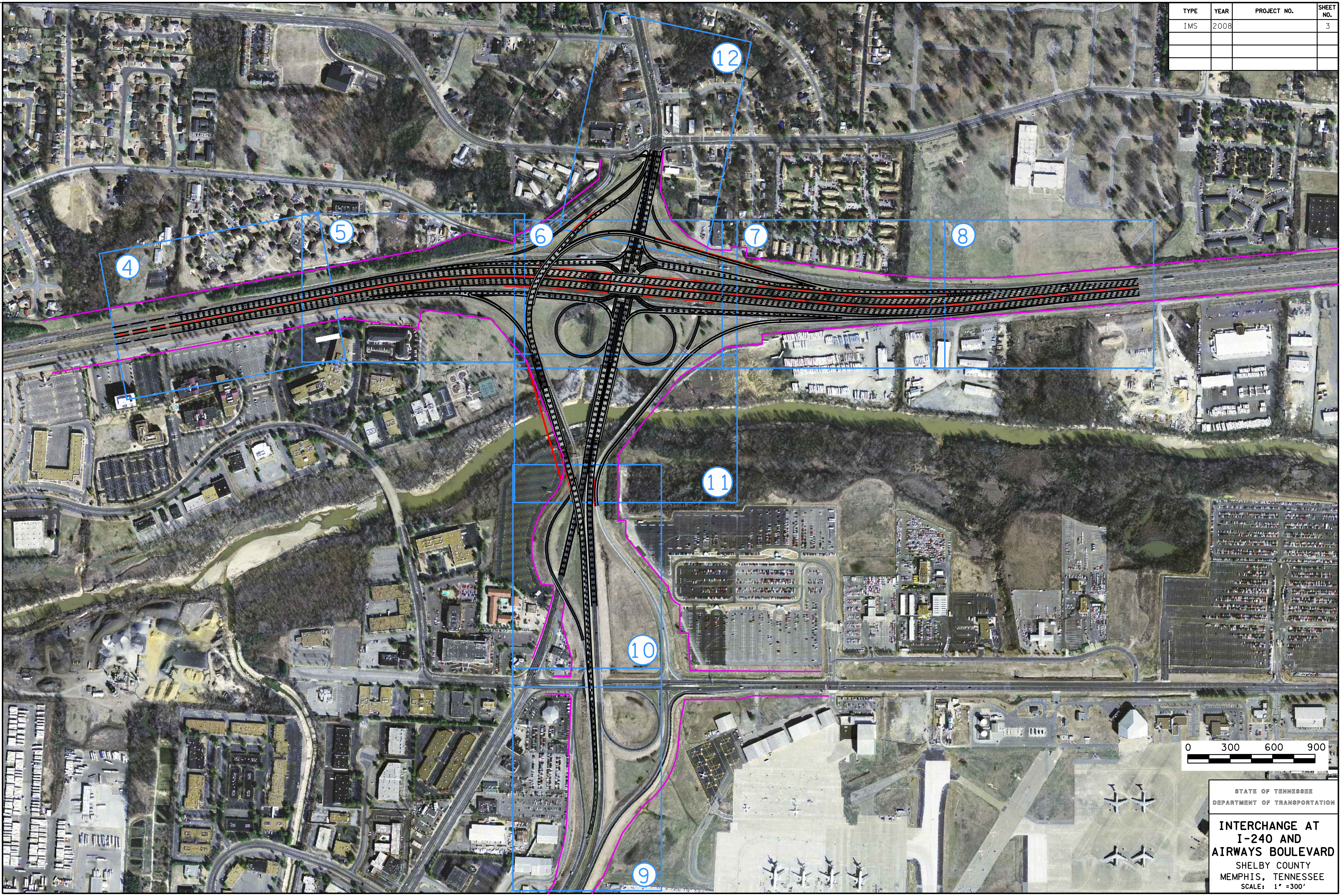

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT I-240 AND AIRWAYS BOULEVARD

SHELBY COUNTY
MEMPHIS, TENNESSEE
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TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

TYPE	YEAR	PROJECT NO.	SHEET NO.
IMS	2008		4

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

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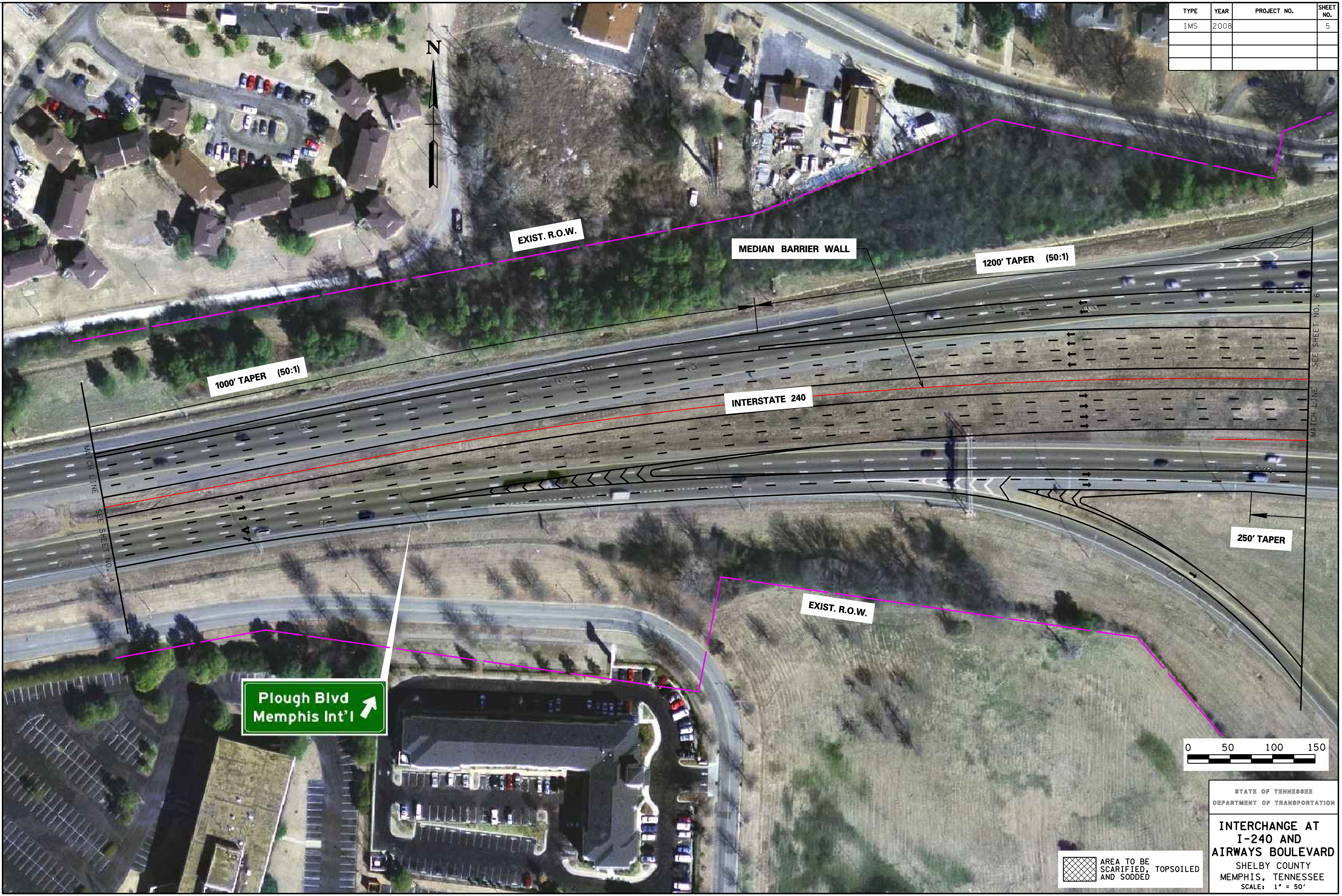

▨ AREA TO BE SCARIFIED, TOPSOILED AND SODDED

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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TENNESSEE D.O.T.
DESIGN DIVISION
FILE NO.

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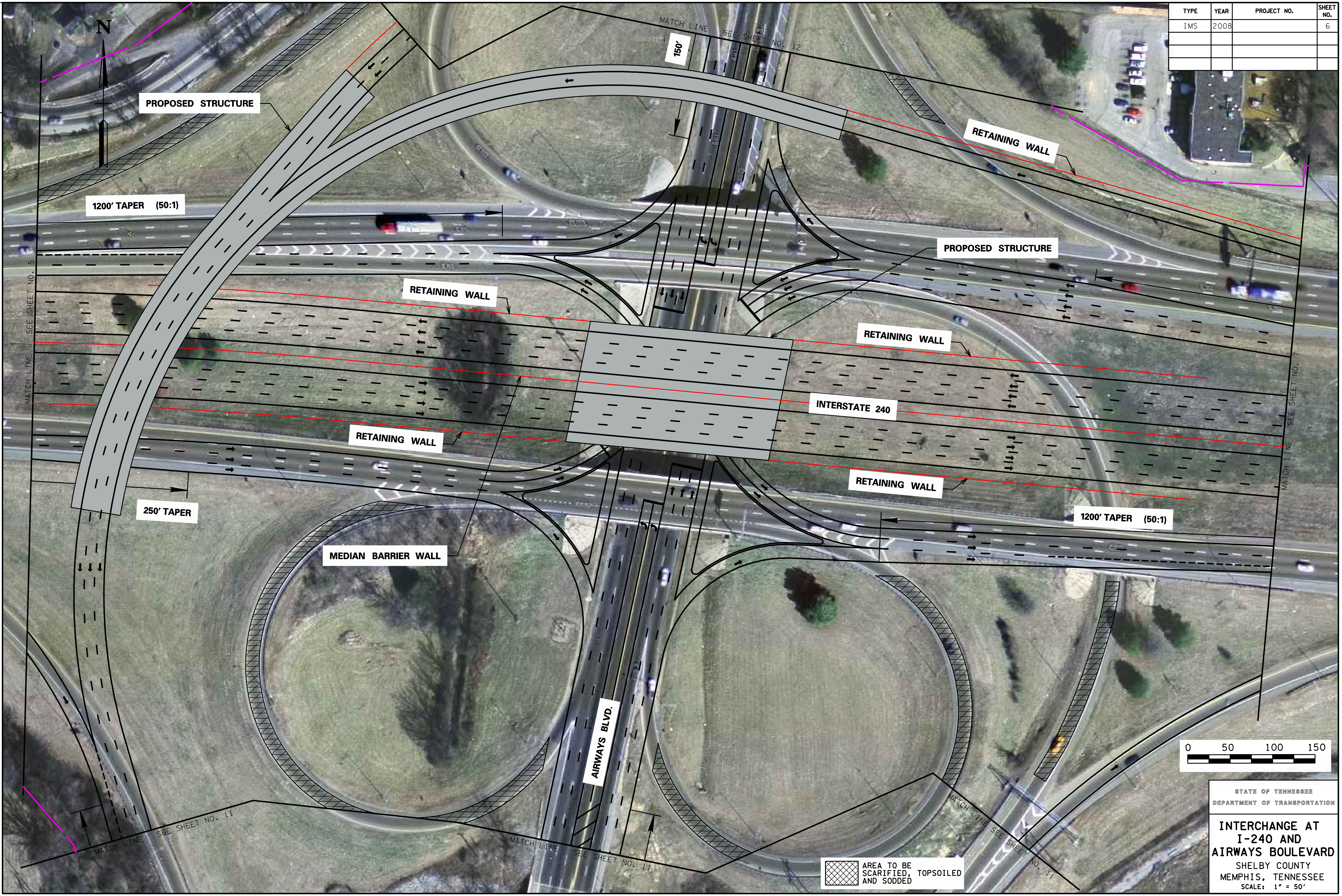

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT I-240 AND AIRWAYS BOULEVARD

SHELBY COUNTY
MEMPHIS, TENNESSEE
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TENNESSEE D.O.T.
DESIGN DIVISION

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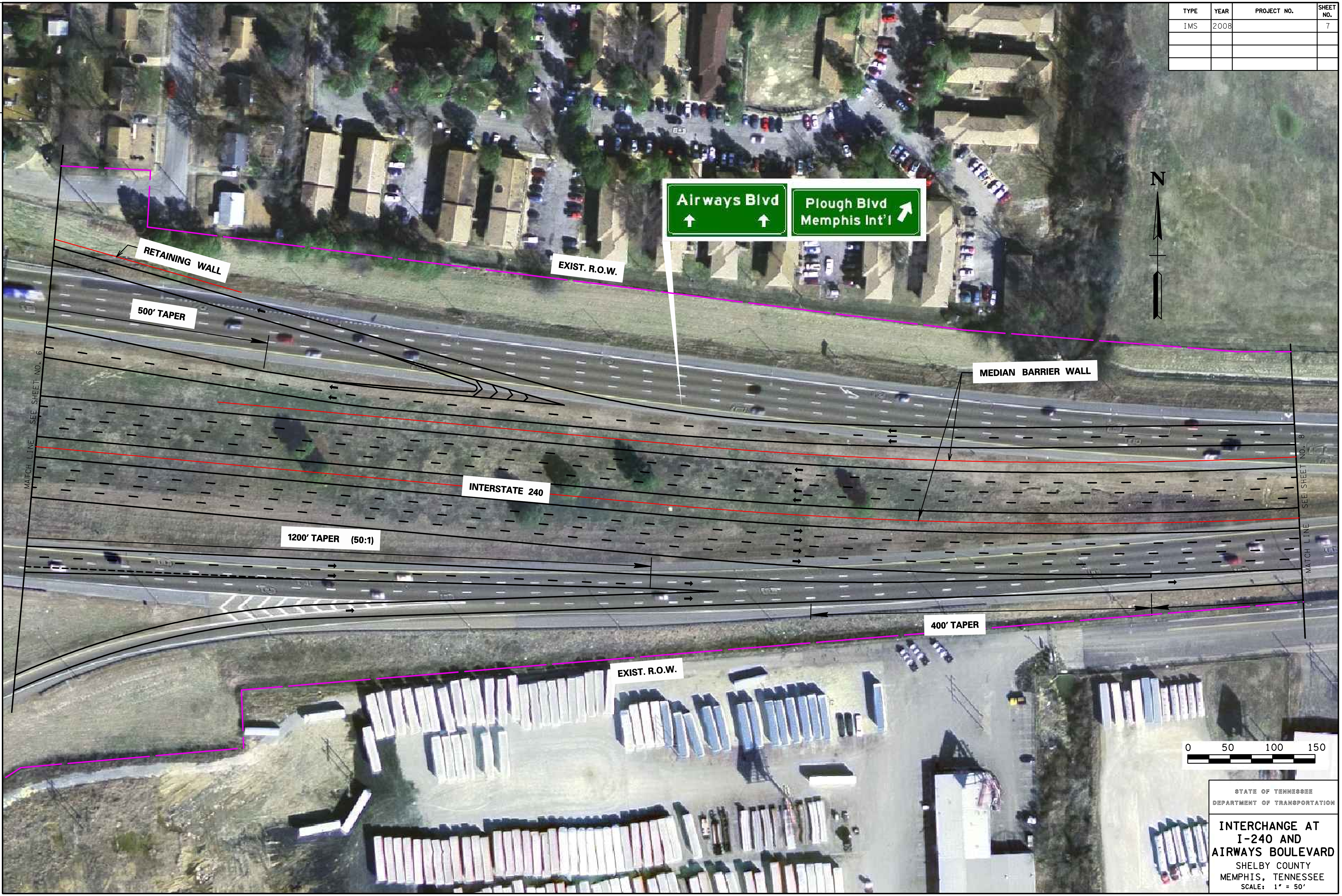

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT I-240 AND AIRWAYS BOULEVARD

SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

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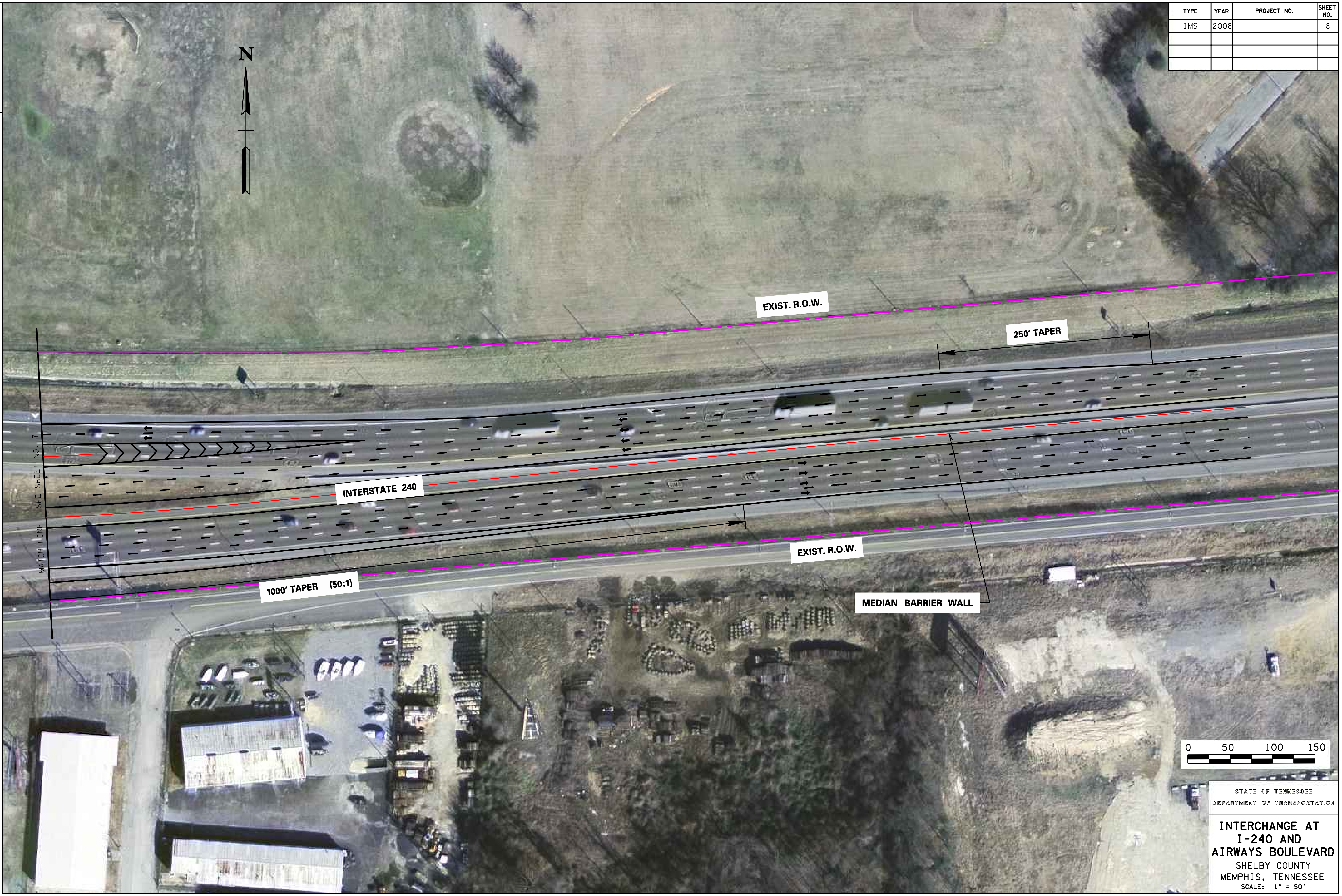

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

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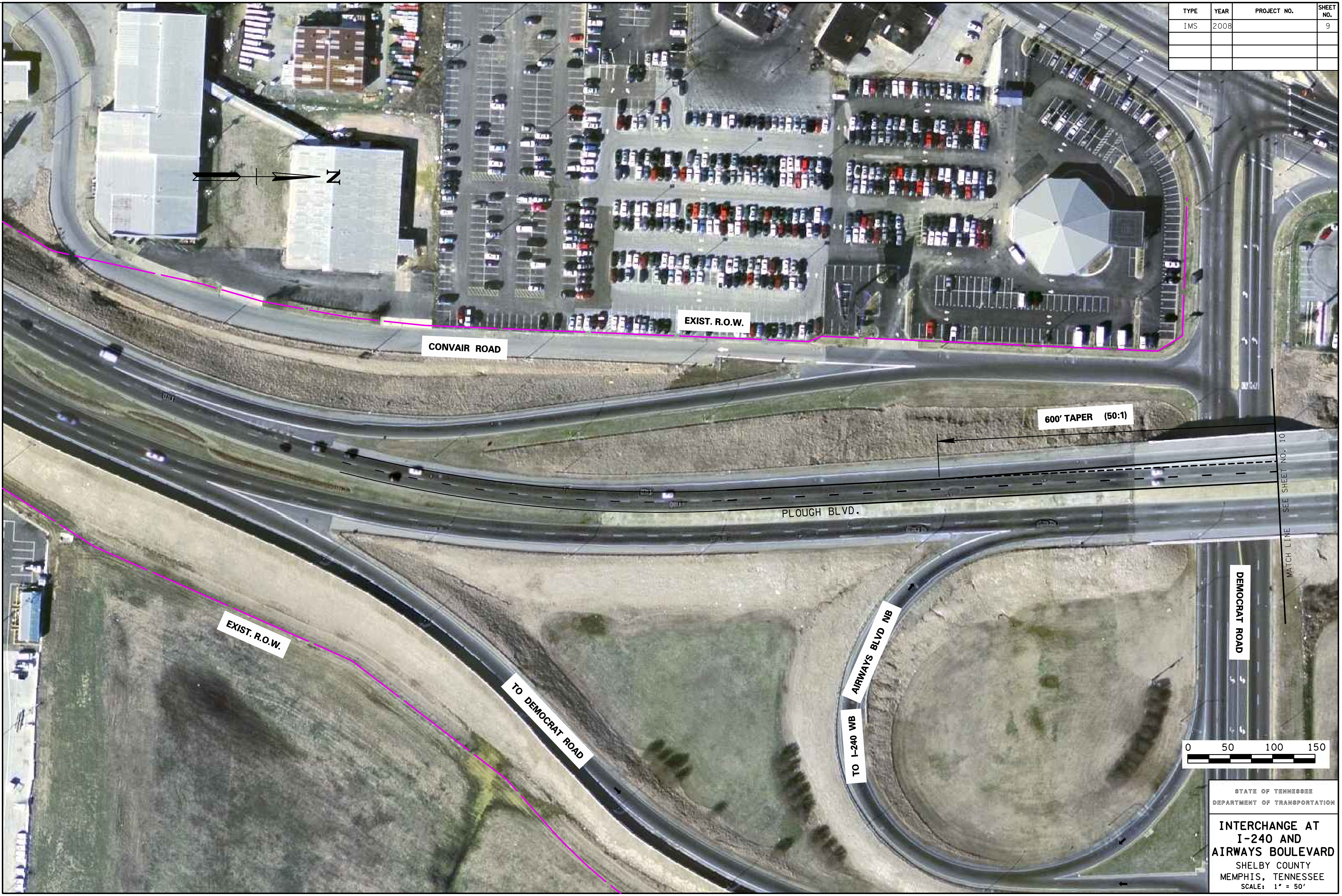

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD

SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

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IMS	2008		10

▨ AREA TO BE SCARIFIED, TOPSOILED AND SODDED

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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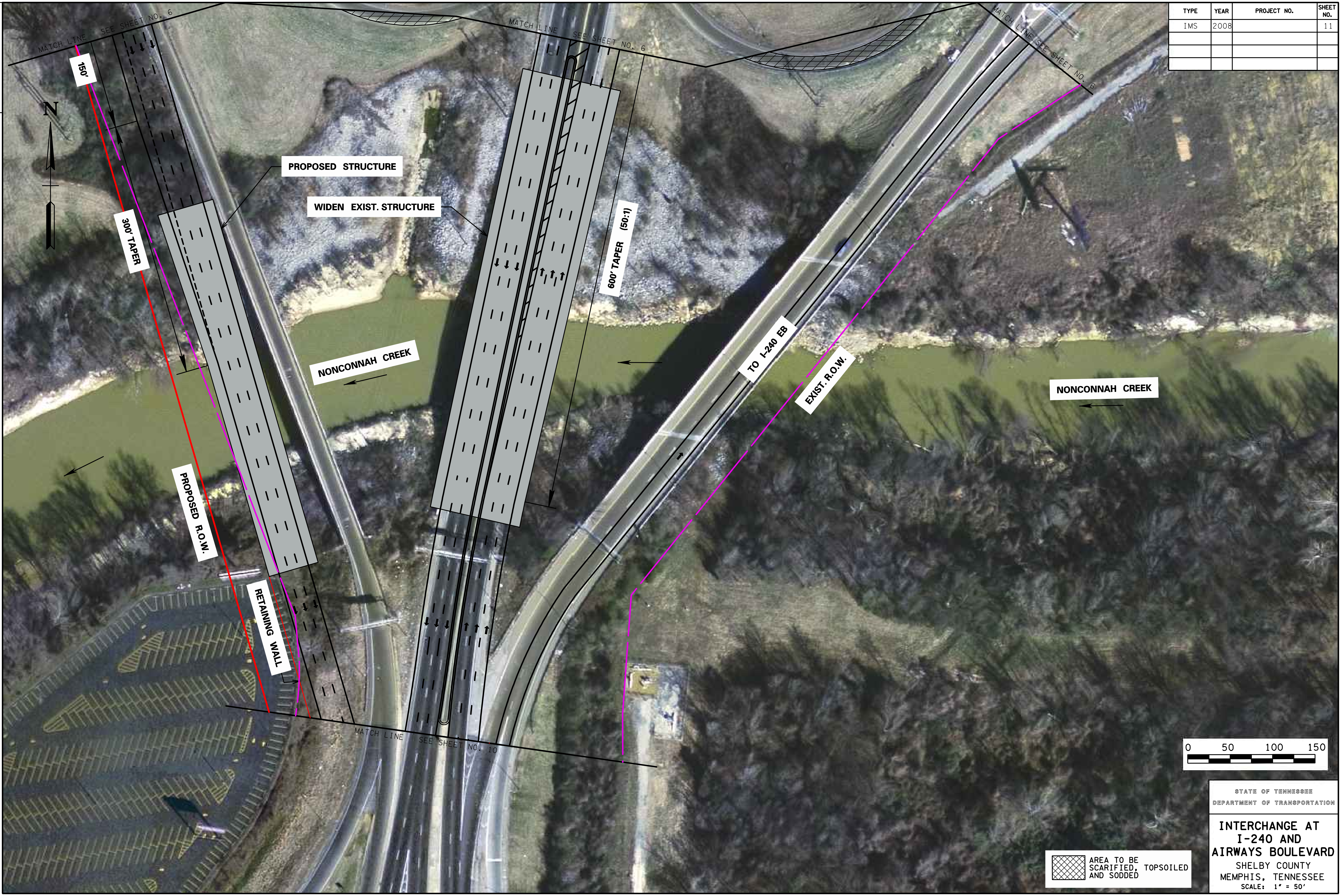
TENNESSEE D.O.T.
DESIGN DIVISION
FILE NO.



▨ AREA TO BE SCARIFIED, TOPSOILED AND SODDED

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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TENNESSEE D.O.T.
DESIGN DIVISION

FILE NO.

TYPE	YEAR	PROJECT NO.	SHEET NO.
IMS	2008		12

▨ AREA TO BE SCARIFIED, TOPSOILED AND SODDED

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

INTERCHANGE AT
I-240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE
SCALE: 1" = 50'

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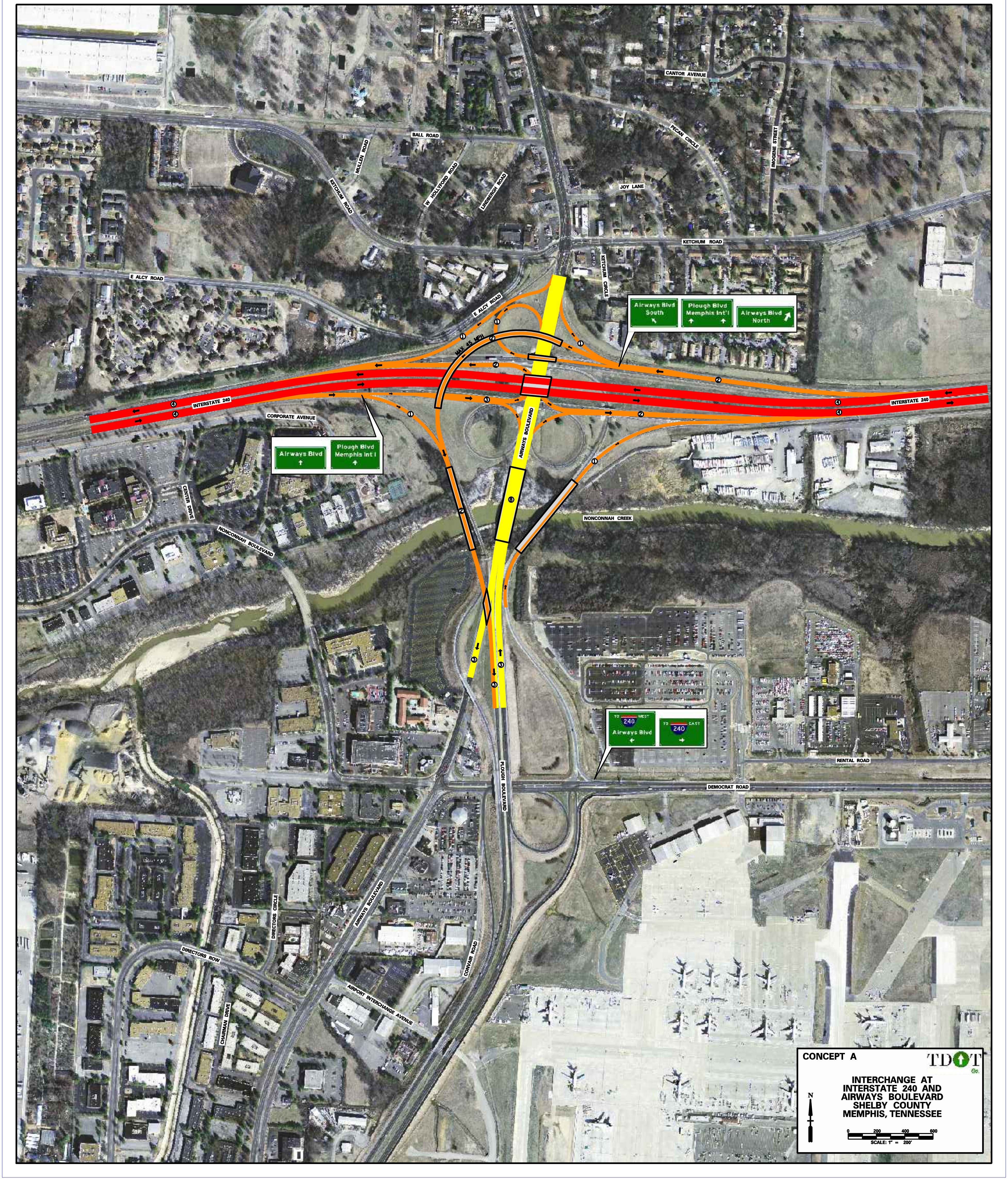
APPENDIX E

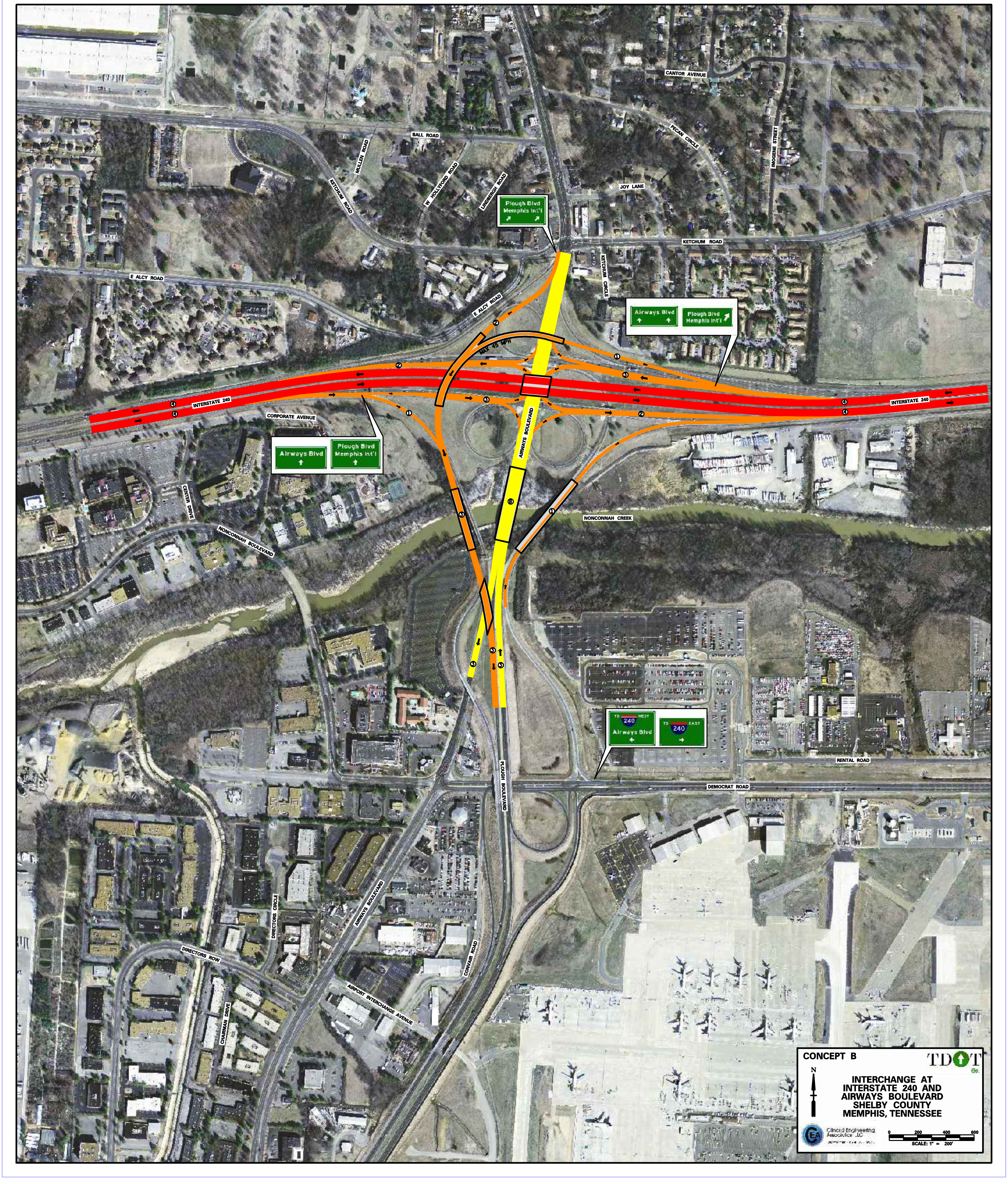
CONCEPTS INVESTIGATED



CONCEPT A

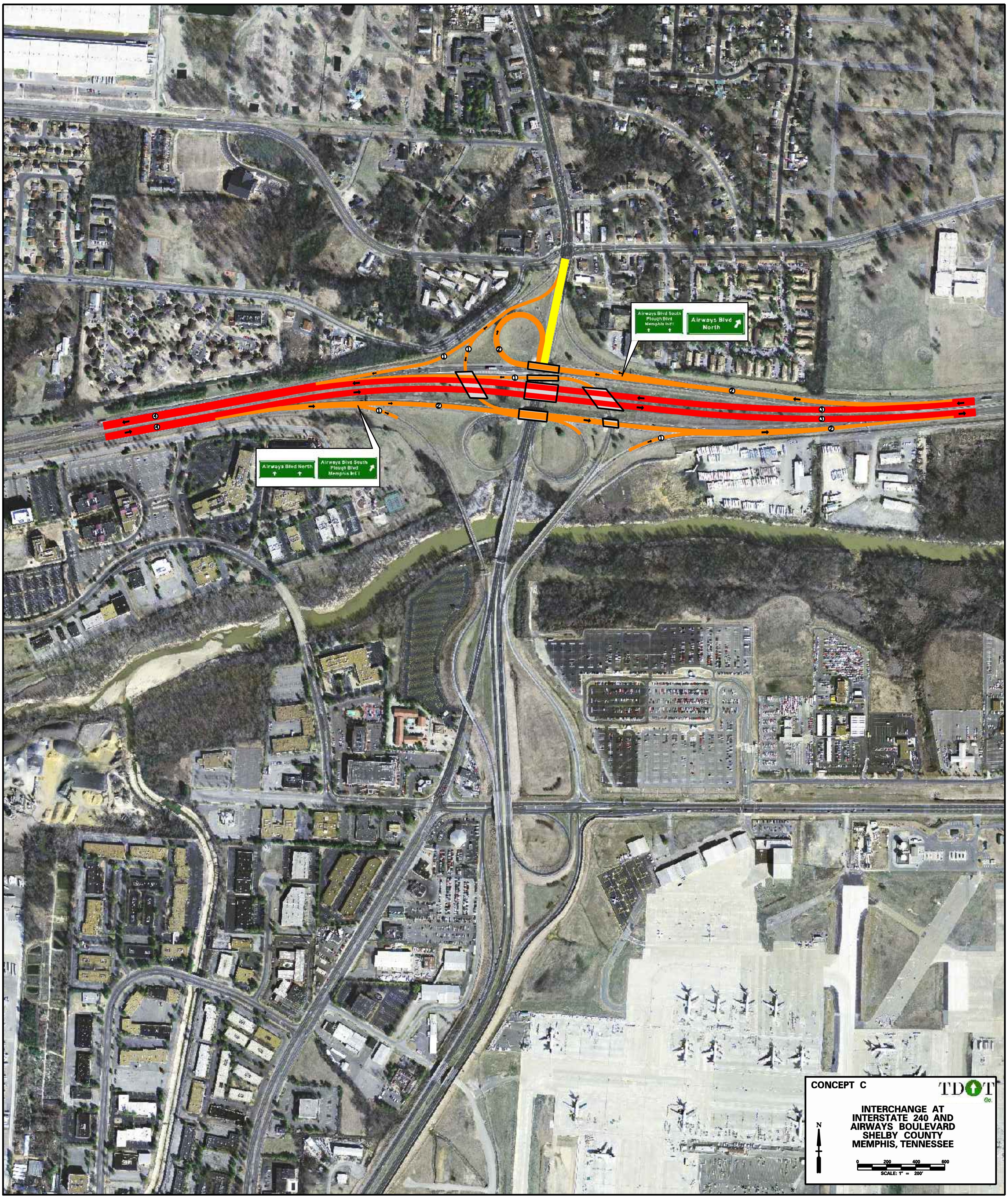
TDOT
Go.

**INTERCHANGE AT
INTERSTATE 240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE**



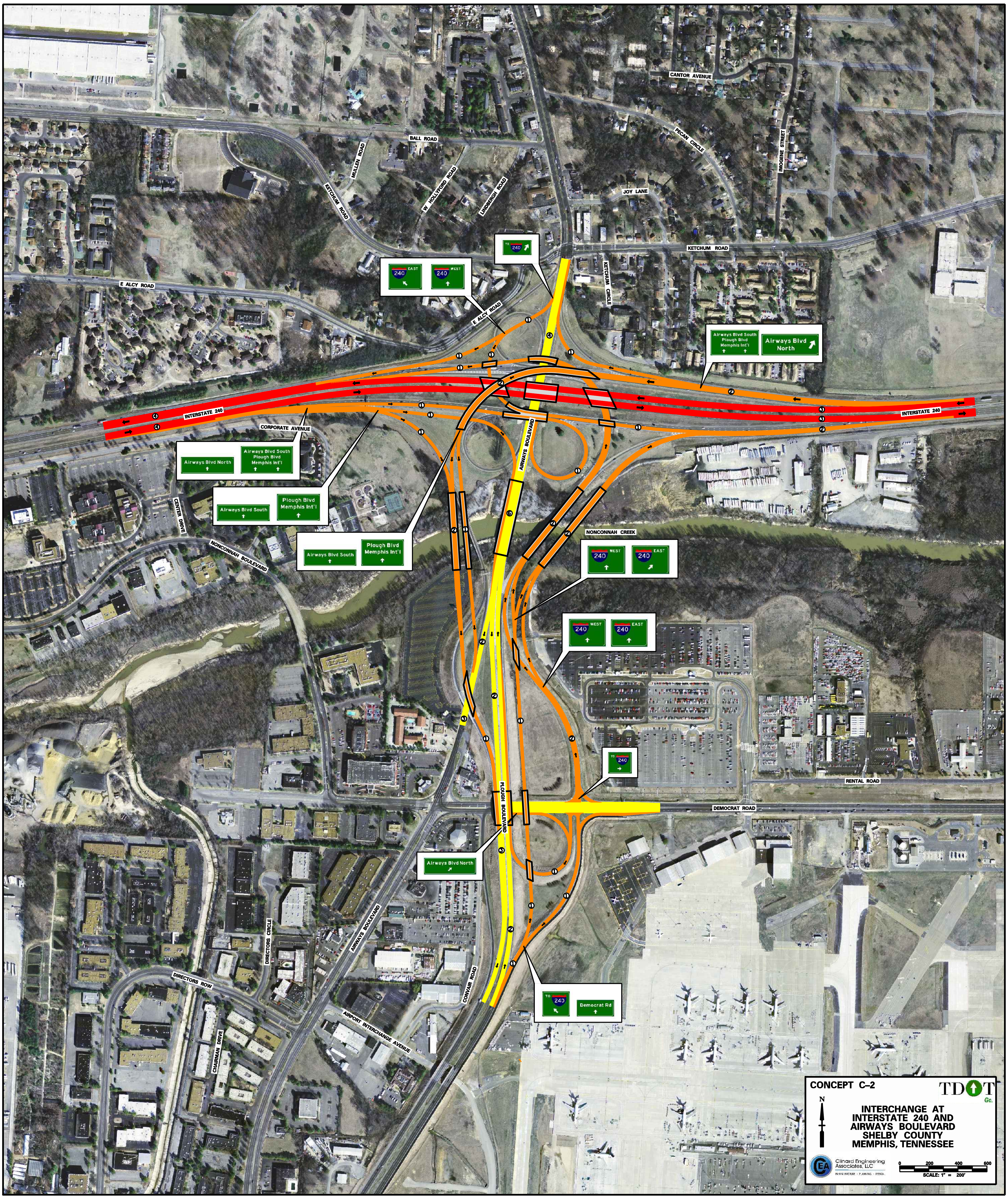
CONCEPT B

INTERCHANGE AT
INTERSTATE 240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE



CONCEPT C

**INTERCHANGE AT
INTERSTATE 240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE**



CONCEPT C–2

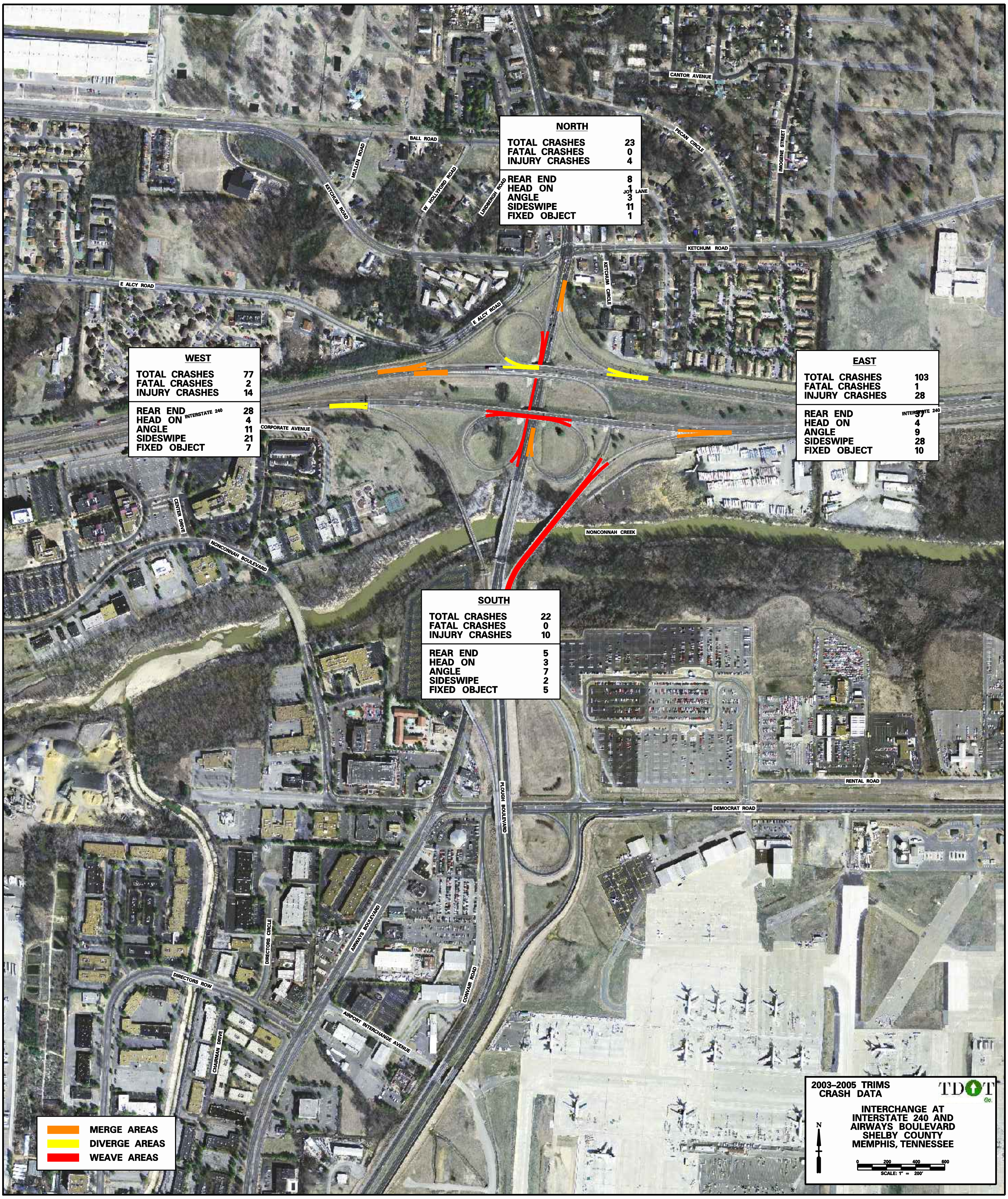
TDOT Go.

INTERCHANGE AT
INTERSTATE 240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE

Clinard Engineering Associates, LLC
INFRASTRUCTURE • PLANNING • DESIGN

APPENDIX F

MEETING HAND-OUTS & NOTES / BACKGROUND INFO



NORTH

TOTAL CRASHES	23
FATAL CRASHES	0
INJURY CRASHES	4
REAR END	8
HEAD ON	1
ANGLE	3
SIDESWIPE	11
FIXED OBJECT	1

WEST

TOTAL CRASHES	77
FATAL CRASHES	2
INJURY CRASHES	14
REAR END	28
HEAD ON	4
ANGLE	11
SIDESWIPE	21
FIXED OBJECT	7

EAST

TOTAL CRASHES	103
FATAL CRASHES	1
INJURY CRASHES	28
REAR END	37
HEAD ON	4
ANGLE	9
SIDESWIPE	28
FIXED OBJECT	10

SOUTH

TOTAL CRASHES	22
FATAL CRASHES	0
INJURY CRASHES	10
REAR END	5
HEAD ON	3
ANGLE	7
SIDESWIPE	2
FIXED OBJECT	5

🟧	MERGE AREAS
🟨	DIVERGE AREAS
🟥	WEAVE AREAS

2003–2005 TRIMS
CRASH DATA

INTERCHANGE AT
INTERSTATE 240 AND
AIRWAYS BOULEVARD
SHELBY COUNTY
MEMPHIS, TENNESSEE

Interstate 240 & Airways Boulevard Interchange
Interchange Modification Study (IMS)

Wednesday, April 18, 2007
1:00 p.m.

Location:
City of Memphis
City Hall 4th Floor, Conference Room C

AGENDA

---

1. Introductions and Meeting Objectives
2. Overview of Project Area
3. Review Traffic Data and Crash History
4. Discussion of Concepts Developed (Updated)
5. Questions & Answers
6. Adjourn

If you have any questions or comments, please contact:
Tom Clinard, PE
Clinard Engineering Associates, LLC
Phone: (615) 370-6079 ● E-mail: tclinard@clinardengineering.com

Memphis Business Journal - October 5, 1998
http://memphis.bizjournals.com/memphis/stories/1998/10/05/story7.html

Memphis Business Journal

Depot Group Seeks Interchange Improvement for I-240/Airways

Memphis Business Journal - October 2, 1998 by Theresa Bechard

The old Defense Depot property has the potential to become a central-city industrial hub, but to make that happen its managers want better roads capable of handling up to 1,000 trucks a day.

That's 10 times the volume the roadways were originally designed for.

The Depot Redevelopment Corp.of Memphis and Shelby County presented its proposition to improve the interchange at I-240 and Airways to the Memphis Metropolitan Planning Organization (MMPO) last week.

More truck traffic is expected to cause complications at the interchange as the remaining space at the Memphis Defense Depot is leased for manufacturing and distribution purposes.

"We were raising the red flag that this is a situation that needs attention," says Depot Redevelopment Corp. president Jim Covington. "It's an upgrade that needs a lot of study. It's the front door to the airport.

"It's a convenience and we market our facility on the fact that it's a mile away from the airport, and we want to continue that vein in a positive way."

The Memphis Defense Depot covers 640 acres and has 5.5 million square feet under roof. As space continues to be leased at the complex, the truck traffic from the Depot will present a problem that needs attention, says Covington.

When the interchange was constructed in the 1960s, traffic was not conceived to be the way it is today.

"The intersection needs to be realigned so that the configuration of the intersection is safer for trucks to use," says Gene Burr, project manager for planning for the Depot Redevelopment Corp. "Right now, it's too tight, and there have been a number of accidents at the intersection of Airways and Ketchum."

The Memphis Defense Depot is located on Airways about a mile north of I-240 and is also close to I-55. The close proximity to these highways is one of the major draws that the Depot Redevelopment Corp. has been using to market the facility. But traffic problems in that area have given them reason to worry about losing future leasees.

"We're trying to use Airways and Dunn Ave. for truck traffic," says Burr. "In the short term, we recognize that that is something that the city needs to take care of.

"Any problems are bound to interfere with our leasing prospects," he says.

When the Memphis Defense Depot was fully operational, 100-200 trucks passed through per day. Today, just one of the Depot's tenants, McAuley's, Inc., has 30 to 40 trucks pass through per day.

Covington points out that with this one company, the Depot is already handling one-third of the traffic volume the site was experiencing during the Persian Gulf War, and this truck volume is expected to grow.

"In doing our plan we had some consultants estimate 1,000 trucks a day for industry at the Depot," says Covington. "Our fear is that we're just going to complicate that interchange. What we don't want is gridlock on an interchange like that."

Gene Bryan, MMPO coordinator, says since the request for improvements to the interchange was just submitted last week, it will be a while before a decision is made.

"The MMPO may vote to add it to the major road plans, but until we can determine an exact funding source it would be very difficult to pin down a time," says Bryan.

Although the MMPO has not yet determined if it will add the Depot Redevelopment Corp.'s request for the interchange improvements to their list of road plans, Covington sees the redevelopment of the Depot as a 15-year project and says that the MMPO was very receptive.

(Staff Writer Theresa Bechard can reached at 523-1000, ext. 636, or via e-mail at theresab@mem.net.)

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Memphis Business Journal - April 10, 2007
http://memphis.bizjournals.com/memphis/stories/2007/04/09/daily16.html

Memphis Business Journal

Airport to build $48M ground transportation center

Memphis Business Journal - 2:33 PM CDT Tuesday, April 10, 2007

Memphis-Shelby County Airport Authority will build a $48 million, 78-acre ground transportation center near Memphis International Airport.

Located on the corner of Winchester and Airways, the center will house rental car companies, hotel shuttle buses and potentially transportation to the city's tourist attractions.

"The consolidation of the current rental facilities to the new center will enable the airport to provide better customer service for passengers, decrease emissions, reduce 80 percent of the bus traffic at the airport terminal and cut in half the travel time from baggage claim to the rental car lots," the authority said in its monthly newsletter.

Passengers will be transported to the center by bus.

To help finance the $48 million facility, the six rental car firms serving the airport will be charged a $4 per-transaction fee.

The new facility will take about 3 1/2 years to build. MSCAA will accept construction bids this summer. The goal is to complete the facility by 2011.

The airport also said Tuesday work on the road leading to the terminal is scheduled to be completed in November. The new inbound roadway will have three lanes, and its design will eliminate the traffic signal and intersection located just north of the parking garage.

In addition, parking lot C has been resurfaced and a new parking lot will open by the end of May, which will serve as a waiting area for vehicles that come to pick up arriving passengers.

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Interstate 240 I.M.S.
Interchange with Airways Boulevard
Memphis, Tennessee

Progress Meeting No. 2
April 18, 2007

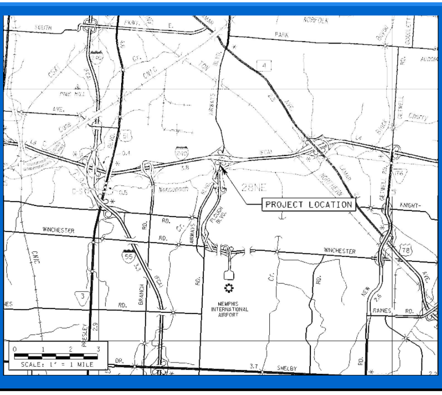
TDOT

AGENDA

- Project Overview
- Purpose & Need
- Study Area Development
- Current Transportation Plans
- Operational & Safety Characteristics
- Concepts For Improvements
- Next Steps

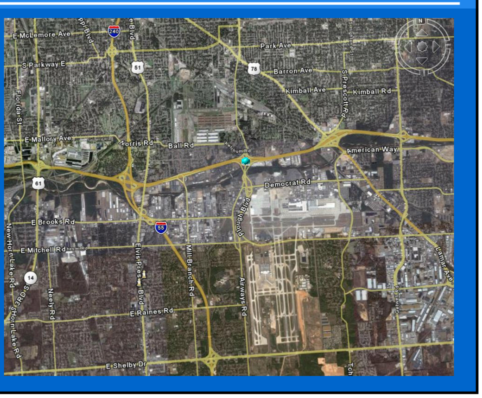
TDOT

PROJECT LOCATION



TDOT

PROJECT LOCATION



TDOT

GROUND TRANSPORTATION CENTER


Memphis Business Journal

BUSINESS PULSE SURVEY: Tax time

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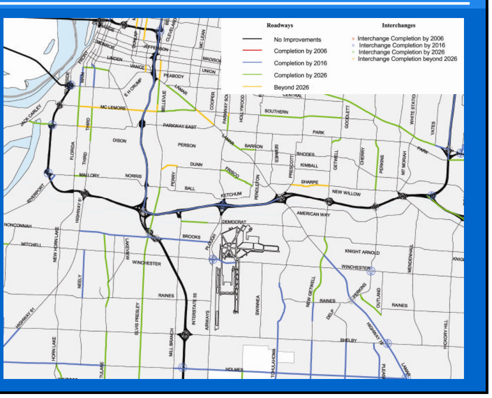
In addition, parking lot C has been resurfaced and a new parking lot will open by the end of May, which will serve as a waiting area for vehicles that come to pick up arriving passengers.

TDOT

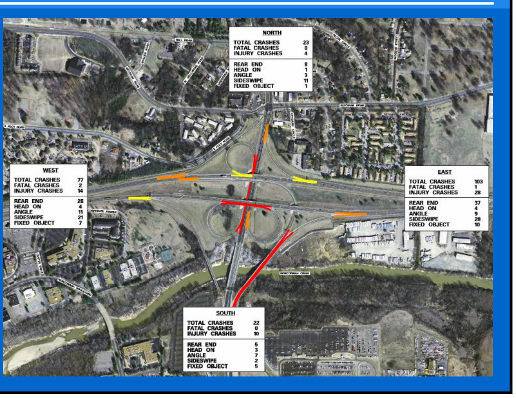
DEFENSE DEPOT SITE

TDOT

2026 LRTP NETWORK HORIZON YEAR



CRASH DATA



NORTH

TOTAL CRASHES	23
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INJURY CRASHES	4
REAR END	8
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SIDESWIPE	11
FIXED OBJECT	1

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FIXED OBJECT	7

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ANGLE	9
SIDESWIPE	28
FIXED OBJECT	10

SOUTH

TOTAL CRASHES	22
FATAL CRASHES	0
INJURY CRASHES	10
REAR END	5
HEAD ON	3
ANGLE	7
SIDESWIPE	2
FIXED OBJECT	5

EXISTING SYSTEM LOS

Existing Freeway Analysis (4)

Location	2012 AM	2012 PM	S. Life	2032 AM	2032 PM
EB I-240 West of Airways Boulevard	E	E		F	E
WB I-240 West of Airways Boulevard	D	E		E	F
EB I-240 East of Airways Boulevard	D	D		D	D
WB I-240 East of Airways Boulevard	D	D		E	D

Existing Ramp Analysis (5)

Location	2012 AM	2012 PM	2032 AM	2032 PM
EB I-240 to SB Airways Boulevard	F	E	F	F
NB Airways Boulevard to EB I-240	see note	see note	see note	see note
WB I-240 to NB Airways Boulevard	D	D	E	D
NB Airways Boulevard to WB I-240	D	F	D	F
WB I-240 to SB Airways Boulevard	see note	see note	see note	see note
SB Airways Boulevard to WB I-240	B	B	B	B

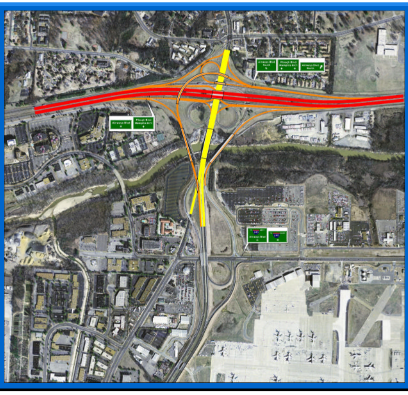
Note: Some ramp junctions with the study area result in a lane adition or lane drop. Analyses for these locations are shown in the table below.

Location	Add/Drop	Lanes	(vph)	2012	Year 2032
I-240 WB to Airways Blvd. SB	Drop	1	2,000	1,834	2,201
Airways Blvd. NB to I-240 EB	Add	1	2,000	1,572	1,886

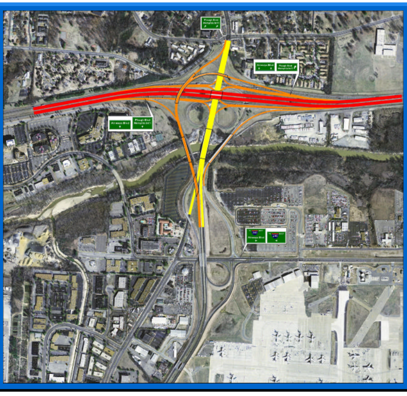
Existing Weave Analysis (3)

Location	2012 AM	2012 PM	2032 AM	2032 PM
NB I-240 @ Airways Blvd. On and Off Ramps	F	F	F	F
SB Airways Blvd. @ I-240 On and Off Ramps	F	C	F	D
NB Airways Blvd. to I-240	C	E	D	F

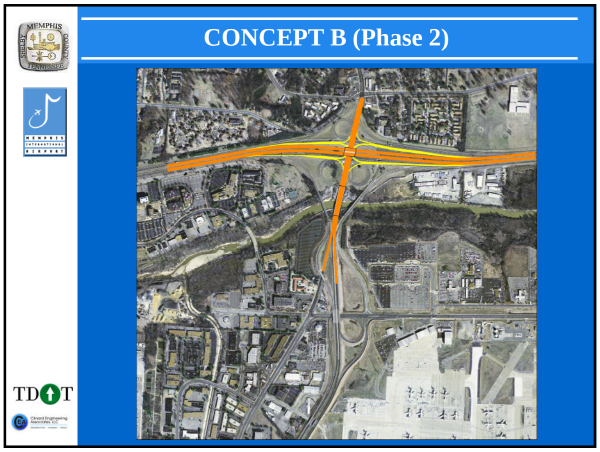
CONCEPT A



CONCEPT B

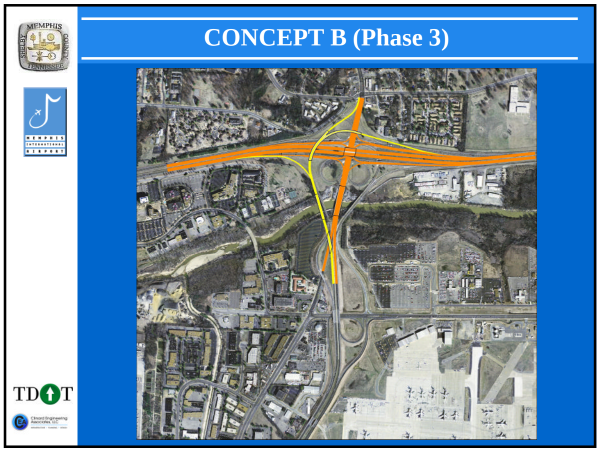


CONCEPT B (Phase 1)



CONCEPT B (Phase 2)

TDOT



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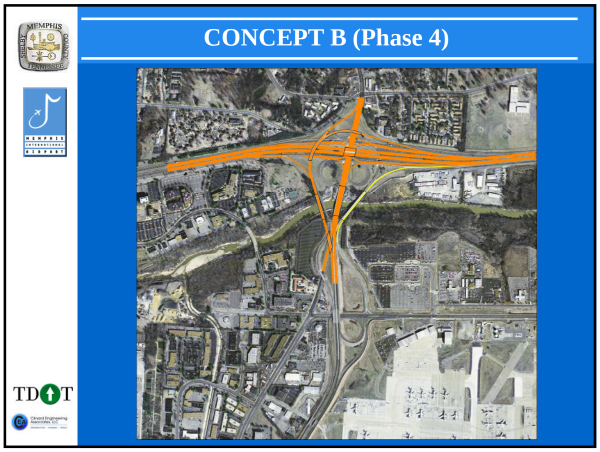

CONCEPT B (Phase 4)

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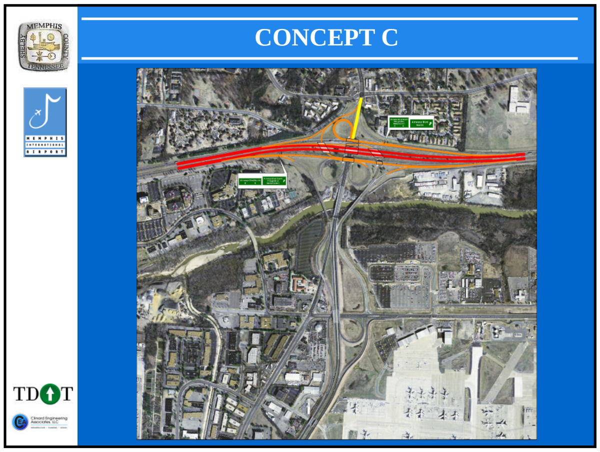
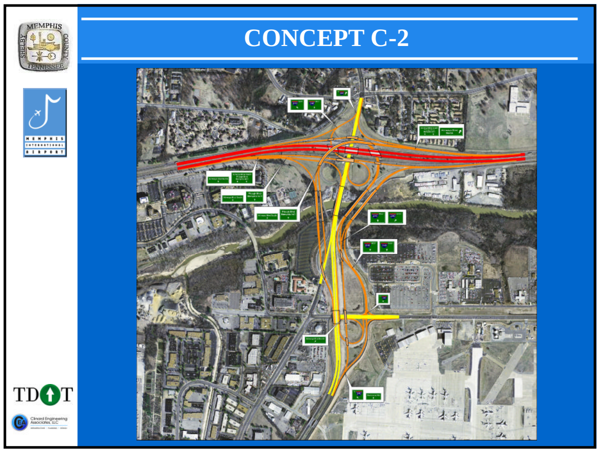


CONCEPT C

TDOT



CONCEPT C-2

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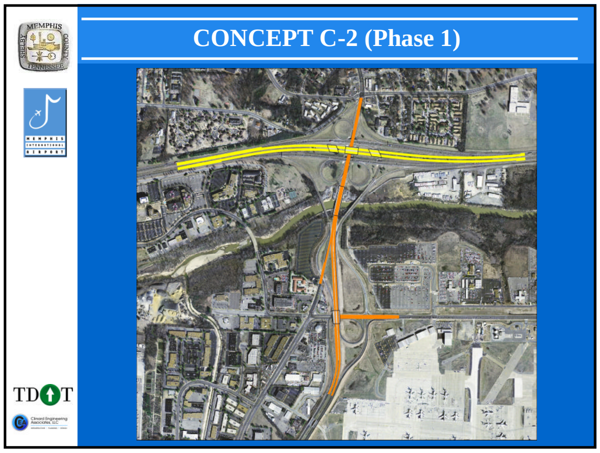

CONCEPT C-2 (Phase 1)

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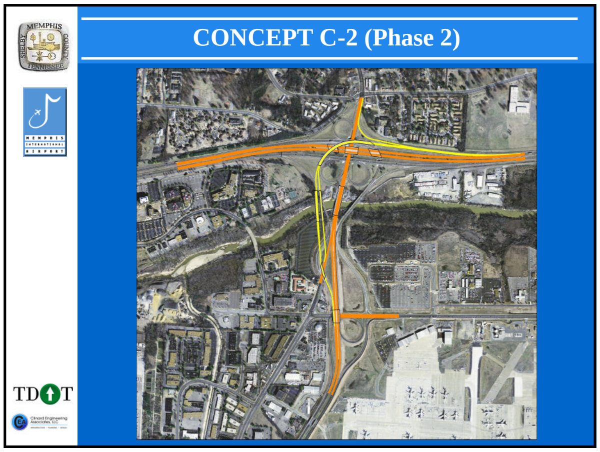

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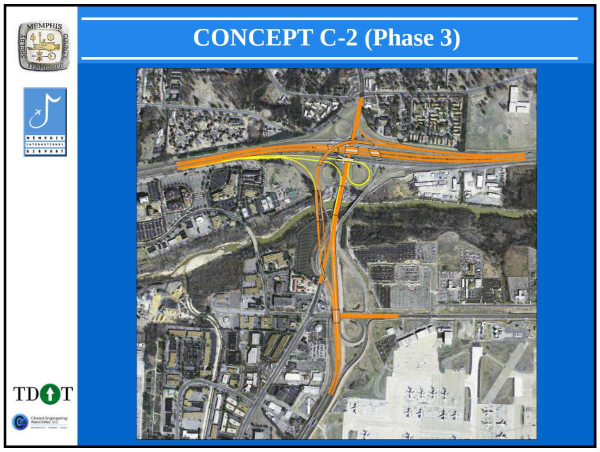
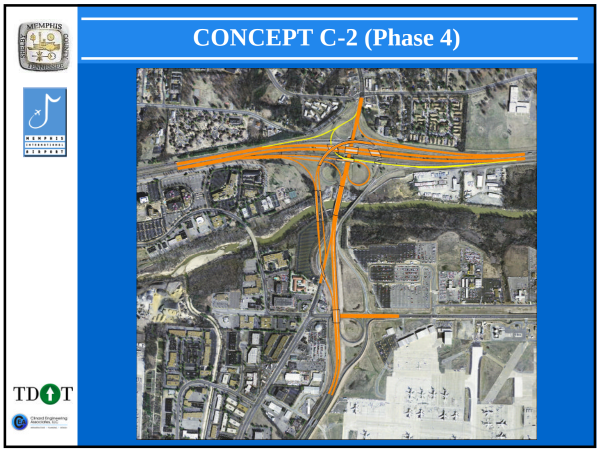


CONCEPT C-2 (Phase 3)



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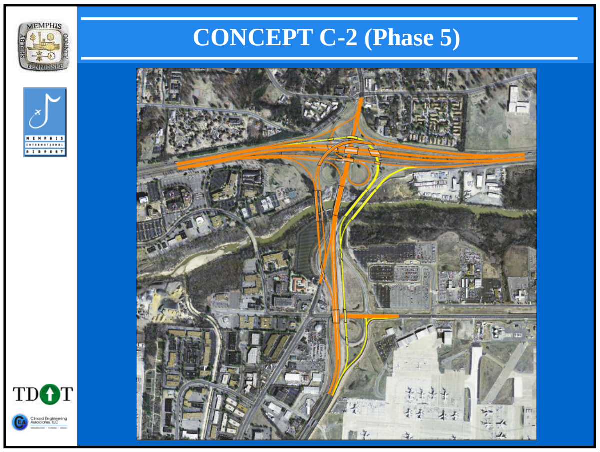
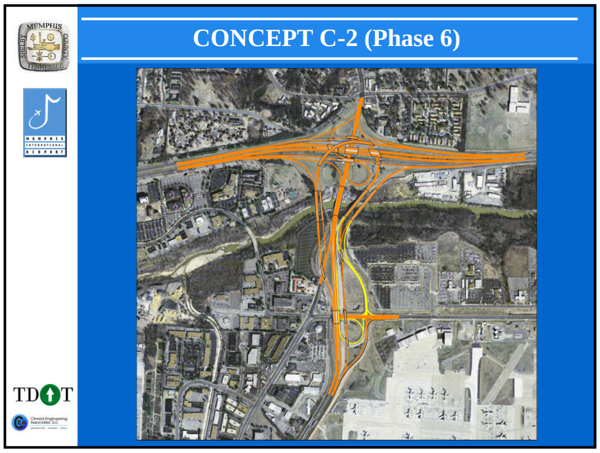
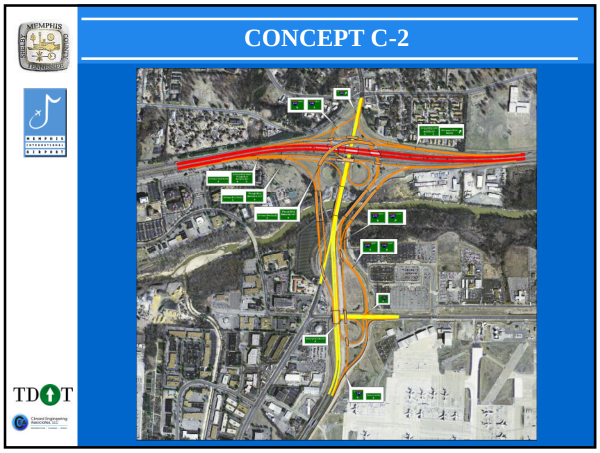


CONCEPT C-2 (Phase 5)

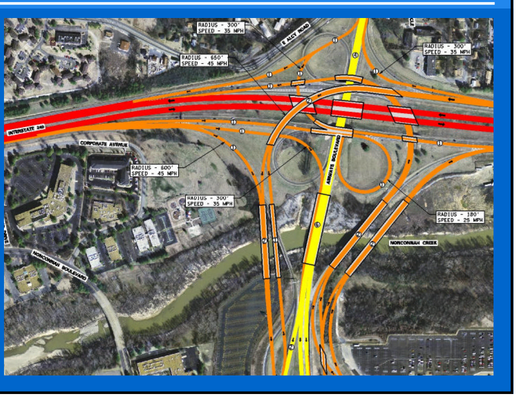


CONCEPT C-2 (Phase 6)



CONCEPT C-2

CONCEPT C-2 (Design Speeds)



TDOT

SUMMARY

- Findings
- Recommendations
- Schedule – Next Steps

TDOT

APPENDIX G

CAPACITY ANALYSIS: EXISTING CONDITIONS

Existing Freeway Analysis (4)

Location	2012 AM	2012 PM	S. Life	2032 AM	2032 PM
EB I-240 West of Airways Boulevard	E	E		F	E
WB I-240 West of Airways Boulevard	D	E		E	F
EB I-240 East of Airways Boulevard	D	D		D	D
WB I-240 East of Airways Boulevard	D	D		E	D

Existing Ramp Analysis (5)

Location	2012 AM	2012 PM	2032 AM	2032 PM
EB I-240 to SB Airways Boulevard	F	E	F	F
NB Airways Boulevard to EB I-240	see note	see note	see note	see note
WB I-240 to NB Airways Boulevard	D	D	E	D
NB Airways Boulevard to WB I-240	D	F	D	F
WB I-240 to SB Airways Boulevard	see note	see note	see note	see note
SB Airways Boulevard to WB I-240	B	B	B	B

Note: Some ramp junctions with the study area result in a lane adition or lane drop. Analyses for these locations are shown in the table below.

Location	Add/Drop	Lanes	(vph)	2012	Year 2032
I-240 WB to Airways Blvd. SB	Drop	1	2,000	1,834	2,201
Airways Blvd. NB to I-240 EB	Add	1	2,000	1,572	1,886

Existing Weave Analysis (3)

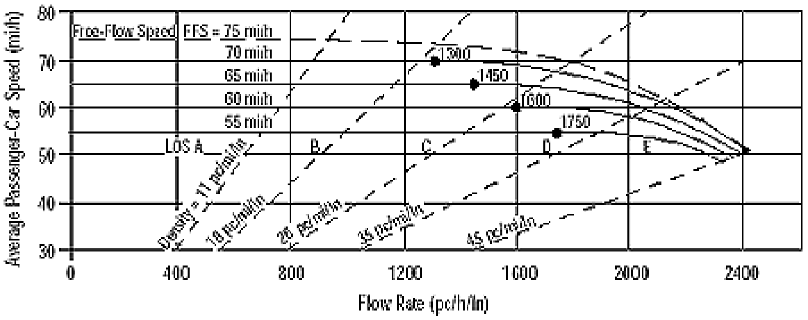
Location	2012 AM	2012 PM	2032 AM	2032 PM
NB I-240 @ Airways Blvd. On and Off Ramps	F	F	F	F
SB Airways Blvd. @ I-240 On and Off Ramps	F	C	F	D
NB Airways Blvd. to I-240	C	E	D	F

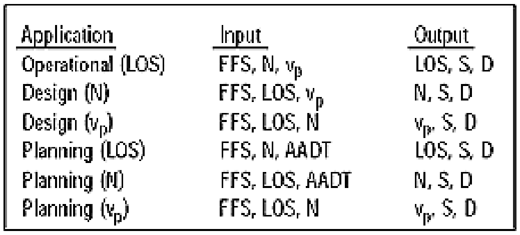
Existing Intersections (3)

Location	2012 AM	2012 PM	2032 AM	2032 PM
Airways Boulevard & Ketchum Road	F	E	F	F
Airways Boulevard & Democrat Road	D	D	E	E
Democrat Road & Plough/I-240 Ramps	B	B	C	C

2012 CAPACITY ANALYSIS
(EXISTING)

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6014 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2317	pc/h/ln
S	56.4	mi/h
D = v_p / S	41.1	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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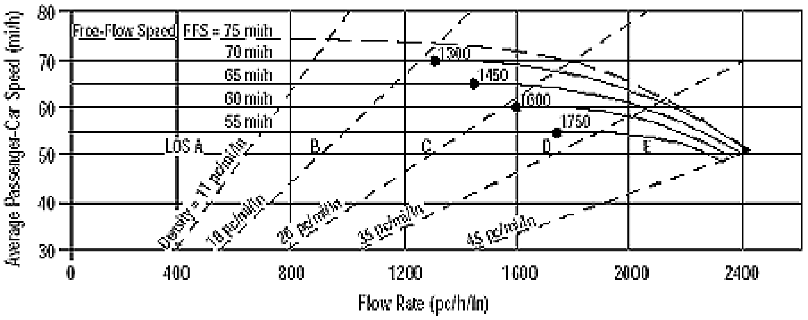
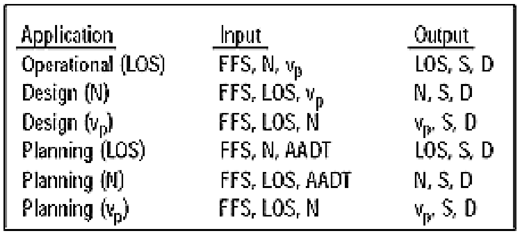
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	West of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5465 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2105	pc/h/ln
S	62.6	mi/h
D = v_p / S	33.6	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

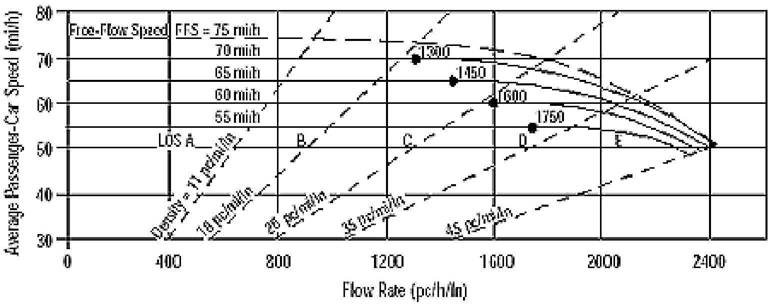
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6418 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1854	pc/h/ln
S	67.2	mi/h
D = v_p / S	27.6	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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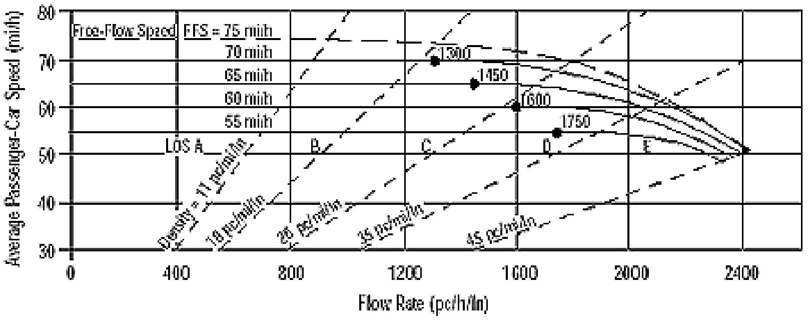
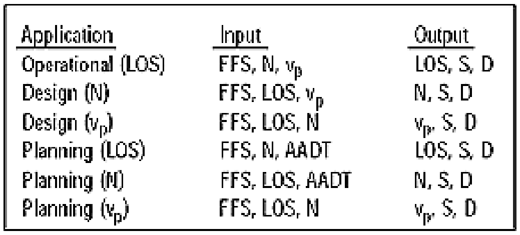
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	East of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7108 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2053	pc/h/ln
S	63.8	mi/h
D = v_p / S	32.2	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

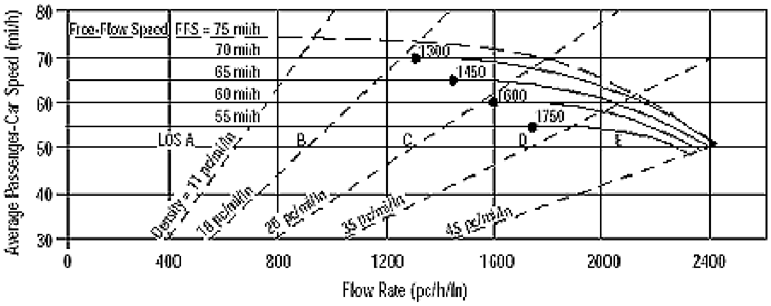
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		Site Information	
Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5794 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	3		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2232	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	59.2	mi/h	S	mi/h
D = v_p / S	37.7	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	E		Required Number of Lanes, N	

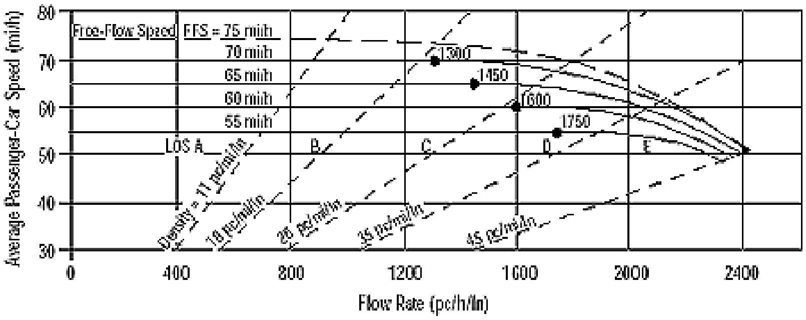
Glossary

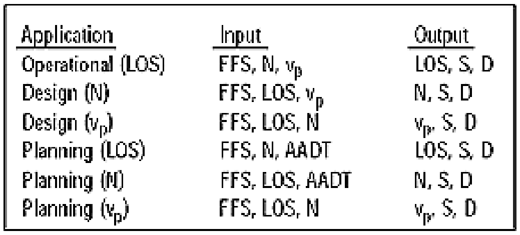
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6200 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2388	pc/h/ln
S	53.8	mi/h
D = v_p / S	44.4	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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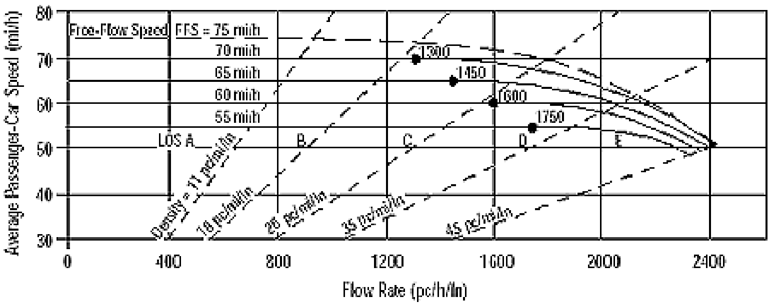
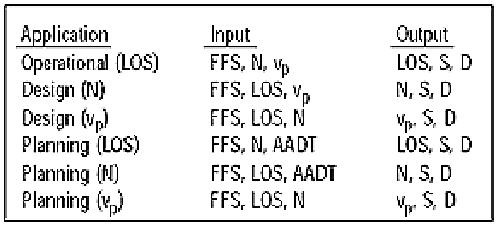
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6954 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2009	pc/h/ln
S	64.7	mi/h
D = v_p / S	31.1	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

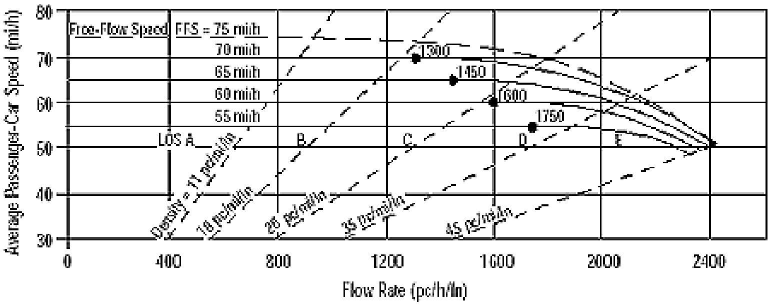
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6560 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1895	pc/h/ln
S	66.6	mi/h
D = v_p / S	28.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain Level	Downstream Adj Ramp
☐ Yes ☐ On		☑ Yes ☑ On
☑ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = 1100 ft
Vu = veh/h	Sketch (show lanes, L_A, L_D, V_R, V_f)	VD = 426 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6014	0.90	Level	8	0	0.962	1.00	6950
Ramp	622	0.90	Level	4	0	0.980	1.00	705
UpStream								
DownStream	426	0.90	Level	4	0	0.980	1.00	483

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.554 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 4164 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6950	6750	Yes
V_{12}	4164	4400:All	No
$V_{FO} = V_F - V_R$	6245	6750	No
V_R	705	2100	No

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 37.8 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= F (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.361 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 50.3 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 53.4 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 51.5 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain Level	Downstream Adj Ramp
☐ Yes ☐ On ☑ No ☐ Off		☑ Yes ☐ On ☐ No ☑ Off
L_{up} = ft		L_{down} = 735 ft
Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 35.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	VD = 1834 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	7108	0.90	Level	8	0	0.962	1.00	8214
Ramp	610	0.90	Level	4	0	0.980	1.00	691
UpStream								
DownStream	1834	0.90	Level	4	0	0.980	1.00	2079

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.436 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 3971 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	8214	9000	No
V_{12}	3971	4400:All	No
$V_{FO} = V_F - V_R$	7523	9000	No
V_R	691	2000	No

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 33.9 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= D (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = (Exibit 25-19)	D_s = 0.490 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 48.6 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 56.0 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 52.2 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

00 Upstream Adj Ramp ☑ Yes ☐ On ☐ No ☑ Off L_{up} = 870 ft Vu = 1834 veh/h	Terrain Level S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	Downstream Adj Ramp ☐ Yes ☐ On ☑ No ☑ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5104	0.90	Level	8	0	0.962	1.00	5898
Ramp	361	0.90	Level	4	0	0.980	1.00	409
UpStream	1834	0.90	Level	4	0	0.980	1.00	2079
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.204 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 1202 pc/h	V_{12} = pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}	6307	9000	No
V_{R12}	1611	4600:All	No

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 16.9 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = B (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = 0.327 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 50.7 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 48.8 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information *Site Information*

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4664	0.90	Level	8	0	0.962	1.00	5390
Ramp	440	0.90	Level	4	0	0.980	1.00	499
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.596 using Equation (Exhibit 25-5)

V_{12}= 3214 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	5889	6750	No
V_{R12}	4098	4600:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 33.0 (pc/ mi /ln)

LOS = D (Exhibit 25-4)

Speed Estimation

M_S = 0.496 (Exibit 25-19)

S_R= 48.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 49.1 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain Level

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1100 ft

VD = 458 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF\ f_{HV}\ f_p$
Freeway	5794	0.90	Level	8	0	0.962	1.00	6695
Ramp	452	0.90	Level	4	0	0.980	1.00	512
UpStream								
DownStream	458	0.90	Level	4	0	0.980	1.00	519

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F\ (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.569 using Equation (Exhibit 25-11)

V_{12} = 4031 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6695	6750	No
V_{12}	4031	4400:All	No
$V_{FO} = V_F - V_R$	6183	6750	No
V_R	512	2100	No

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$$

D_R = 35.3 (pc/ mi /ln)

LOS= E (Exhibit 25-4)

Speed Estimation

D_s = 0.344 (Exhibit 25-19)

S_R= 50.5 mph (Exhibit 25-19)

S_0= 53.8 mph (Exhibit 25-19)

S = 51.8 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information **Site Information**

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain Level

S_{FF} = 55.0 mph S_{FR} = 35.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 735 ft

VD = 1023 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6560	0.90	Level	8	0	0.962	1.00	7580
Ramp	541	0.90	Level	4	0	0.980	1.00	613
UpStream								
DownStream	1023	0.90	Level	4	0	0.980	1.00	1159

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.436 using Equation (Exhibit 25-11)

V_{12} = 3651 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7580	9000	No
V_{12}	3651	4400:All	No
$V_{FO} = V_F - V_R$	6967	9000	No
V_R	613	2000	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 31.2 (pc/ mi /ln)

LOS= D (Exhibit 25-4)

Speed Estimation

D_s = 0.483 (Exhibit 25-19)

S_R= 48.7 mph (Exhibit 25-19)

S_0= 56.6 mph (Exhibit 25-19)

S = 52.5 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

00

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 870 ft

Vu = 1023 veh/h

Terrain Level

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☑ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5753	0.90	Level	8	0	0.962	1.00	6648
Ramp	447	0.90	Level	4	0	0.980	1.00	507
UpStream	1023	0.90	Level	4	0	0.980	1.00	1159
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.192 using Equation (Exhibit 25-5)

V_{12}= 1274 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7155	9000	No
V_{R12}	1781	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 18.2 (pc/ mi /ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.331 (Exibit 25-19)

S_R= 50.7 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 47.2 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off		☐ Yes ☐ On ☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4996	0.90	Level	8	0	0.962	1.00	5773
Ramp	757	0.90	Level	4	0	0.980	1.00	858
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.596 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3442 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6631	6750	No
V_{R12}	4713	4600:All	Yes

	Actual	Maximum	LOS F?
V_{FI}=V_F		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 37.6 (pc/ mi /ln)

LOS = F (Exhibit 25-4)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

M_S = 0.695 (Exibit 25-19)

S_R= 46.0 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 47.0 mph (Exhibit 25-14)

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	EB I-240 & Airways
Agency/Company	Clinard Engineering	Weaving Seg Location	
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	55	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.14
Weaving seg length, L (ft)	300	Weaving ratio, R	0.47
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	5014	0.90	8	0	1.5	1.2	0.962	1.00	5793
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	378	0.90	8	0	1.5	1.2	0.962	1.00	436
Vw2	426	0.90	6	0	1.5	1.2	0.971	1.00	487
Vw				923	Vnw				5793
V									6716

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	2.79	1.27		
Weaving and non-weaving speeds, Si (mi/h)	26.87	34.86		

Number of lanes required for unconstrained operation, Nw 0.86

Maximum number of lanes, Nw (max) 1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	33.49
Weaving segment density, D (pc/mi/ln)	50.14
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	6276
Capacity as a 15-minute flow rate, c (veh/h)	6035
Capacity as a full-hour volume, c_h (veh/h)	5431

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information / Site Information

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 & Airways SB
Agency/Company	Clinard Engineering	Weaving Seg Location	3
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	55	Weaving type	B
Weaving number of lanes, N	3	Volume ratio, VR	0.49
Weaving seg length, L (ft)	700	Weaving ratio, R	0.19
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	2372	0.90	6	0	1.5	1.2	0.971	1.00	2714
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	426	0.90	6	0	1.5	1.2	0.971	1.00	487
Vw2	1834	0.90	6	0	1.5	1.2	0.971	1.00	2098
Vw				2585	Vnw				2714
V									5299

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.00		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	1.36	1.45		
Weaving and non-weaving speeds, Si (mi/h)	34.08	33.38		

Number of lanes required for unconstrained operation, Nw	2.33
Maximum number of lanes, Nw (max)	3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	33.72
Weaving segment density, D (pc/mi/ln)	52.39
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	4507
Capacity as a 15-minute flow rate, c (veh/h)	4376
Capacity as a full-hour volume, c_h (veh/h)	3938

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	Brian Gaffney
Agency/Company	Clinard Engineering
Date Performed	1/26/2007
Analysis Time Period	Existing AM

Site Information

Freeway/Dir of Travel	Airways Blvd NB to I-240
Weaving Seg Location	
Jurisdiction	Shelby County
Analysis Year	2012

Inputs

Freeway free-flow speed, SFF (mi/h)	55
Weaving number of lanes, N	2
Weaving seg length, L (ft)	850
Terrain	Level

Weaving type	A
Volume ratio, VR	0.62
Weaving ratio, R	0.12

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	fHV	fp	v
Vo1	332	0.90	6	0	1.5	1.2	0.971	1.00	379
Vo2	202	0.90	6	0	1.5	1.2	0.971	1.00	231
Vw1	776	0.90	6	0	1.5	1.2	0.971	1.00	888
Vw2	108	0.90	6	0	1.5	1.2	0.971	1.00	123
Vw				1011	Vnw				610
V									1621

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	1.31	0.93		
Weaving and non-weaving speeds, Si (mi/h)	34.48	38.27		

Number of lanes required for unconstrained operation, Nw	1.16
Maximum number of lanes, Nw (max)	1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	35.82
Weaving segment density, D (pc/mi/ln)	22.63
Level of service, LOS	C
Capacity of base condition, c_b (pc/h)	
Capacity as a 15-minute flow rate, c (veh/h)	
Capacity as a full-hour volume, c_h (veh/h)	

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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FREEWAY WEAVING WORKSHEET

General Information

Analyst	Brian Gaffney
Agency/Company	Clinard Engineering
Date Performed	1/26/2007
Analysis Time Period	Existing PM

Site Information

Freeway/Dir of Travel	EB I-240 & Airways
Weaving Seg Location	
Jurisdiction	Shelby County
Analysis Year	2012

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	55
Weaving number of lanes, N	4
Weaving seg length, L (ft)	300
Terrain	Level

Weaving type	A
Volume ratio, VR	0.15
Weaving ratio, R	0.48

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	4924	0.90	8	0	1.5	1.2	0.962	1.00	5689
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	418	0.90	8	0	1.5	1.2	0.962	1.00	483
Vw2	458	0.90	6	0	1.5	1.2	0.971	1.00	524
Vw				1007	Vnw				5689
V									6696

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	2.85	1.32		
Weaving and non-weaving speeds, Si (mi/h)	26.68	34.40		

Number of lanes required for unconstrained operation, Nw	0.90
Maximum number of lanes, Nw (max)	1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	32.96
Weaving segment density, D (pc/mi/ln)	50.78
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	6201
Capacity as a 15-minute flow rate, c (veh/h)	5962
Capacity as a full-hour volume, c_h (veh/h)	5366

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS2000™ Version 4.1d

FREEWAY WEAVING WORKSHEET

General Information

Analyst	Brian Gaffney
Agency/Company	Clinard Engineering
Date Performed	1/26/2007
Analysis Time Period	Existing PM

Site Information

Freeway/Dir of Travel	I-240 & Airways SB
Weaving Seg Location	3
Jurisdiction	Shelby County
Analysis Year	2012

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	55
Weaving number of lanes, N	3
Weaving seg length, L (ft)	700
Terrain	Level

Weaving type	B
Volume ratio, VR	0.61
Weaving ratio, R	0.31

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	929	0.90	6	0	1.5	1.2	0.971	1.00	1063
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	458	0.90	6	0	1.5	1.2	0.971	1.00	524
Vw2	1023	0.90	6	0	1.5	1.2	0.971	1.00	1170
Vw				1694	Vnw				1063
V									2757

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.00		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	1.03	1.23		
Weaving and non-weaving speeds, Si (mi/h)	37.18	35.18		

Number of lanes required for unconstrained operation, Nw 2.66

Maximum number of lanes, Nw (max) 3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	36.38
Weaving segment density, D (pc/mi/ln)	25.26
Level of service, LOS	C
Capacity of base condition, c_b (pc/h)	4171
Capacity as a 15-minute flow rate, c (veh/h)	4050
Capacity as a full-hour volume, c_h (veh/h)	3645

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information / Site Information

Analyst	Brian Gaffney	Freeway/Dir of Travel	Airways Blvd NB to I-240
Agency/Company	Clinard Engineering	Weaving Seg Location	
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Inputs

Freeway free-flow speed, SFF (mi/h)	55	Weaving type	A
Weaving number of lanes, N	2	Volume ratio, VR	0.56
Weaving seg length, L (ft)	850	Weaving ratio, R	0.26
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	fHV	fp	v
Vo1	416	0.90	6	0	1.5	1.2	0.971	1.00	476
Vo2	602	0.90	6	0	1.5	1.2	0.971	1.00	688
Vw1	970	0.90	6	0	1.5	1.2	0.971	1.00	1110
Vw2	341	0.90	6	0	1.5	1.2	0.971	1.00	390
Vw				1500	Vnw				1164
V									2664

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	1.95	1.53		
Weaving and non-weaving speeds, Si (mi/h)	30.25	32.78		

Number of lanes required for unconstrained operation, Nw	1.16
Maximum number of lanes, Nw (max)	1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	31.31
Weaving segment density, D (pc/mi/ln)	42.54
Level of service, LOS	E
Capacity of base condition, c_b (pc/h)	
Capacity as a 15-minute flow rate, c (veh/h)	
Capacity as a full-hour volume, c_h (veh/h)	

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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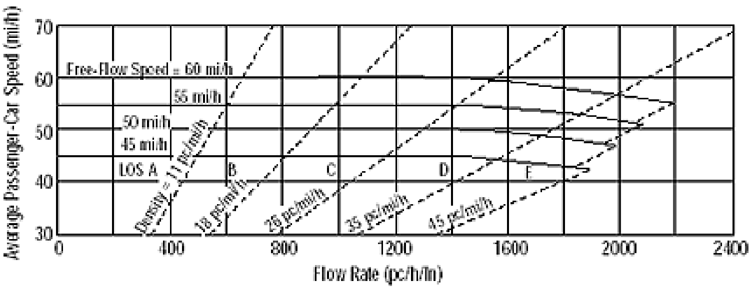
MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - AM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	North of I-240
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1698	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	971
Speed, S (mi/h)	45.0
D (pc/mi/ln)	21.6
LOS	C

Design

Design (N)

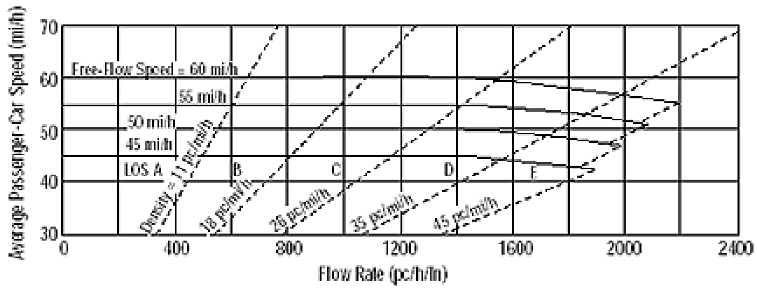
Required Number of Lanes, N

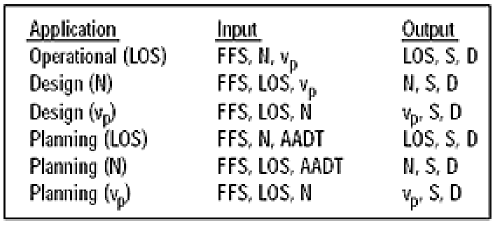
Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

MULTILANE HIGHWAYS WORKSHEET(Direction 1)





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - AM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	South of I-240
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1320	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	755
Speed, S (mi/h)	45.0
D (pc/mi/ln)	16.8
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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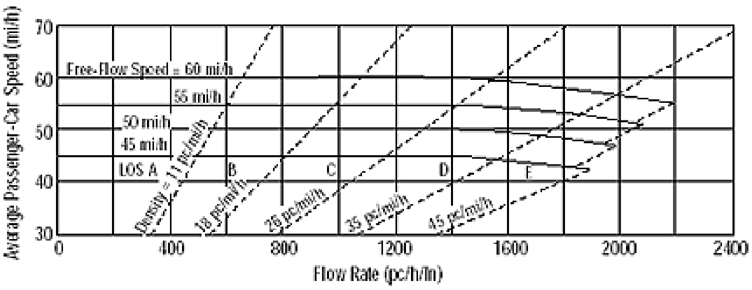
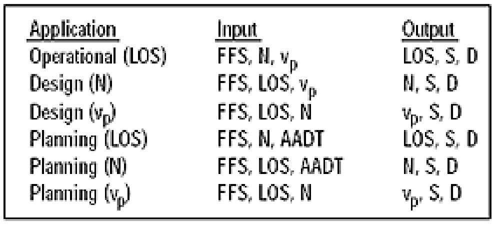
MULTILANE HIGHWAYS WORKSHEET(Direction 1)





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - PM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	North of I-240
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1291	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

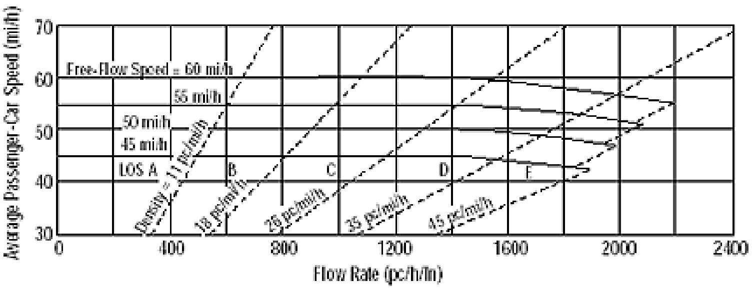
Flow Rate, v_p (pc/h/ln)	738
Speed, S (mi/h)	45.0
D (pc/mi/ln)	16.4
LOS	B

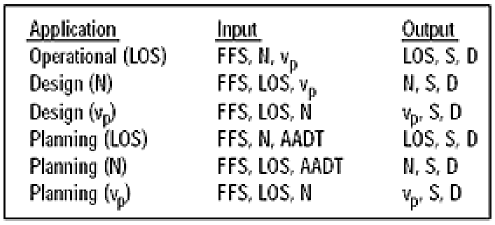
Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

MULTILANE HIGHWAYS WORKSHEET(Direction 1)





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - PM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	South of I-240
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	873	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	499
Speed, S (mi/h)	45.0
D (pc/mi/ln)	11.1
LOS	B

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Ketchum&Airways*
Agency or Co.	*Clinard Engineering*	Area Type	*CBD or Similar*
Date Performed	*1/18/2007*	Jurisdiction	*Shelby County*
Time Period	*AM Existing*	Analysis Year	*2012*
		Project ID	*I-240 & Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	2	1	1	1	3	0	1	3	0
Lane group	L	T	R	L	T	R	L	TR		L	TR	
Volume, V (vph)	80	199	251	64	381	882	176	1861	271	81	2844	92
% Heavy vehicles, %HV	0	0	0	0	0	0	4	4	4	4	4	4
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P	P	P	P	P	P
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	NS Perm	07	08
Timing	G = 10.0	G = 35.0	G =	G =	G = 10.0	G = 85.0	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 160.0		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	89	221	279	71	423	980	196	2369		90	3262	
Lane group capacity, c	147	711	454	197	374	454	143	2339		143	2374	
v/c ratio, X	0.61	0.31	0.61	0.36	1.13	2.16	1.37	1.01		0.63	1.37	
	0.31	0.22	0.31	0.06	0.22	0.31	0.63	0.53		0.63	0.53	

Total green ratio, g/C												
Uniform delay, d_1	44.3	52.4	46.8	71.9	62.5	55.0	55.9	37.5		39.5	37.5	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50		0.50	0.50	
Incremental delay, d_2	17.1	1.1	6.1	5.1	87.1	528.7	204.7	21.8		19.2	171.1	
Initial queue delay, d_3												
Control delay	61.4	53.5	52.9	77.0	149.6	583.7	260.6	59.3		58.6	208.6	
Lane group LOS	E	D	D	E	F	F	F	E		E	F	
Approach delay	54.4			434.7			74.7			204.5		
Approach LOS	D			F			E			F		
Intersection delay	194.2			X_C = 2.21			Intersection LOS			F		

HCS2000™ Version 4.1d

HCS2000™ DETAILED REPORT

General Information		**Site Information**	
Analyst	*Brian Gaffney*	Intersection	*Ketchum&Airways*
Agency or Co.	*Clinard Engineering*	Area Type	*CBD or Similar*
Date Performed	*1/18/2007*	Jurisdiction	*Shelby County*
Time Period	*PM Existing*	Analysis Year	*2012*
		Project ID	*I-240 & Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	2	1	1	1	3	0	1	3	0
Lane group	L	T	R	L	T	R	L	TR		L	TR	
Volume, V (vph)	201	237	160	138	209	496	320	1216	296	159	1536	114
% Heavy vehicles, %HV	0	0	0	0	0	0	4	4	4	4	4	4
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P	P	P	P	P	P
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	NS Perm	07	08
Timing	G = 10.0	G = 20.0	G =	G =	G = 10.0	G = 40.0	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 100.0		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	223	263	178	153	232	551	356	1680		177	1834	
Lane group capacity, c	300	650	509	315	342	509	228	1743		228	1777	
v/c ratio, X	0.74	0.40	0.35	0.49	0.68	1.08	1.56	0.96		0.78	1.03	
	0.35	0.20	0.35	0.10	0.20	0.35	0.55	0.40		0.55	0.40	

Total green ratio, g/C												
Uniform delay, d_1	29.1	34.8	24.1	42.6	37.0	32.5	29.4	29.3		23.0	30.0	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50		0.50	0.50	
Incremental delay, d_2	15.3	1.9	1.9	5.3	10.4	64.0	273.0	14.5		22.4	30.1	
Initial queue delay, d_3												
Control delay	44.4	36.7	26.0	47.8	47.4	96.5	302.4	43.8		45.4	60.1	
Lane group LOS	D	D	C	D	D	F	F	D		D	E	
Approach delay	36.4			76.4			89.0			58.8		
Approach LOS	D			E			F			E		
Intersection delay	70.0			X_C = 2.05			Intersection LOS			E		

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Airways&Democrat*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Existing AM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	2	1	0	2	1	1	2	3	0
Lane group	L	T	R	L	TR		L	T	R	L	TR	
Volume, V (vph)	3	220	36	180	208	4	125	6	492	582	687	493
% Heavy vehicles, %HV	0	0	0	0	0	0	0	0	0	0	0	0
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P	P	P	P	P	P
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Arrival type, AT	3	3	3	3	3		3	3	3	3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		0
Lane width	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0	0	0	0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	Thru & RT	07	08
Timing	G = *5.0*	G = *10.0*	G =	G =	G = *15.0*	G = *20.0*	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y = *5*	Y =	Y =
Duration of Analysis, T = *0.25*					Cycle Length, C = *70.0*			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	3	244	40	200	235		139	7	547	647	1311	
Lane group capacity, c	238	516	692	250	271		750	543	692	750	1389	
v/c ratio, X	0.01	0.47	0.06	0.80	0.87		0.19	0.01	0.79	0.86	0.94	

Total green ratio, g/C	0.29	0.14	0.43	0.07	0.14		0.21	0.29	0.43	0.21	0.29	
Uniform delay, d_1	18.5	27.6	11.7	32.0	29.4		22.5	17.9	17.3	26.5	24.5	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50	0.50	0.50	0.50	0.50	
Incremental delay, d_2	0.1	3.1	0.2	22.9	29.1		0.5	0.0	9.0	12.5	14.0	
Initial queue delay, d_3												
Control delay	18.6	30.7	11.9	55.0	58.5		23.0	18.0	26.2	39.0	38.5	
Lane group LOS	B	C	B	D	E		C	B	C	D	D	
Approach delay	27.9			56.9			25.5			38.7		
Approach LOS	C			E			C			D		
Intersection delay	37.4			$X_C = 0.82$			Intersection LOS			D		

HCS2000™ Version 4.1d

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Airways&Democrat*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Existing PM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	*1*	*2*	*1*	*2*	*1*	*0*	*2*	*1*	*1*	*2*	*3*	*0*
Lane group	*L*	*T*	*R*	*L*	*TR*		*L*	*T*	*R*	*L*	*TR*	
Volume, V (vph)	*1*	*562*	*188*	*356*	*165*	*11*	*95*	*25*	*740*	*286*	*655*	*116*
% Heavy vehicles, %HV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Peak-hour factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Pretimed (P) or actuated (A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Start-up lost time, l_1	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Extension of effective green, e	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Arrival type, AT	*3*	*3*	*3*	*3*	*3*		*3*	*3*	*3*	*3*	*3*	
Unit extension, UE	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*		*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	
Filtering/metering, I	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Initial unmet demand, Q_b	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Ped / Bike / RTOR volumes	*0*		*0*	*0*		*0*	*0*		*0*	*0*		*0*
Lane width	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*		*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	
Parking / Grade / Parking	*N*	*0*	*N*	*N*	*0*	*N*	*N*	*0*	*N*	*N*	*0*	*N*
Parking maneuvers, N_m												
Buses stopping, N_B	*0*	*0*	*0*	*0*	*0*		*0*	*0*	*0*	*0*	*0*	
Min. time for pedestrians, G_p	*3.2*			*3.2*			*3.2*			*3.2*		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	Thru & RT	07	08
Timing	G = *20.0*	G = *15.0*	G =	G =	G = *10.0*	G = *25.0*	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y = *5*	Y =	Y =
Duration of Analysis, T = *0.25*					Cycle Length, C = *90.0*			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	*1*	*624*	*209*	*396*	*195*		*106*	*28*	*822*	*318*	*857*	
Lane group capacity, c	*547*	*602*	*538*	*778*	*314*		*389*	*528*	*897*	*389*	*1408*	
v/c ratio, X	*0.00*	*1.04*	*0.39*	*0.51*	*0.62*		*0.27*	*0.05*	*0.92*	*0.82*	*0.61*	

Total green ratio, g/C	0.44	0.17	0.33	0.22	0.17		0.11	0.28	0.56	0.11	0.28	
Uniform delay, d_1	14.4	37.5	23.0	30.7	34.9		36.7	23.8	18.1	39.1	28.2	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50	0.50	0.50	0.50	0.50	
Incremental delay, d_2	0.0	46.5	2.1	2.4	8.9		1.7	0.2	15.6	17.1	2.0	
Initial queue delay, d_3												
Control delay	14.4	84.0	25.1	33.1	43.8		38.4	24.0	33.7	56.3	30.2	
Lane group LOS	B	F	C	C	D		D	C	C	E	C	
Approach delay	69.1			36.6			33.9			37.3		
Approach LOS	E			D			C			D		
Intersection delay	43.7			X_C = 0.92			Intersection LOS			D		

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Democrat&Ramps*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Existing AM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	*2*	*2*	*1*	*1*	*2*	*0*	*1*	*0*	*1*	*0*	*0*	*0*
Lane group	*L*	*T*	*R*	*L*	*TR*		*L*		*R*			
Volume, V (vph)	*105*	*942*	*156*	*79*	*504*	*205*	*108*		*361*			
% Heavy vehicles, %HV	*0*	*0*	*0*	*0*	*0*	*0*	*0*		*0*			
Peak-hour factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*		*0.90*			
Pretimed (P) or actuated (A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*		*P*			
Start-up lost time, I_1	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*		*2.0*			
Extension of effective green, e	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*		*2.0*			
Arrival type, AT	*3*	*3*	*3*	*3*	*3*		*3*		*3*			
Unit extension, UE	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*		*3.0*		*3.0*			
Filtering/metering, I	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*			
Initial unmet demand, Q_b	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*		*0.0*		*0.0*			
Ped / Bike / RTOR volumes	*0*		*0*	*0*		*0*	*0*		*0*	*0*		
Lane width	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*		*12.0*		*12.0*			
Parking / Grade / Parking	*N*	*0*	*N*	*N*	*0*	*N*	*N*	*0*	*N*	*N*		*N*
Parking maneuvers, N_m												
Buses stopping, N_B	*0*	*0*	*0*	*0*	*0*		*0*		*0*			
Min. time for pedestrians, G_p	*3.2*			*3.2*			*3.2*			*3.2*		

Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = *10.0*	G = *25.0*	G =	G =	G = *15.0*	G =	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y =	Y =	Y =
Duration of Analysis, T = *0.25*						Cycle Length, C = *65.0*		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	*117*	*1047*	*173*	*88*	*788*		*120*		*401*			
Lane group capacity, c	*1086*	*1388*	*1118*	*278*	*1328*		*417*		*745*			
v/c ratio, X	*0.11*	*0.75*	*0.15*	*0.32*	*0.59*		*0.29*		*0.54*			
Total green ratio, g/C	*0.62*	*0.38*	*0.69*	*0.15*	*0.38*		*0.23*		*0.46*			

Uniform delay, d_1	6.1	17.3	3.4	24.5	15.9		20.6		12.5			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.2	3.8	0.3	3.0	2.0		1.7		2.8			
Initial queue delay, d_3												
Control delay	6.3	21.2	3.7	27.4	17.9		22.3		15.3			
Lane group LOS	A	C	A	C	B		C		B			
Approach delay	17.6			18.9			16.9					
Approach LOS	B			B			B					
Intersection delay	17.9			$X_C = 0.64$			Intersection LOS			B		

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	*Brian Gaffney*	Intersection	*Democrat&Ramps*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Existing PM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	2	1	1	2	0	1	0	1	0	0	0
Lane group	L	T	R	L	TR		L		R			
Volume, V (vph)	424	584	453	141	744	519	88		226			
% Heavy vehicles, %HV	0	0	0	0	0	0	0		0			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90			
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P		P			
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Arrival type, AT	3	3	3	3	3		3		3			
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0		3.0			
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000			
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0		0.0			
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		
Lane width	12.0	12.0	12.0	12.0	12.0		12.0		12.0			
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N		N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0		0			
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

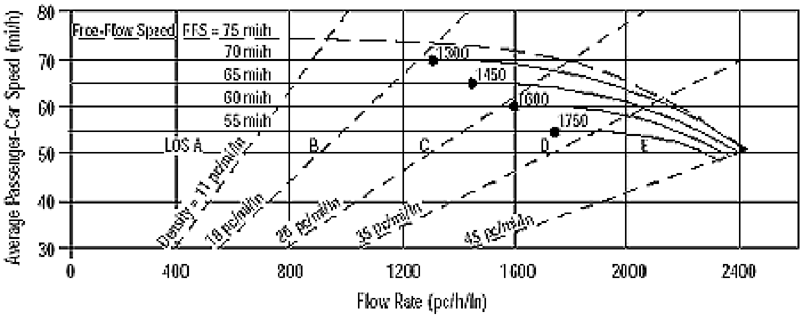
Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = 10.0	G = 30.0	G =	G =	G = 10.0	G =	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y =	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 65.0		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	471	649	503	157	1404		98		251			
Lane group capacity, c	1399	1666	1118	278	1563		278		621			
v/c ratio, X	0.34	0.39	0.45	0.56	0.90		0.35		0.40			
Total green ratio, g/C	0.69	0.46	0.69	0.15	0.46		0.15		0.38			

Uniform delay, d_1	8.6	11.5	4.5	25.5	16.1		24.6		14.6			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.7	0.7	1.3	8.1	8.6		3.5		2.0			
Initial queue delay, d_3												
Control delay	9.2	12.2	5.8	33.6	24.7		28.1		16.5			
Lane group LOS	A	B	A	C	C		C		B			
Approach delay	9.3			25.6			19.8					
Approach LOS	A			C			B					
Intersection delay	17.5			X_C = 0.78			Intersection LOS			B		

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5030 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1937	pc/h/ln
S	66.0	mi/h
D = v_p / S	29.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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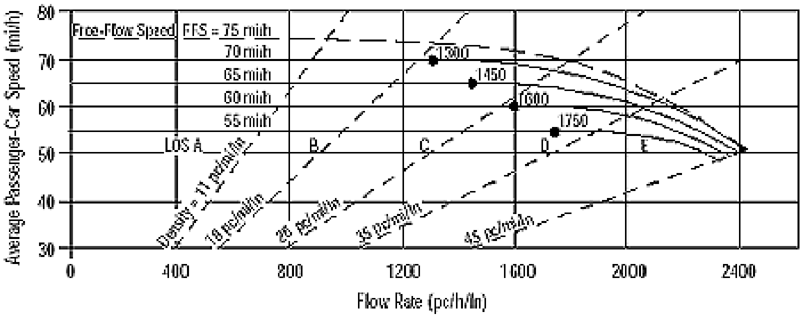
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	At Lamar Avenue Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5791 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2231	pc/h/ln
S	59.2	mi/h
D = v_p / S	37.7	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed

DDHV - Directional design hour volume

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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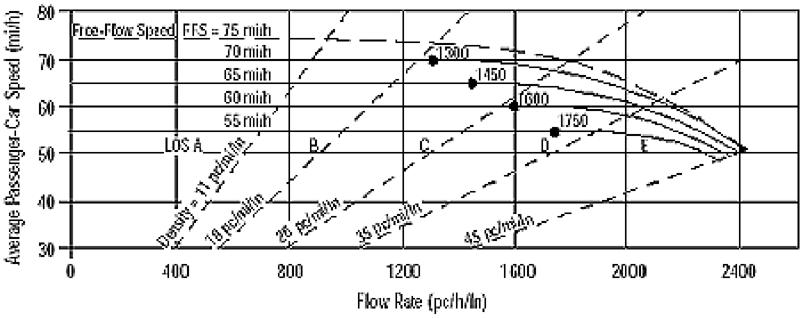
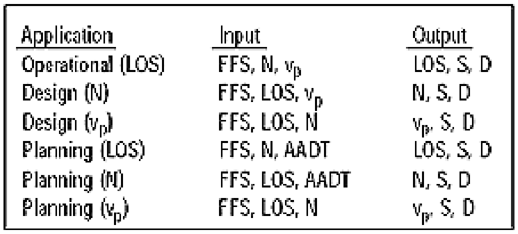
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4913 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs / Calc Speed Adj and FFS

Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	3		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures / Design (N)

Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1892	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	66.7	mi/h	S	mi/h
D = v_p / S	28.4	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary / Factor Location

N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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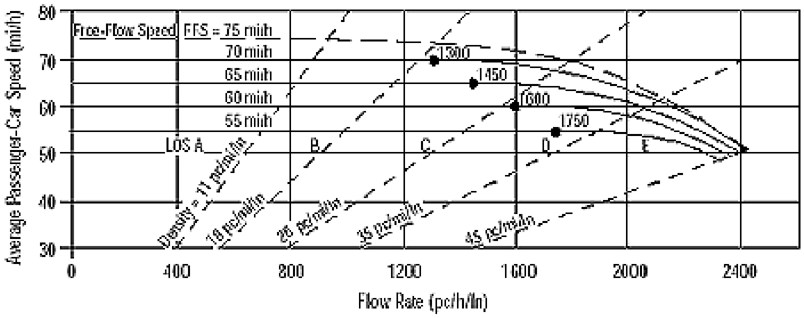
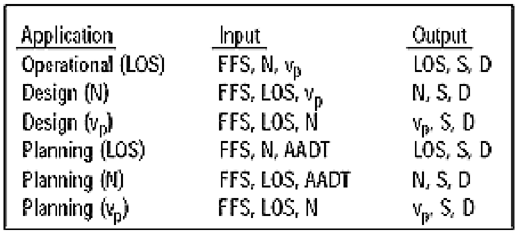
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney		
Agency or Company	Clinard Engineering		
Date Performed	10/17/2008		
Analysis Time Period	Existing AM		

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4252 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1638	pc/h/ln
S	69.2	mi/h
D = v_p / S	23.7	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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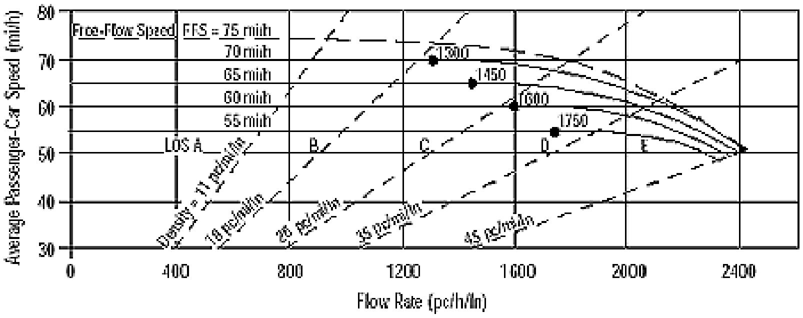
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Lamar Avenue Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5748 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2214	pc/h/ln
S	59.7	mi/h
D = v_p / S	37.1	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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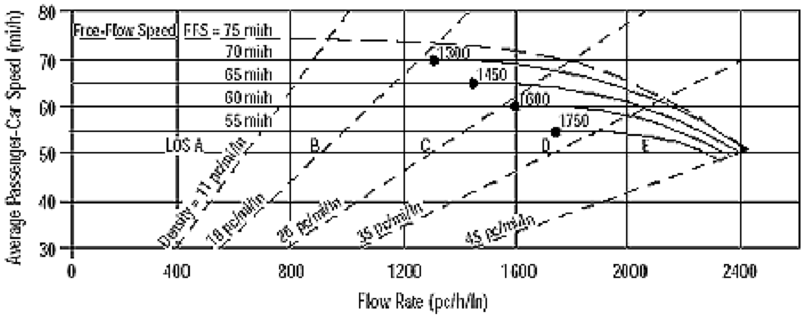
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5313 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2046	pc/h/ln
S	63.9	mi/h
D = v_p / S	32.0	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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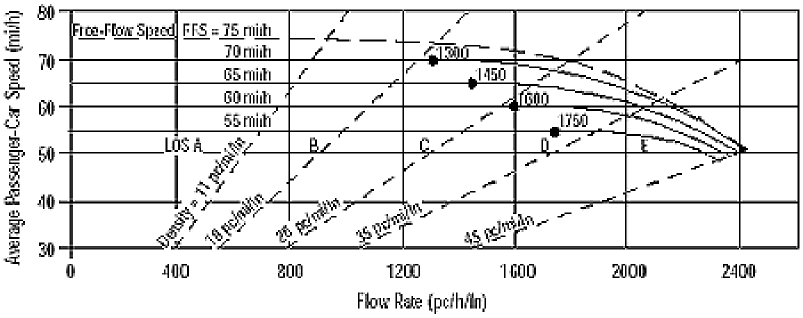
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / *Site Information*

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5067 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1952	pc/h/ln
S	65.7	mi/h
D = v_p / S	29.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

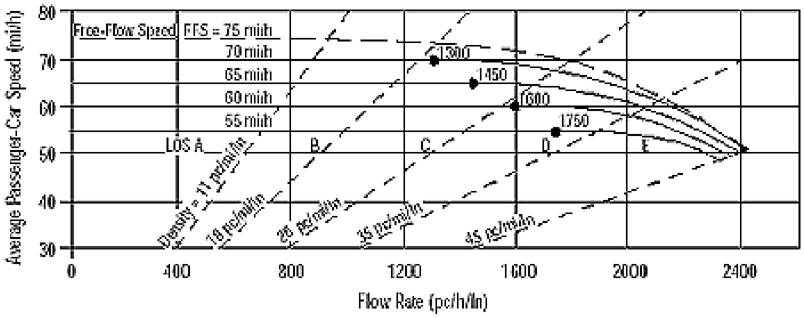
Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5427 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2090	pc/h/ln
S	63.0	mi/h
D = v_p / S	33.2	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5465	0.90	Level	8	0	0.962	1.00	6315
Ramp	1213	0.90	Level	4	0	0.980	1.00	1375
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.539 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 4037 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6315	6750	No
V_{12}	4037	4400:All	No
$V_{FO} = V_F - V_R$	4940	6750	No
V_R	1375	2100	No

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 39.0 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= E (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.422 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 49.5 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 55.4 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 51.5 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4913	0.90	Level	8	0	0.962	1.00	5677
Ramp	1101	0.90	Level	4	0	0.980	1.00	1248
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.577 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3278 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6925	6750	Yes
V_{R12}	4526	4600:All	No

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 40.2 (pc/ mi /ln)

LOS = F (Exhibit 25-4)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

M_S = 0.681 (Exibit 25-19)

S_R= 46.1 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 46.7 mph (Exhibit 25-14)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☐ No ☐ Off		☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6200	0.90	Level	8	0	0.962	1.00	7164
Ramp	773	0.90	Level	4	0	0.980	1.00	876
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.541 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 4275 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7164	6750	Yes
V_{12}	4275	4400:All	No
$V_{FO} = V_F - V_R$	6288	6750	No
V_R	876	2100	No

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 41.0 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= F (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = (Exibit 25-19)	D_s = 0.377 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 50.1 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 53.0 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 51.2 mph (Exhibit 25-15)

HCS2000™

Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5067	0.90	Level	8	0	0.962	1.00	5855
Ramp	727	0.90	Level	4	0	0.980	1.00	824
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.577 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3381 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6679	6750	No
V_{R12}	4205	4600:All	No

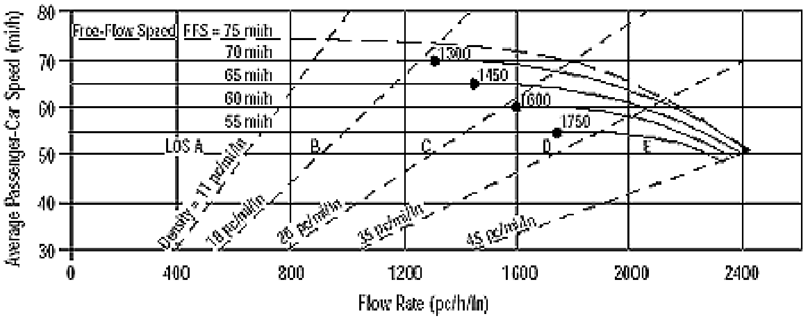
	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 37.9 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = E (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = 0.582 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 47.4 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 47.4 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

2032 CAPACITY ANALYSIS
(EXISTING)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6357 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2449	pc/h/ln
S		mi/h
D = v_p / S		pc/mi/ln
LOS	F	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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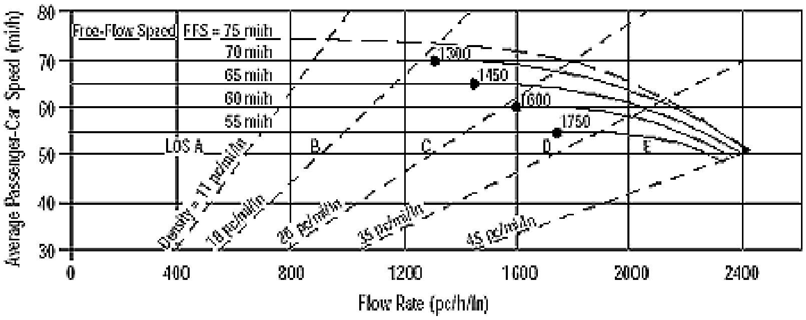
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	West of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5604 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2159	pc/h/ln
S	61.2	mi/h
D = v_p / S	35.3	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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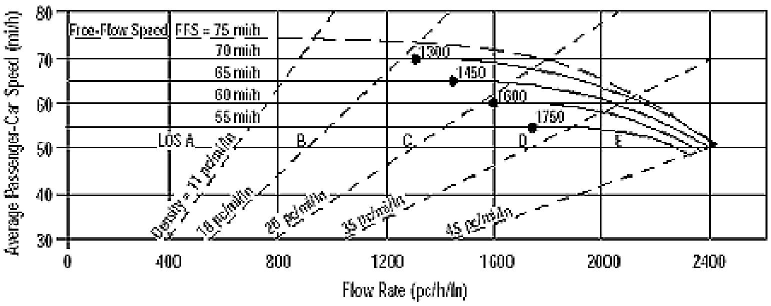
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6842 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1977	pc/h/ln
S	65.3	mi/h
D = v_p / S	30.3	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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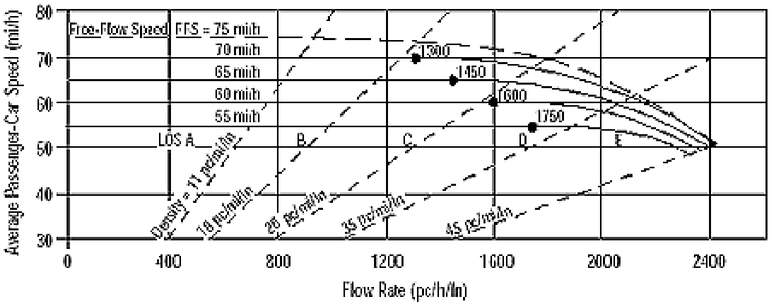
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7576 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2189	pc/h/ln
S	60.4	mi/h
D = v_p / S	36.2	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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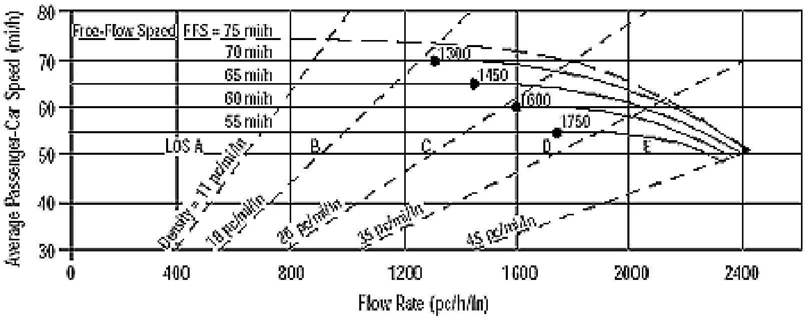
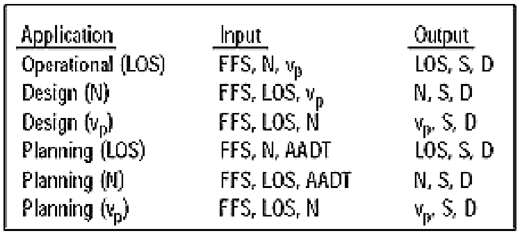
Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6022 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2320	pc/h/ln
S	56.3	mi/h
D = v_p / S	41.2	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

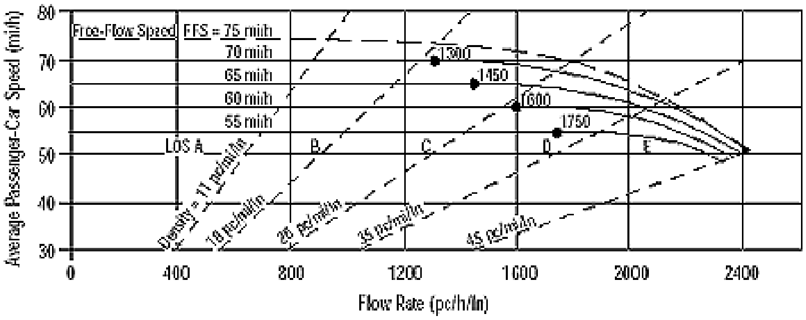
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

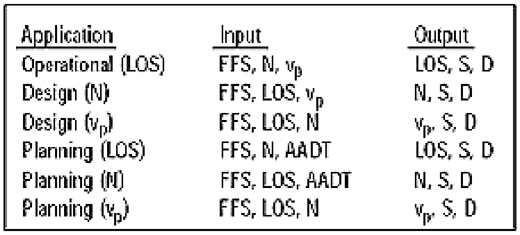
Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™ Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	West of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6559 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2526	pc/h/ln
S		mi/h
D = v_p / S		pc/mi/ln
LOS	F	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

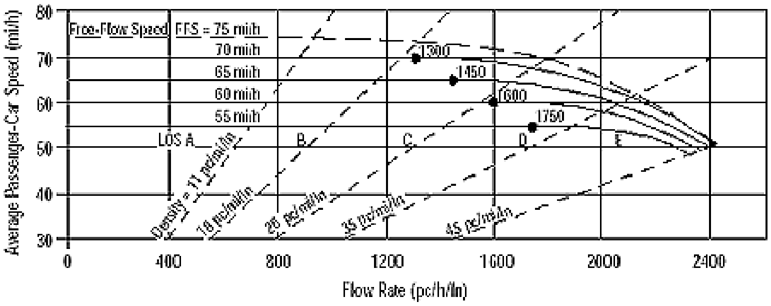
Glossary

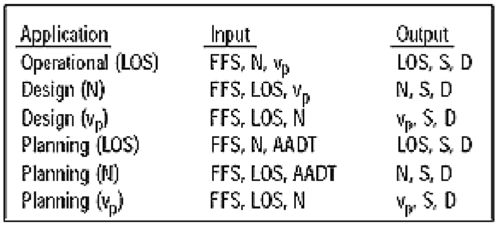
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7414 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2142	pc/h/ln
S	61.7	mi/h
D = v_p / S	34.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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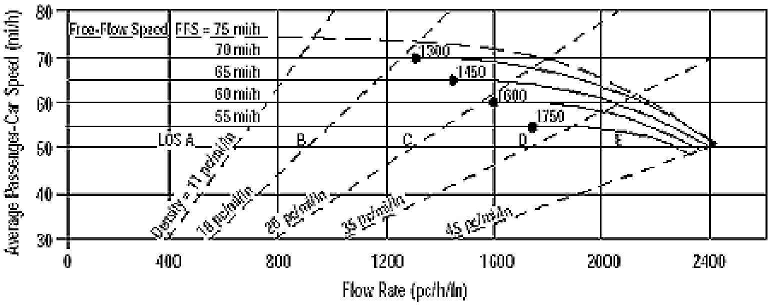
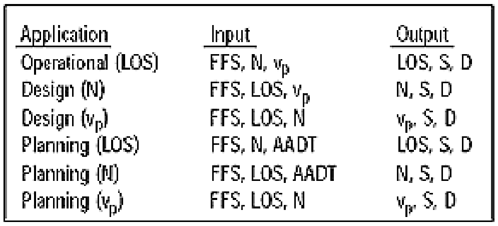
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6992 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2020	pc/h/ln
S	64.5	mi/h
D = v_p / S	31.3	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information — Site Information

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain Level

S $_{FF}$ = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1100 ft

VD = 511 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6357	0.90	Level	8	0	0.962	1.00	7346
Ramp	746	0.90	Level	4	0	0.980	1.00	845
UpStream								
DownStream	511	0.90	Level	4	0	0.980	1.00	579

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge Areas)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Estimation of v_{12} (Diverge Areas)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.537 using Equation (Exhibit 25-11)

V_{12} = 4339 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
V_{FI}=V_F	7346	6750	Yes
V_{12}	4339	4400:All	No
$V_{FO} = V_F - V_R$	6501	6750	No
V_R	845	2100	No

Level of Service Determination (if not F) (Merge Areas)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Level of Service Determination (if not F) (Diverge Areas)

$$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$$

D_R = 39.3 (pc/ mi /ln)

LOS= F (Exhibit 25-4)

Speed Estimation (Merge Areas)

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Speed Estimation (Diverge Areas)

D_s = 0.374 (Exhibit 25-19)

S_R= 50.1 mph (Exhibit 25-19)

S_0= 52.5 mph (Exhibit 25-19)

S = 51.1 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain Level

S $_{FF}$ = 55.0 mph S_{FR} = 35.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 735 ft

VD = 2201 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	7576	0.90	Level	8	0	0.962	1.00	8754
Ramp	732	0.90	Level	4	0	0.980	1.00	830
UpStream								
DownStream	2201	0.90	Level	4	0	0.980	1.00	2494

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.436 using Equation (Exhibit 25-11)

V_{12} = 4285 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	8754	9000	No
V_{12}	4285	4400:All	No
$V_{FO} = V_F - V_R$	7924	9000	No
V_R	830	2000	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 36.6 (pc/ mi /ln)

LOS= E (Exhibit 25-4)

Speed Estimation

D_s = 0.503 (Exhibit 25-19)

S_R= 48.5 mph (Exhibit 25-19)

S_0= 55.5 mph (Exhibit 25-19)

S = 51.8 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

00

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 870 ft

Vu = 2201 veh/h

Terrain Level

S $_{FF}$ = 55.0 mph S$_{FR}$ = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☑ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5171	0.90	Level	8	0	0.962	1.00	5975
Ramp	433	0.90	Level	4	0	0.980	1.00	491
UpStream	2201	0.90	Level	4	0	0.980	1.00	2494
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.194 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 1157 pc/h	V_{12} = pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}	6466	9000	No
V_{R12}	1648	4600:All	No

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
V_{FI}=V_F		See Exhibit 25-14	
V_{12}		4400:All	
V_{FO} = V_F - V_R		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
D_R = 5.475 + 0.00734 v $_R$ + 0.0078 V_{12} - 0.00627 L_A	D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D
D_R = 17.2 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = B (Exhibit 25-4)	LOS= (Exhibit 25-4)
Speed Estimation	***Speed Estimation***
M_S = 0.328 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 50.7 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 48.5 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4643	0.90	Level	8	0	0.962	1.00	5365
Ramp	528	0.90	Level	4	0	0.980	1.00	598
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12}

Merge Areas

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.596 using Equation (Exhibit 25-5)

V_{12}= 3199 pc/h

Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	5963	6750	No
V_{R12}	4180	4600:All	No

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 33.6 (pc/ mi /ln)

LOS = D (Exhibit 25-4)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

M_S = 0.516 (Exibit 25-19)

S_R= 48.3 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 48.9 mph (Exhibit 25-14)

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain Level

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1100 ft

VD = 550 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6022	0.90	Level	8	0	0.962	1.00	6959
Ramp	542	0.90	Level	4	0	0.980	1.00	614
UpStream								
DownStream	550	0.90	Level	4	0	0.980	1.00	623

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge Areas)

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Estimation of v_{12} (Diverge Areas)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.558 using Equation (Exhibit 25-11)

V_{12} = 4153 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6959	6750	Yes
V_{12}	4153	4400:All	No
$V_{FO} = V_F - V_R$	6345	6750	No
V_R	614	2100	No

Level of Service Determination (if not F) (Merge Areas)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Level of Service Determination (if not F) (Diverge Areas)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 36.4 (pc/ mi /ln)

LOS= F (Exhibit 25-4)

Speed Estimation (Merge Areas)

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Speed Estimation (Diverge Areas)

D_s = 0.353 (Exhibit 25-19)

S_R= 50.4 mph (Exhibit 25-19)

S_0= 53.3 mph (Exhibit 25-19)

S = 51.5 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain Level	Downstream Adj Ramp
☐ Yes ☐ On ☑ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 35.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	☑ Yes ☐ On ☐ No ☑ Off L_{down} = 735 ft VD = 1228 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6992	0.90	Level	8	0	0.962	1.00	8080
Ramp	649	0.90	Level	4	0	0.980	1.00	736
UpStream								
DownStream	1228	0.90	Level	4	0	0.980	1.00	1392

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.436 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 3938 pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
V_{FI}=V_F	8080	9000	No
V_{12}	3938	4400:All	No
$V_{FO} = V_F - V_R$	7344	9000	No
V_R	736	2000	No

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 33.6 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= D (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.494 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 48.6 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 56.2 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 52.2 mph (Exhibit 25-15)

HCS2000™ Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Southbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

00

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 870 ft

Vu = 1228 veh/h

Terrain Level

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☑ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6023	0.90	Level	8	0	0.962	1.00	6960
Ramp	536	0.90	Level	4	0	0.980	1.00	607
UpStream	1228	0.90	Level	4	0	0.980	1.00	1392
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.179 using Equation (Exhibit 25-5)

V_{12}= 1246 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7567	9000	No
V_{R12}	1853	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 18.7 (pc/ mi /ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.332 (Exibit 25-19)

S_R= 50.7 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 46.4 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd Northbound
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5115	0.90	Level	8	0	0.962	1.00	5911
Ramp	908	0.90	Level	4	0	0.980	1.00	1029
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.596 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3524 pc/h	V_{12} = pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}	6940	6750	Yes
V_{R12}	4975	4600:All	Yes

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 39.6 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = F (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = 0.825 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 44.3 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 45.7 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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FREEWAY WEAVING WORKSHEET

General Information / Site Information

Analyst	Brian Gaffney	Freeway/Dir of Travel	EB I-240 & Airways
Agency/Company	Clinard Engineering	Weaving Seg Location	
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Inputs

Freeway free-flow speed, SFF (mi/h)	55	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.16
Weaving seg length, L (ft)	300	Weaving ratio, R	0.47
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	5157	0.90	8	0	1.5	1.2	0.962	1.00	5959
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	454	0.90	8	0	1.5	1.2	0.962	1.00	524
Vw2	511	0.90	6	0	1.5	1.2	0.971	1.00	584
Vw				1108	Vnw				5959
V									7067

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	3.04	1.45		
Weaving and non-weaving speeds, Si (mi/h)	26.13	33.39		

Number of lanes required for unconstrained operation, Nw	0.93
Maximum number of lanes, Nw (max)	1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	31.99
Weaving segment density, D (pc/mi/ln)	55.22
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	6164
Capacity as a 15-minute flow rate, c (veh/h)	5927
Capacity as a full-hour volume, c_h (veh/h)	5334

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 & Airways SB
Agency/Company	Clinard Engineering	Weaving Seg Location	3
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	55	Weaving type	B
Weaving number of lanes, N	3	Volume ratio, VR	0.47
Weaving seg length, L (ft)	700	Weaving ratio, R	0.19
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	3047	0.90	6	0	1.5	1.2	0.971	1.00	3487
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	511	0.90	6	0	1.5	1.2	0.971	1.00	584
Vw2	2201	0.90	6	0	1.5	1.2	0.971	1.00	2518
Vw				3102	Vnw				3487
V									6589

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.00		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	1.54	1.68		
Weaving and non-weaving speeds, Si (mi/h)	32.70	31.79		

Number of lanes required for unconstrained operation, Nw 2.30

Maximum number of lanes, Nw (max) 3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	32.21
Weaving segment density, D (pc/mi/ln)	68.19
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	4564
Capacity as a 15-minute flow rate, c (veh/h)	4431
Capacity as a full-hour volume, c_h (veh/h)	3988

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	Airways Blvd NB to I-240
Agency/Company	Clinard Engineering	Weaving Seg Location	
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Inputs

Freeway free-flow speed, SFF (mi/h)	55	Weaving type	A
Weaving number of lanes, N	2	Volume ratio, VR	0.62
Weaving seg length, L (ft)	850	Weaving ratio, R	0.12
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	fHV	fp	v
Vo1	399	0.90	6	0	1.5	1.2	0.971	1.00	456
Vo2	243	0.90	6	0	1.5	1.2	0.971	1.00	278
Vw1	931	0.90	6	0	1.5	1.2	0.971	1.00	1065
Vw2	129	0.90	6	0	1.5	1.2	0.971	1.00	147
Vw				1212	Vnw				734
V									1946

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	1.56	1.18		
Weaving and non-weaving speeds, Si (mi/h)	32.57	35.62		

Number of lanes required for unconstrained operation, Nw	1.19
Maximum number of lanes, Nw (max)	1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	33.66
Weaving segment density, D (pc/mi/ln)	28.91
Level of service, LOS	D
Capacity of base condition, c_b (pc/h)	
Capacity as a 15-minute flow rate, c (veh/h)	
Capacity as a full-hour volume, c_h (veh/h)	

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

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FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	EB I-240 & Airways
Agency/Company	Clinard Engineering	Weaving Seg Location	
Date Performed	1/26/2007	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	55	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.17
Weaving seg length, L (ft)	300	Weaving ratio, R	0.48
Terrain	Level		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	4978	0.90	8	0	1.5	1.2	0.962	1.00	5752
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	502	0.90	8	0	1.5	1.2	0.962	1.00	580
Vw2	550	0.90	6	0	1.5	1.2	0.971	1.00	629
Vw				1209	Vnw				5752
V									6961

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	3.10	1.50		
Weaving and non-weaving speeds, Si (mi/h)	25.99	32.97		

Number of lanes required for unconstrained operation, Nw	0.99
Maximum number of lanes, Nw (max)	1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	31.50
Weaving segment density, D (pc/mi/ln)	55.24
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	6066
Capacity as a 15-minute flow rate, c (veh/h)	5833
Capacity as a full-hour volume, c_h (veh/h)	5250

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	Brian Gaffney
Agency/Company	Clinard Engineering
Date Performed	1/26/2007
Analysis Time Period	Existing PM

Site Information

Freeway/Dir of Travel	I-240 & Airways SB
Weaving Seg Location	3
Jurisdiction	Shelby County
Analysis Year	2032

Inputs

Freeway free-flow speed, SFF (mi/h)	55
Weaving number of lanes, N	3
Weaving seg length, L (ft)	700
Terrain	Level

Weaving type	B
Volume ratio, VR	0.61
Weaving ratio, R	0.31

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	fHV	fp	v
Vo1	1115	0.90	6	0	1.5	1.2	0.971	1.00	1276
Vo2	0	0.90	6	0	1.5	1.2	0.971	1.00	0
Vw1	550	0.90	6	0	1.5	1.2	0.971	1.00	629
Vw2	1228	0.90	6	0	1.5	1.2	0.971	1.00	1405
Vw				2034	Vnw				1276
V									3310

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.00		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	1.17	1.48		
Weaving and non-weaving speeds, Si (mi/h)	35.74	33.17		

Number of lanes required for unconstrained operation, Nw	2.70
Maximum number of lanes, Nw (max)	3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	34.70
Weaving segment density, D (pc/mi/ln)	31.80
Level of service, LOS	D
Capacity of base condition, c_b (pc/h)	4171
Capacity as a 15-minute flow rate, c (veh/h)	4050
Capacity as a full-hour volume, c_h (veh/h)	3645

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	Brian Gaffney
Agency/Company	Clinard Engineering
Date Performed	1/26/2007
Analysis Time Period	Existing PM

Site Information

Freeway/Dir of Travel	Airways Blvd NB to I-240
Weaving Seg Location	
Jurisdiction	Shelby County
Analysis Year	2032

Inputs

Freeway free-flow speed, SFF (mi/h)	55
Weaving number of lanes, N	2
Weaving seg length, L (ft)	850
Terrain	Level

Weaving type	A
Volume ratio, VR	0.56
Weaving ratio, R	0.26

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
Vo1	499	0.90	6	0	1.5	1.2	0.971	1.00	571
Vo2	723	0.90	6	0	1.5	1.2	0.971	1.00	827
Vw1	1163	0.90	6	0	1.5	1.2	0.971	1.00	1330
Vw2	409	0.90	6	0	1.5	1.2	0.971	1.00	468
Vw				1798	Vnw				1398
V									3196

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.15	0.00		
b (Exhibit 24-6)	2.20	4.00		
c (Exhibit 24-6)	0.97	1.30		
d (Exhibit 24-6)	0.80	0.75		
Weaving intensity factor, Wi	2.33	1.94		
Weaving and non-weaving speeds, Si (mi/h)	28.53	30.32		

Number of lanes required for unconstrained operation, Nw 1.19

Maximum number of lanes, Nw (max) 1.40

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

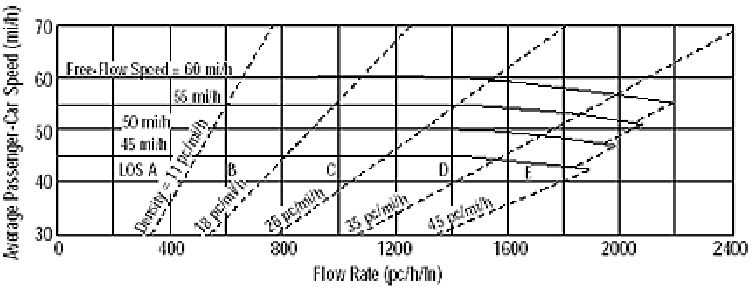
Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	29.29
Weaving segment density, D (pc/mi/ln)	54.56
Level of service, LOS	F
Capacity of base condition, c_b (pc/h)	
Capacity as a 15-minute flow rate, c (veh/h)	
Capacity as a full-hour volume, c_h (veh/h)	

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - AM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	North of I-240
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	2037	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	1165
Speed, S (mi/h)	45.0
D (pc/mi/ln)	25.9
LOS	C

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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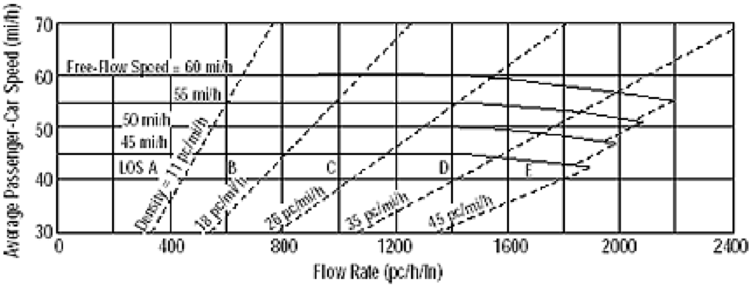
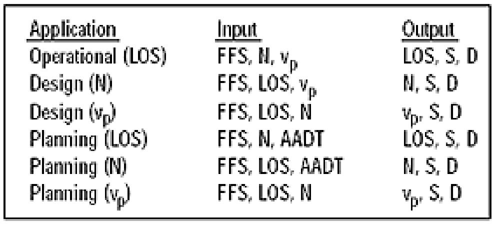
MULTILANE HIGHWAYS WORKSHEET(Direction 1)





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - AM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	South of I-240
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1583	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	905
Speed, S (mi/h)	45.0
D (pc/mi/ln)	20.1
LOS	C

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

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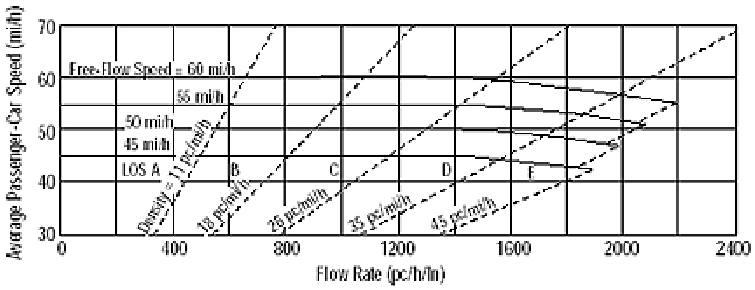
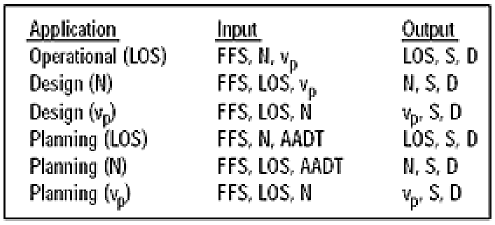
MULTILANE HIGHWAYS WORKSHEET(Direction 1)





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - PM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	North of I-240
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1549	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	886
Speed, S (mi/h)	45.0
D (pc/mi/ln)	19.7
LOS	C

Design

Design (N)

Required Number of Lanes, N

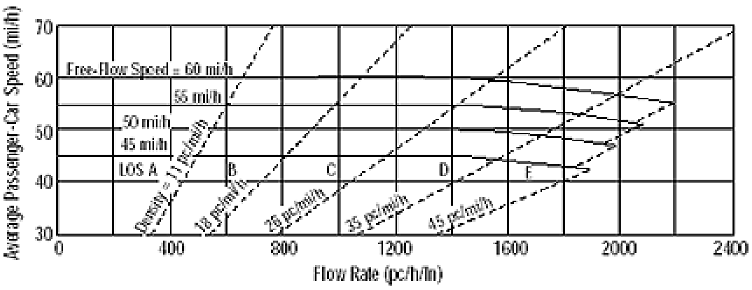
Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

HCS2000™ Version 4.1d

MULTILANE HIGHWAYS WORKSHEET(Direction 1)



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering AssociatesI-240 Interchange @ Airways Boulevard
Date Performed	3/23/2007
Analysis Time Period	Existing - PM

Site Information

Highway/Direction to Travel	Airways Boulevard
From/To	South of I-240
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

☑ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	1047	Peak-Hour Factor, PHF	0.90
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.971

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearence, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	45.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	45.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	599
Speed, S (mi/h)	45.0
D (pc/mi/ln)	13.3
LOS	B

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	Brian Gaffney	Intersection	Ketchum&Airways
Agency or Co.	Clinard Engineering	Area Type	CBD or Similar
Date Performed	1/18/2007	Jurisdiction	Shelby County
Time Period	AM Existing	Analysis Year	2032
		Project ID	I-240 & Airways Blvd

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	2	1	1	1	3	0	1	3	0
Lane group	L	T	R	L	T	R	L	TR		L	TR	
Volume, V (vph)	96	239	301	77	457	1058	211	2233	325	97	3413	110
% Heavy vehicles, %HV	0	0	0	0	0	0	4	4	4	4	4	4
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P	P	P	P	P	P
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	NS Perm	07	08
Timing	G = 10.0	G = 35.0	G =	G =	G = 10.0	G = 85.0	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 160.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	107	266	334	86	508	1176	234	2842		108	3914	
Lane group capacity, c	147	711	454	197	374	454	143	2339		143	2374	
v/c ratio, X	0.73	0.37	0.74	0.44	1.36	2.59	1.64	1.22		0.76	1.65	
	0.31	0.22	0.31	0.06	0.22	0.31	0.63	0.53		0.63	0.53	

Total green ratio, g/C												
Uniform delay, d_1	44.8	53.2	49.1	72.3	62.5	55.0	55.9	37.5		48.6	37.5	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50		0.50	0.50	
Incremental delay, d_2	26.9	1.5	10.2	6.9	177.8	722.0	315.7	100.9		30.4	293.8	
Initial queue delay, d_3												
Control delay	71.7	54.7	59.3	79.2	240.3	777.0	371.6	138.4		79.0	331.3	
Lane group LOS	E	D	E	E	F	F	F	F		E	F	
Approach delay	59.4			589.1			156.2			324.6		
Approach LOS	E			F			F			F		
Intersection delay	299.8			X_C = 2.92			Intersection LOS			F		

HCS2000™ DETAILED REPORT

General Information

Analyst	*Brian Gaffney*
Agency or Co.	*Clinard Engineering*
Date Performed	*1/18/2007*
Time Period	*PM Existing*

Site Information

Intersection	*Ketchum&Airways*
Area Type	*CBD or Similar*
Jurisdiction	*Shelby County*
Analysis Year	*2032*
Project ID	*I-240 & Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	2	1	1	1	3	0	1	3	0
Lane group	L	T	R	L	T	R	L	TR		L	TR	
Volume, V (vph)	241	284	192	166	251	595	384	1459	355	191	1843	137
% Heavy vehicles, %HV	0	0	0	0	0	0	4	4	4	4	4	4
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P	P	P	P	P	P
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Arrival type, AT	3	3	3	3	3	3	3	3		3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		0
Lane width	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0	0	0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	NS Perm	07	08
Timing	G = 10.0	G = 20.0	G =	G =	G = 10.0	G = 40.0	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 100.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	268	316	213	184	279	661	427	2015		212	2200	
Lane group capacity, c	266	650	509	315	342	509	228	1743		228	1777	
v/c ratio, X	1.01	0.49	0.42	0.58	0.82	1.30	1.87	1.16		0.93	1.24	
	0.35	0.20	0.35	0.10	0.20	0.35	0.55	0.40		0.55	0.40	

Total green ratio, g/C												
Uniform delay, d_1	34.8	35.4	24.7	43.0	38.2	32.5	30.2	30.0		28.7	30.0	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50		0.50	0.50	
Incremental delay, d_2	57.1	2.6	2.5	7.7	19.0	148.3	409.0	77.2		43.8	112.2	
Initial queue delay, d_3												
Control delay	91.9	38.0	27.3	50.7	57.2	180.8	439.2	107.2		72.5	142.2	
Lane group LOS	F	D	C	D	E	F	F	F		E	F	
Approach delay	53.3			128.8			165.2			136.0		
Approach LOS	D			F			F			F		
Intersection delay	135.6			X_C = 2.68			Intersection LOS			F		

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Airways&Democrat*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Existing AM*	Analysis Year	*2032*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	1	2	1	2	1	0	2	1	1	2	3	0
Lane group	L	T	R	L	TR		L	T	R	L	TR	
Volume, V (vph)	3	264	44	216	249	5	150	7	591	698	824	592
% Heavy vehicles, %HV	0	0	0	0	0	0	0	0	0	0	0	0
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P	P	P	P	P	P
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Arrival type, AT	3	3	3	3	3		3	3	3	3	3	
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		0
Lane width	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0	0	0	0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	Thru & RT	07	08
Timing	G = 5.0	G = 10.0	G =	G =	G = 15.0	G = 20.0	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 70.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	3	293	49	240	283		167	8	657	776	1574	
Lane group capacity, c	238	516	692	250	271		750	543	692	750	1389	
v/c ratio, X	0.01	0.57	0.07	0.96	1.04		0.22	0.01	0.95	1.03	1.13	

Total green ratio, g/C	0.29	0.14	0.43	0.07	0.14		0.21	0.29	0.43	0.21	0.29	
Uniform delay, d_1	18.8	28.0	11.8	32.4	30.0		22.7	17.9	19.3	27.5	25.0	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50	0.50	0.50	0.50	0.50	
Incremental delay, d_2	0.1	4.5	0.2	47.5	66.7		0.7	0.0	23.8	42.1	69.5	
Initial queue delay, d_3												
Control delay	18.8	32.5	12.0	79.9	96.7		23.4	18.0	43.1	69.6	94.5	
Lane group LOS	B	C	B	E	F		C	B	D	E	F	
Approach delay	29.4			89.0			38.9			86.3		
Approach LOS	C			F			D			F		
Intersection delay	72.0			$X_C = 0.99$			Intersection LOS			E		

HCS2000™ DETAILED REPORT

General Information

Analyst	*Brian Gaffney*
Agency or Co.	*Clinard Engineering Associates*
Date Performed	*5/29/2008*
Time Period	*Existing PM*

Site Information

Intersection	*Airways&Democrat*
Area Type	*All other areas*
Jurisdiction	*Memphis*
Analysis Year	*2032*
Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	*1*	*2*	*1*	*2*	*1*	*0*	*2*	*1*	*1*	*2*	*3*	*0*
Lane group	*L*	*T*	*R*	*L*	*TR*		*L*	*T*	*R*	*L*	*TR*	
Volume, V (vph)	*9*	*667*	*225*	*435*	*201*	*13*	*114*	*30*	*888*	*343*	*786*	*139*
% Heavy vehicles, %HV	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Peak-hour factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Pretimed (P) or actuated (A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Start-up lost time, l_1	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Extension of effective green, e	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Arrival type, AT	*3*	*3*	*3*	*3*	*3*		*3*	*3*	*3*	*3*	*3*	
Unit extension, UE	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*		*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	
Filtering/metering, I	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Initial unmet demand, Q_b	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Ped / Bike / RTOR volumes	*0*		*0*	*0*		*0*	*0*		*0*	*0*		*0*
Lane width	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*		*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	
Parking / Grade / Parking	*N*	*0*	*N*	*N*	*0*	*N*	*N*	*0*	*N*	*N*	*0*	*N*
Parking maneuvers, N_m												
Buses stopping, N_B	*0*	*0*	*0*	*0*	*0*		*0*	*0*	*0*	*0*	*0*	
Min. time for pedestrians, G_p	*3.2*			*3.2*			*3.2*			*3.2*		

Phasing	Excl. Left	EW Perm	03	04	Excl. Left	Thru & RT	07	08
Timing	G = *20.0*	G = *15.0*	G =	G =	G = *10.0*	G = *25.0*	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y = *5*	Y =	Y =
Duration of Analysis, T = *0.25*					Cycle Length, C = *90.0*			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	*10*	*741*	*250*	*483*	*237*		*127*	*33*	*987*	*381*	*1027*	
Lane group capacity, c	*512*	*602*	*538*	*778*	*314*		*389*	*528*	*897*	*389*	*1408*	
v/c ratio, X	*0.02*	*1.23*	*0.46*	*0.62*	*0.75*		*0.33*	*0.06*	*1.10*	*0.98*	*0.73*	

Total green ratio, g/C	0.44	0.17	0.33	0.22	0.17		0.11	0.28	0.56	0.11	0.28	
Uniform delay, d_1	14.7	37.5	23.7	31.6	35.7		36.9	23.9	20.0	39.9	29.4	
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50	0.50	0.50	0.50	0.50	
Incremental delay, d_2	0.1	117.9	2.9	3.7	15.5		2.2	0.2	61.3	40.8	3.4	
Initial queue delay, d_3												
Control delay	14.8	155.4	26.5	35.3	51.2		39.1	24.1	81.3	80.7	32.8	
Lane group LOS	B	F	C	D	D		D	C	F	F	C	
Approach delay	121.8			40.5			75.0			45.7		
Approach LOS	F			D			E			D		
Intersection delay	70.5			X_C = 1.06			Intersection LOS			E		

HCS2000™ DETAILED REPORT

General Information		Site Information	
Analyst	Brian Gaffney	Intersection	Democrat&Ramps
Agency or Co.	Clinard Engineering Associates	Area Type	All other areas
Date Performed	5/29/2008	Jurisdiction	Memphis
Time Period	Existing AM	Analysis Year	2032
		Project ID	I-240 @ Airways Boulevard

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	2	1	1	2	0	1	0	1	0	0	0
Lane group	L	T	R	L	TR		L		R			
Volume, V (vph)	126	1130	188	95	605	246	129		434			
% Heavy vehicles, %HV	0	0	0	0	0	0	0		0			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90			
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P		P			
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Arrival type, AT	3	3	3	3	3		3		3			
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0		3.0			
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000			
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0		0.0			
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		
Lane width	12.0	12.0	12.0	12.0	12.0		12.0		12.0			
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N		N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0		0			
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = 10.0	G = 25.0	G =	G =	G = 15.0	G =	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y =	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 65.0		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	140	1256	209	106	945		143		482			
Lane group capacity, c	1157	1388	1118	278	1328		417		745			
v/c ratio, X	0.12	0.90	0.19	0.38	0.71		0.34		0.65			
Total green ratio, g/C	0.62	0.38	0.69	0.15	0.38		0.23		0.46			

Uniform delay, d_1	6.9	18.9	3.5	24.7	16.9		20.9		13.4			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.2	10.0	0.4	3.9	3.3		2.2		4.3			
Initial queue delay, d_3												
Control delay	7.1	28.9	3.9	28.7	20.2		23.1		17.7			
Lane group LOS	A	C	A	C	C		C		B			
Approach delay	23.7			21.1			19.0					
Approach LOS	C			C			B					
Intersection delay	22.0			$X_C = 0.76$			Intersection LOS			C		

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Democrat&Ramps*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Existing PM*	Analysis Year	*2032*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	2	1	1	2	0	1	0	1	0	0	0
Lane group	L	T	R	L	TR		L		R			
Volume, V (vph)	509	696	541	169	893	623	106		271			
% Heavy vehicles, %HV	0	0	0	0	0	0	0		0			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90			
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P		P			
Start-up lost time, I_1	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Arrival type, AT	3	3	3	3	3		3		3			
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0		3.0			
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000			
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0		0.0			
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		
Lane width	12.0	12.0	12.0	12.0	12.0		12.0		12.0			
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N		N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0		0			
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

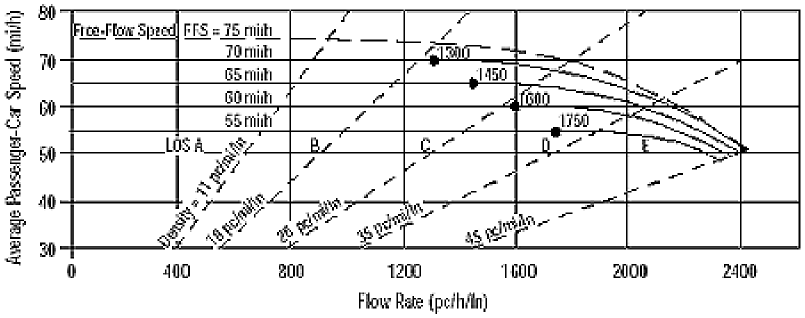
Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = 10.0	G = 30.0	G =	G =	G = 10.0	G =	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y =	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 65.0		

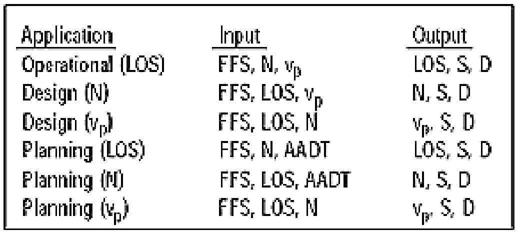
Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	566	773	601	188	1684		118		301			
Lane group capacity, c	1590	1666	1118	278	1563		278		621			
v/c ratio, X	0.36	0.46	0.54	0.68	1.08		0.42		0.48			
Total green ratio, g/C	0.69	0.46	0.69	0.15	0.46		0.15		0.38			

Uniform delay, d_1	11.3	12.0	4.9	26.0	17.5		24.9		15.1			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.6	0.9	1.9	12.5	46.8		4.7		2.7			
Initial queue delay, d_3												
Control delay	11.9	12.9	6.8	38.4	64.3		29.6		17.8			
Lane group LOS	B	B	A	D	E		C		B			
Approach delay	10.7			61.7			21.1					
Approach LOS	B			E			C					
Intersection delay	34.3			$X_c = 0.93$			Intersection LOS			C		

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5362 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2065	pc/h/ln
S	63.5	mi/h
D = v_p / S	32.5	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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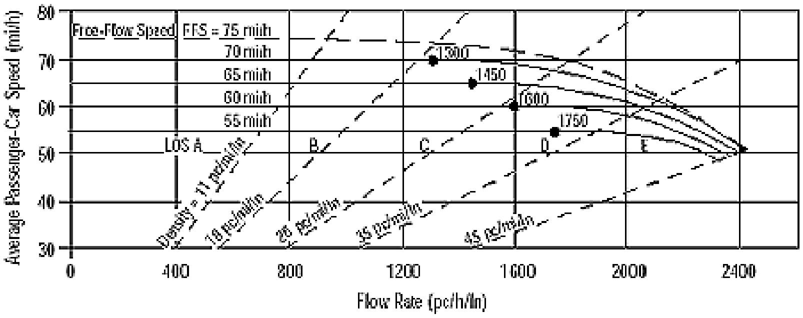
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	At Lamar Avenue Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6172 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2377	pc/h/ln
S	54.2	mi/h
D = v_p / S	43.8	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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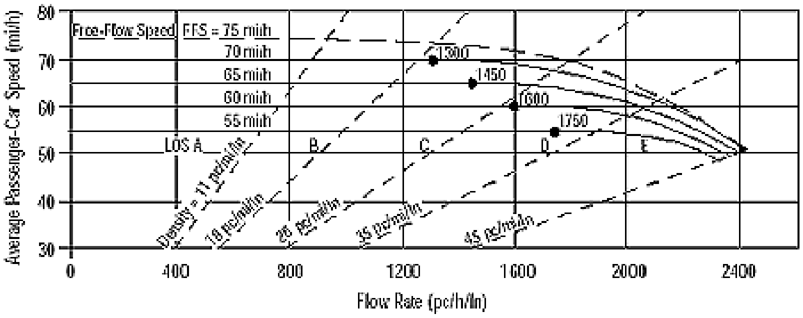
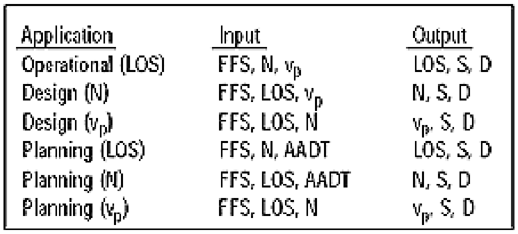
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5197 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2002	pc/h/ln
S	64.8	mi/h
D = v_p / S	30.9	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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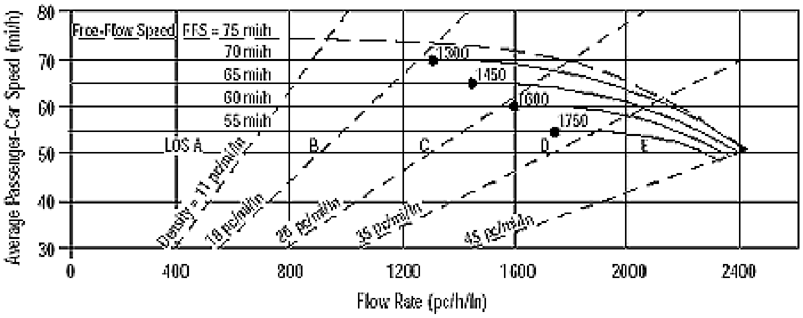
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information | Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4327 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs | Calc Speed Adj and FFS

Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	3		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1667	pc/h/ln
S	69.0	mi/h
D = v_p / S	24.1	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

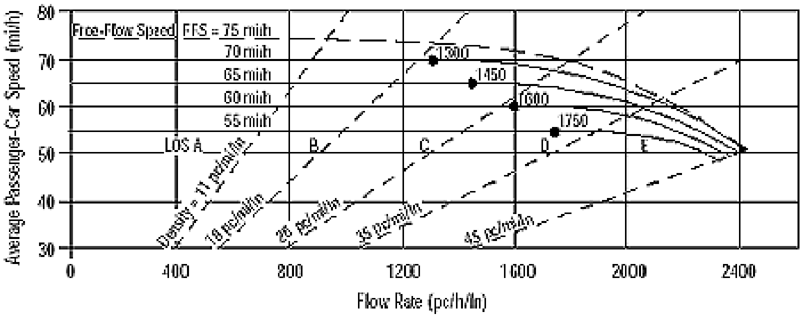
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6128 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2360	pc/h/ln
S	54.9	mi/h
D = v_p / S	43.0	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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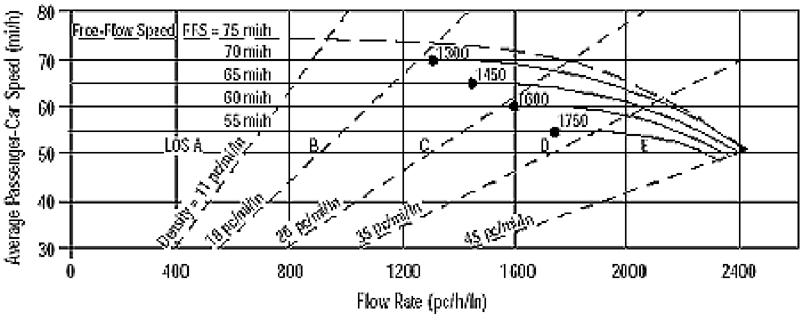
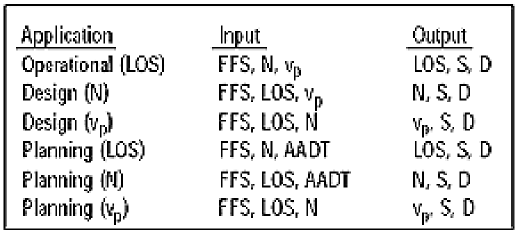
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5663 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2181	pc/h/ln
S	60.6	mi/h
D = v_p / S	36.0	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

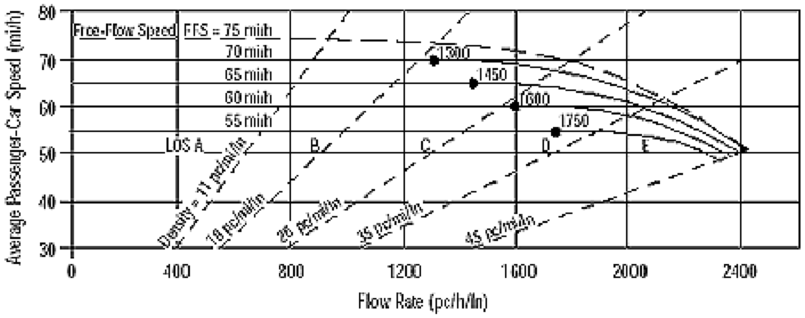
N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

HCS2000™ Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5256 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2025	pc/h/ln
S	64.4	mi/h
D = v_p / S	31.5	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

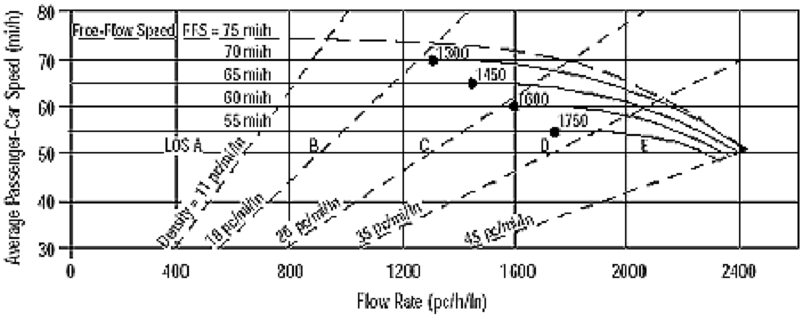
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5745 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2213	pc/h/ln
S	59.7	mi/h
D = v_p / S	37.0	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information **Site Information**

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5604	0.90	Level	8	0	0.962	1.00	6476
Ramp	1272	0.90	Level	4	0	0.980	1.00	1442
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F\ (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.532 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 4119 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6476	6750	No
V_{12}	4119	4400:All	No
$V_{FO} = V_F - V_R$	5034	6750	No
V_R	1442	2100	No

Merge Areas	Diverge Areas
Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 39.7 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= E (Exhibit 25-4)
Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.428 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 49.4 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 55.0 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 51.3 mph (Exhibit 25-15)

HCS2000™ Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5197	0.90	Level	8	0	0.962	1.00	6005
Ramp	1160	0.90	Level	4	0	0.980	1.00	1315
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.577 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3468 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7320	6750	Yes
V_{R12}	4783	4600:All	Yes

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 42.2 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = F (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = 0.787 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 44.8 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 45.5 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6559	0.90	Level	8	0	0.962	1.00	7579
Ramp	814	0.90	Level	4	0	0.980	1.00	923
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.528 using Equation (Exhibit 25-11)

V_{12} = 4438 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7579	6750	Yes
V_{12}	4438	4400:All	Yes
$V_{FO} = V_F - V_R$	6656	6750	No
V_R	923	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 42.4 (pc/ mi /ln)

LOS= F (Exhibit 25-4)

Speed Estimation

D_s = 0.381 (Exhibit 25-19)

S_R= 50.0 mph (Exhibit 25-19)

S_0= 52.0 mph (Exhibit 25-19)

S = 50.8 mph (Exhibit 25-15)

HCS2000™ Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5256	0.90	Level	8	0	0.962	1.00	6074
Ramp	766	0.90	Level	4	0	0.980	1.00	868
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.577 using Equation (Exhibit 25-5)

V_{12}= 3508 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6942	6750	Yes
V_{R12}	4376	4600:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$$

D_R = 39.2 (pc/ mi /ln)

LOS = F (Exhibit 25-4)

Speed Estimation

M_S = 0.631 (Exibit 25-19)

S_R= 46.8 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 46.8 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

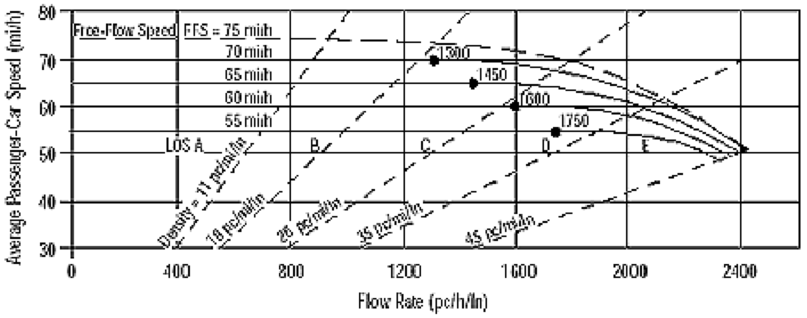
S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

2012 CAPACITY ANALYSIS
LAMAR AVE & MILL BRANCH
(EXISTING)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5030 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1937	pc/h/ln
S	66.0	mi/h
D = v_p / S	29.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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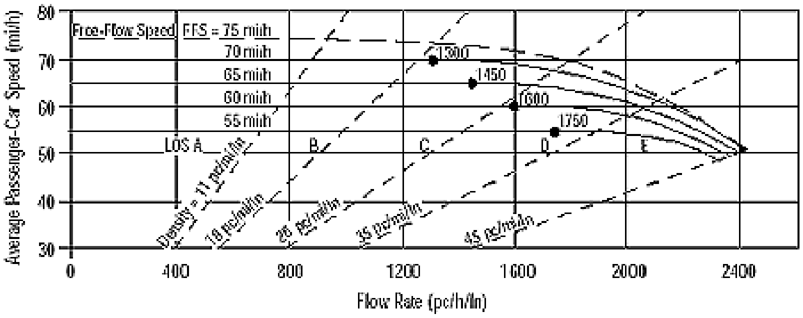
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5791 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2231	pc/h/ln
S	59.2	mi/h
D = v_p / S	37.7	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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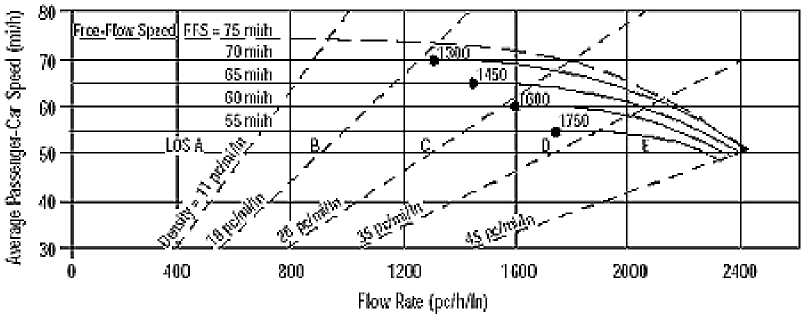
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4913 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1892	pc/h/ln
S	66.7	mi/h
D = v_p / S	28.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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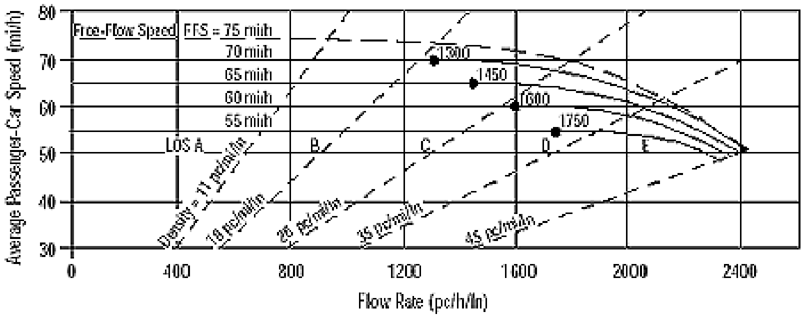
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4252 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1638	pc/h/ln
S	69.2	mi/h
D = v_p / S	23.7	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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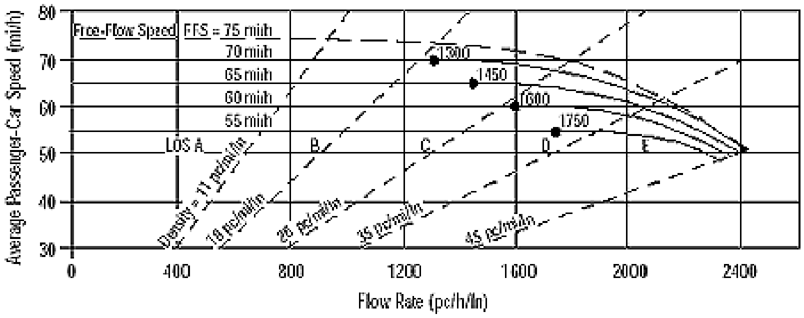
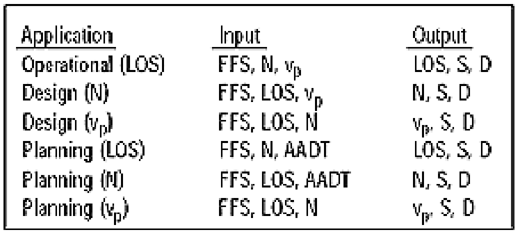
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5748 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2214	pc/h/ln
S	59.7	mi/h
D = v_p / S	37.1	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

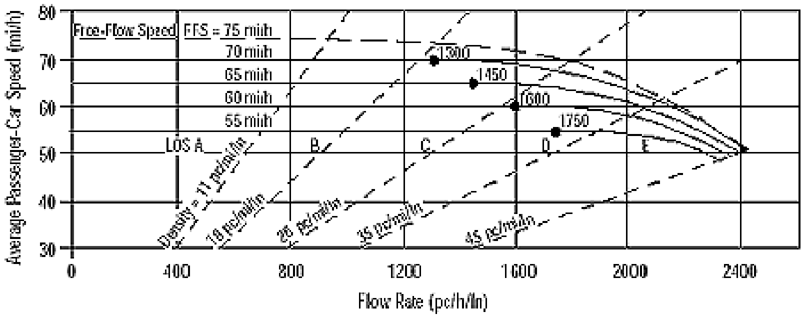
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5313 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2046	pc/h/ln
S	63.9	mi/h
D = v_p / S	32.0	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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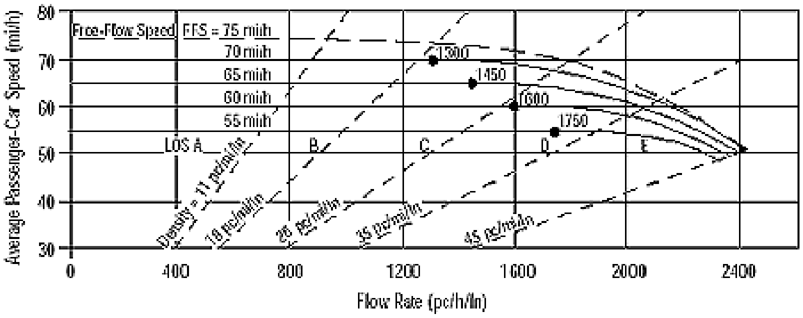
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5067 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1952	pc/h/ln
S	65.7	mi/h
D = v_p / S	29.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

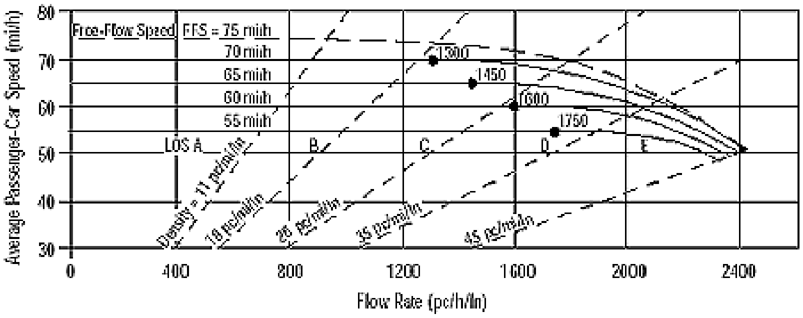
Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5427 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2090	pc/h/ln
S	63.0	mi/h
D = v_p / S	33.2	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5465	0.90	Level	8	0	0.962	1.00	6315
Ramp	1213	0.90	Level	4	0	0.980	1.00	1375
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge Areas)

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Estimation of v_{12} (Diverge Areas)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.539 using Equation (Exhibit 25-11)

V_{12} = 4037 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6315	6750	No
V_{12}	4037	4400:All	No
$V_{FO} = V_F - V_R$	4940	6750	No
V_R	1375	2100	No

Level of Service Determination (if not F) (Merge Areas)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Level of Service Determination (if not F) (Diverge Areas)

$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$

D_R = 39.0 (pc/ mi /ln)

LOS= E (Exhibit 25-4)

Speed Estimation (Merge Areas)

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Speed Estimation (Diverge Areas)

D_s = 0.422 (Exhibit 25-19)

S_R= 49.5 mph (Exhibit 25-19)

S_0= 55.4 mph (Exhibit 25-19)

S = 51.5 mph (Exhibit 25-15)

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Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information **Site Information**

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4913	0.90	Level	8	0	0.962	1.00	5677
Ramp	1101	0.90	Level	4	0	0.980	1.00	1248
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.577 using Equation (Exhibit 25-5)

V_{12}= 3278 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6925	6750	Yes
V_{R12}	4526	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 40.2 (pc/ mi /ln)

LOS = F (Exhibit 25-4)

Speed Estimation

M_S = 0.681 (Exibit 25-19)

S_R= 46.1 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 46.7 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	03/17/2009	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4252	0.90	Level	8	0	0.962	1.00	4913
Ramp	433	0.90	Level	4	0	0.980	1.00	491
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.577 using Equation (Exhibit 25-5)

V_{12}= 2837 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	5404	6750	No
V_{R12}	3328	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 31.2 (pc/ mi /ln)

LOS = D (Exhibit 25-4)

Speed Estimation

M_S = 0.430 (Exhibit 25-19)

S_R= 49.4 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 49.4 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information **Site Information**

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6200	0.90	Level	8	0	0.962	1.00	7164
Ramp	773	0.90	Level	4	0	0.980	1.00	876
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.541 using Equation (Exhibit 25-11)

V_{12} = 4275 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7164	6750	Yes
V_{12}	4275	4400:All	No
$V_{FO} = V_F - V_R$	6288	6750	No
V_R	876	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 41.0 (pc/ mi /ln)

LOS= F (Exhibit 25-4)

Speed Estimation

D_s = 0.377 (Exhibit 25-19)

S_R= 50.1 mph (Exhibit 25-19)

S_0= 53.0 mph (Exhibit 25-19)

S = 51.2 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information **Site Information**

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5067	0.90	Level	8	0	0.962	1.00	5855
Ramp	727	0.90	Level	4	0	0.980	1.00	824
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.577 using Equation (Exhibit 25-5)

V_{12}= 3381 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6679	6750	No
V_{R12}	4205	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 37.9 (pc/ mi /ln)

LOS = E (Exhibit 25-4)

Speed Estimation

M_S = 0.582 (Exibit 25-19)

S_R= 47.4 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 47.4 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	03/17/2009	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5427	0.90	Level	8	0	0.962	1.00	6271
Ramp	658	0.90	Level	4	0	0.980	1.00	746
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.577 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3622 pc/h	V_{12} = pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}	7017	6750	Yes
V_{R12}	4368	4600:All	No

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 39.2 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = F (Exhibit 25-4)	LOS= (Exhibit 25-4)
Speed Estimation	***Speed Estimation***
M_S = 0.629 (Exhibit 25-19)	D_s = (Exhibit 25-19)
S_R= 46.8 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 46.7 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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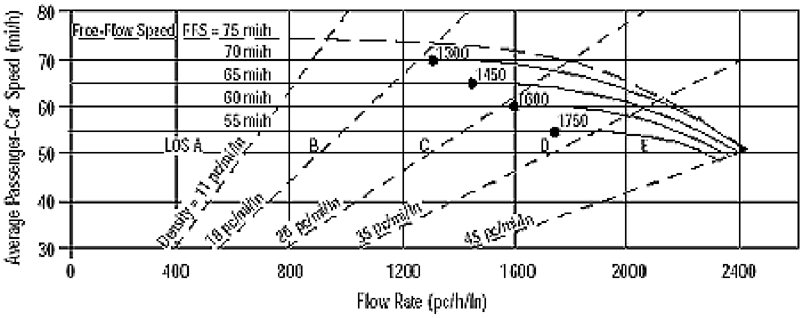
2032 CAPACITY ANALYSIS
LAMAR AVE & MILL BRANCH
(EXISTING)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Lamar Avenue Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5362 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2065	pc/h/ln
S	63.5	mi/h
D = v_p / S	32.5	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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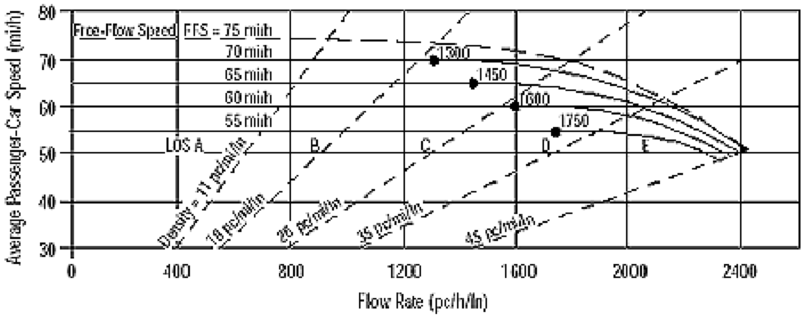
Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / *Site Information*

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6172 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2377	pc/h/ln
S	54.2	mi/h
D = v_p / S	43.8	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

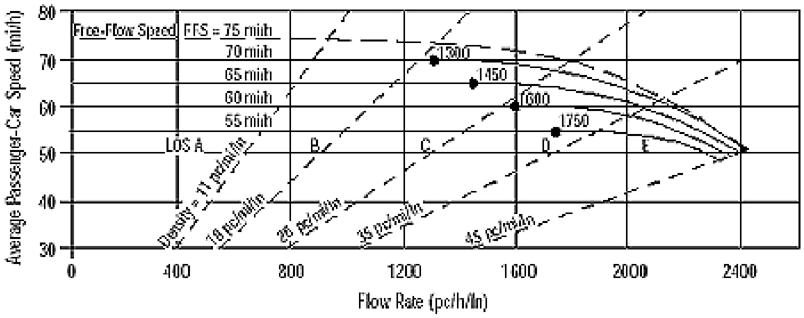
Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™

Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5197 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2002	pc/h/ln
S	64.8	mi/h
D = v_p / S	30.9	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

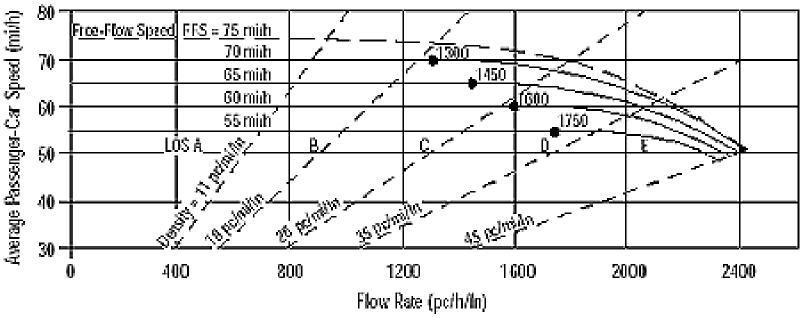
Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™

Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4327 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1667	pc/h/ln
S	69.0	mi/h
D = v_p / S	24.1	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

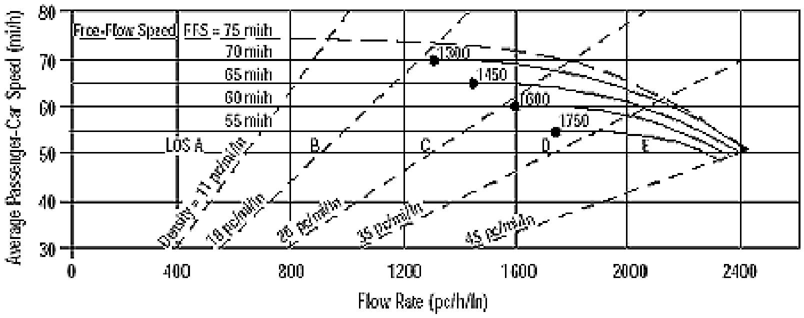
Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		Site Information	
Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6128 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	3		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2360	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	54.9	mi/h	S	mi/h
D = v_p / S	43.0	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	E		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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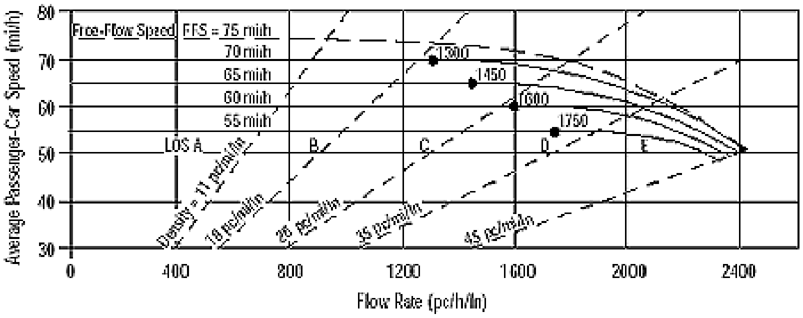
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Lamar Avenue Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

(Site Information in right columns)

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5663 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2181	pc/h/ln
S	60.6	mi/h
D = v_p / S	36.0	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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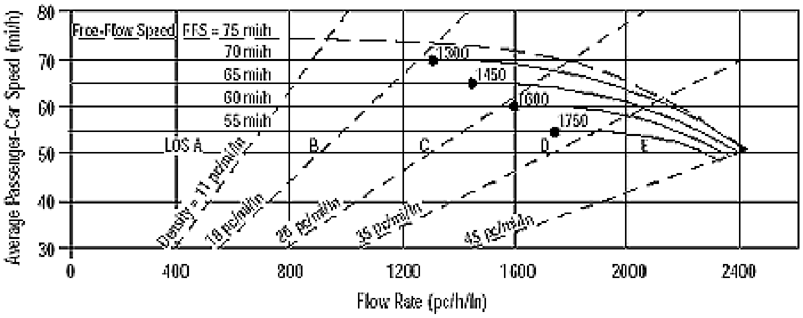
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Existing PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5256 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2025	pc/h/ln
S	64.4	mi/h
D = v_p / S	31.5	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

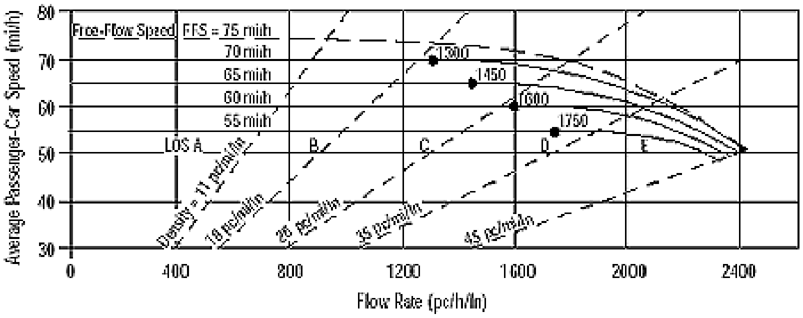
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5745 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	3	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2213	pc/h/ln
S	59.7	mi/h
D = v_p / S	37.0	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits23-8, 23-10
f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11
f_{LC} - Exhibit 23-5
f_p - Page 23-12
f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{ID} - Exhibit 23-7

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Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5604	0.90	Level	8	0	0.962	1.00	6476
Ramp	1272	0.90	Level	4	0	0.980	1.00	1442
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$ L_{EQ} = (Equation 25-2 or 25-3) P_{FM}= using Equation (Exhibit 25-5) V_{12}= pc/h	$V_{12} = V_R + (V_F - V_R)P_{FD}$ L_{EQ} = (Equation 25-8 or 25-9) P_{FD} =0.532 using Equation (Exhibit 25-11) V_{12} = 4119 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6476	6750	No
V_{12}	4119	4400:All	No
$V_{FO} = V_F - V_R$	5034	6750	No
V_R	1442	2100	No

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 39.7 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= E (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = (Exibit 25-19)	D_s = 0.428 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 49.4 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 55.0 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 51.3 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5197	0.90	Level	8	0	0.962	1.00	6005
Ramp	1160	0.90	Level	4	0	0.980	1.00	1315
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$ L_{EQ} = (Equation 25-2 or 25-3) P_{FM}= 0.577 using Equation (Exhibit 25-5) V_{12}= 3468 pc/h	$V_{12} = V_R + (V_F - V_R)P_{FD}$ L_{EQ} = (Equation 25-8 or 25-9) P_{FD} = using Equation (Exhibit 25-11) V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7320	6750	Yes
V_{R12}	4783	4600:All	Yes

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	**Level of Service Determination (if not F)**
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 42.2 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = F (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	**Speed Estimation**
M_S = 0.787 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 44.8 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 45.5 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	03/17/2009	Jurisdiction	Shelby County
Analysis Time Period	Existing AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4327	0.90	Level	8	0	0.962	1.00	5000
Ramp	456	0.90	Level	4	0	0.980	1.00	517
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.577 using Equation (Exhibit 25-5)

V_{12}= 2887 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	5517	6750	No
V_{R12}	3404	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 31.8 (pc/ mi /ln)

LOS = D (Exhibit 25-4)

Speed Estimation

M_S = 0.438 (Exhibit 25-19)

S_R= 49.3 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 49.3 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6559	0.90	Level	8	0	0.962	1.00	7579
Ramp	814	0.90	Level	4	0	0.980	1.00	923
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.528 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 4438 pc/h

Capacity Checks (Merge Areas)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge Areas)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7579	6750	Yes
V_{12}	4438	4400:All	Yes
$V_{FO} = V_F - V_R$	6656	6750	No
V_R	923	2100	No

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 42.4 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= F (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.381 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 50.0 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 52.0 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 50.8 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5256	0.90	Level	8	0	0.962	1.00	6074
Ramp	766	0.90	Level	4	0	0.980	1.00	868
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.577 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 3508 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6942	6750	Yes
V_{R12}	4376	4600:All	No

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	**Level of Service Determination (if not F)**
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 39.2 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = F (Exhibit 25-4)	LOS= (Exhibit 25-4)
Speed Estimation	**Speed Estimation**
M_S = 0.631 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 46.8 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 46.8 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	03/17/2009	Jurisdiction	Shelby County
Analysis Time Period	Existing PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off		☐ Yes ☐ On ☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5745	0.90	Level	8	0	0.962	1.00	6639
Ramp	692	0.90	Level	4	0	0.980	1.00	784
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.577 using Equation (Exhibit 25-5)

V_{12}= 3834 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7423	6750	Yes
V_{R12}	4618	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 41.1 (pc/ mi /ln)

LOS = F (Exhibit 25-4)

Speed Estimation

M_S = 0.716 (Exhibit 25-19)

S_R= 45.7 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 45.6 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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APPENDIX H

CAPACITY ANALYSIS: PROPOSED MODIFICATIONS

Concept B Freeway Analysis (6)

Location	2012 AM	2012 PM	2032 AM	2032 PM
EB I-240 West of Airways Boulevard	C	C	D	C
WB I-240 West of Airways Boulevard	C	D	C	D
EB I-240 @ Airways Boulevard	C	C	C	C
WB I-240 @ Airways Boulevard	C	C	C	C
EB I-240 East of Airways Boulevard	D	D	D	D
WB I-240 East of Airways Boulevard	D	D	E	D

Concept B Ramp Analysis (4)

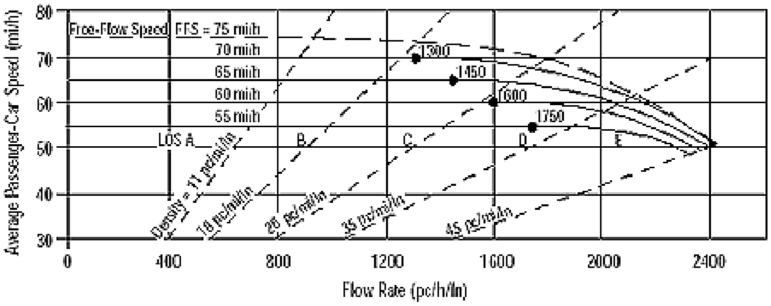
Location	2012 AM	2012 PM	2032 AM	2032 PM
EB I-240 to SB Plough Boulevard	B	B	C	B
Airways Blvd/Democrat Rd to EB I-240	C	C	C	C
WB I-240 to Airways Boulevard / Plough Blvd	D	C	F	C
Airways Bloulevard to WB I-240	C	C	C	C

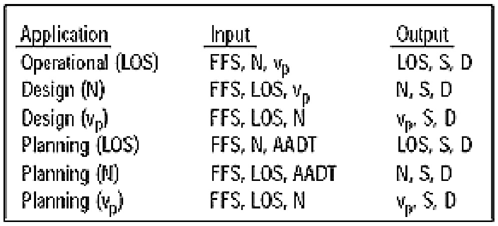
Concept B Intersection Analysis (1)

Location	2012 AM	2012 PM	2032 AM	2032 PM
Single Point Interchange	C	C	C	C
Democrat Road & Plough/I-240 Ramps	B	B	C	D

2012 CAPACITY ANALYSIS
(PROPOSED)

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	3/16/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6014 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1737	pc/h/ln
S	68.5	mi/h
D = v_p / S	25.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

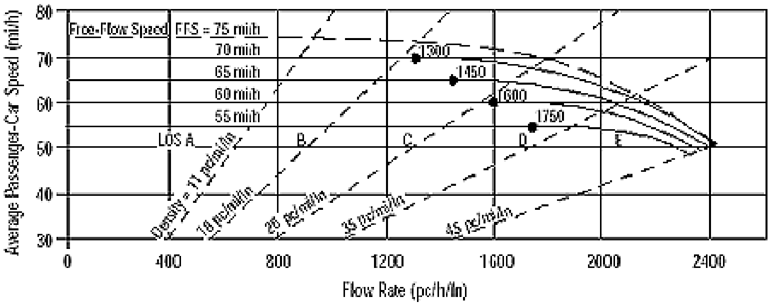
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5465 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1579	pc/h/ln
S	69.5	mi/h
D = v_p / S	22.7	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

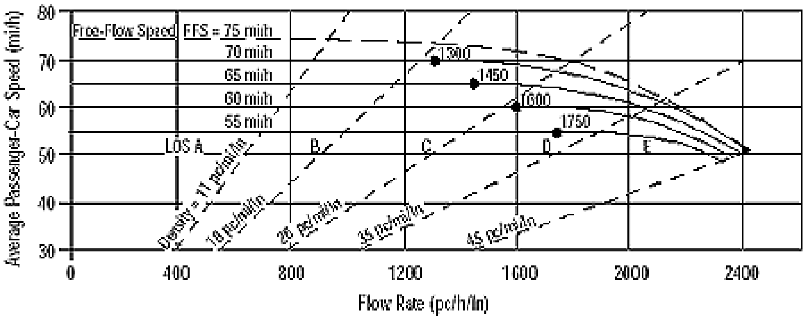
Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits23-8, 23-10
f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11
f_{LC} - Exhibit 23-5
f_p - Page 23-12
f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	Airways Blvd
Date Performed	3/16/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5014 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1448	pc/h/ln
S	69.9	mi/h
D = v_p / S	20.7	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

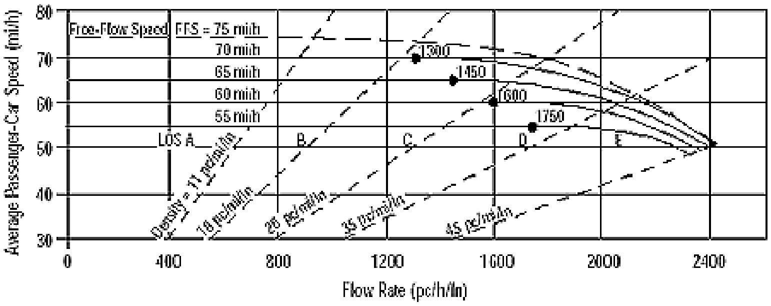
Glossary

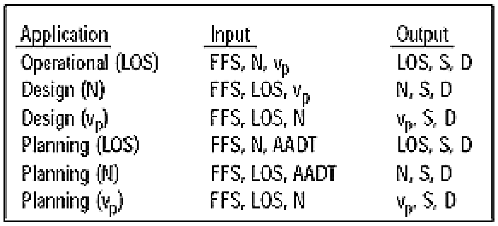
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		***Site Information***	
Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4664 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs			**Calc Speed Adj and FFS**		
Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	4		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures			**Design (N)**	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1347	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	70.0	mi/h	S	mi/h
D = v_p / S	19.2	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary		**Factor Location**	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

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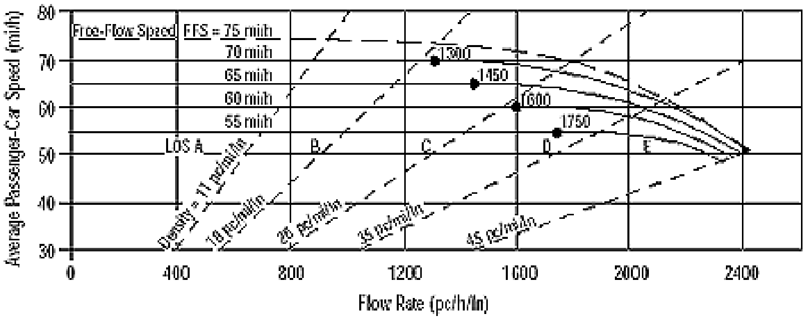
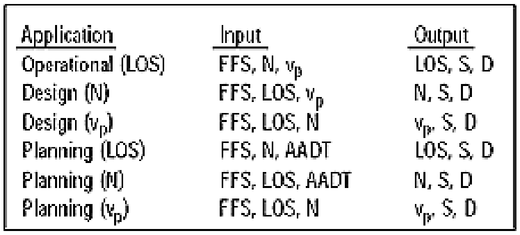
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	East of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6418 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1854	pc/h/ln
S	67.2	mi/h
D = v_p / S	27.6	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

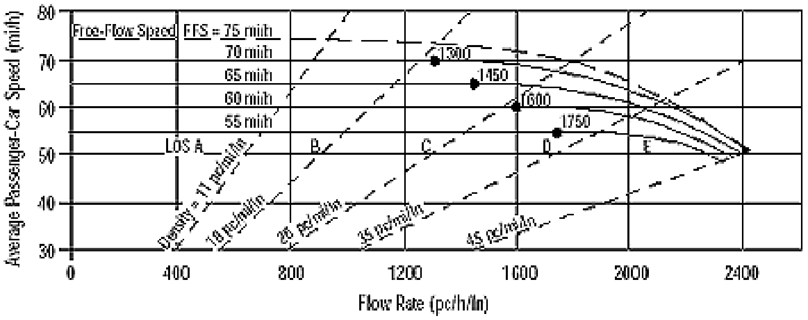
Glossary

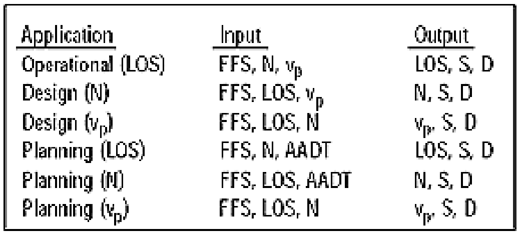
N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Concept B - AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7108 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2053	pc/h/ln
S	63.8	mi/h
D = v_p / S	32.2	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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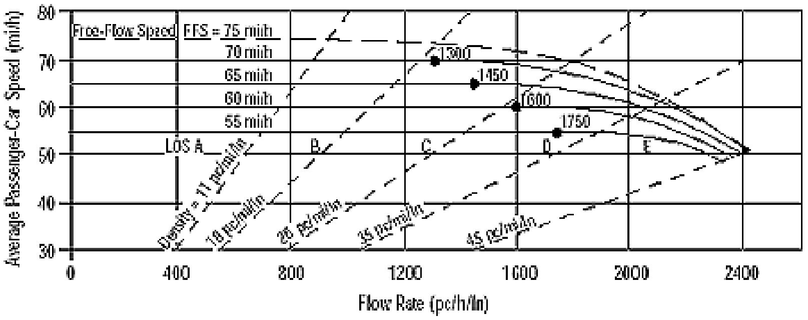
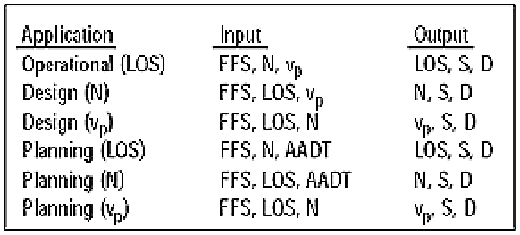
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	3/16/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5794 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1674	pc/h/ln
S	69.0	mi/h
D = v_p / S	24.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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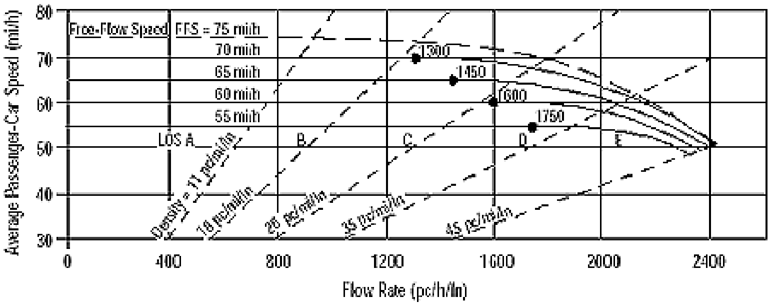
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Concept B - PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	West of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6200 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1791	pc/h/ln
S	68.0	mi/h
D = v_p / S	26.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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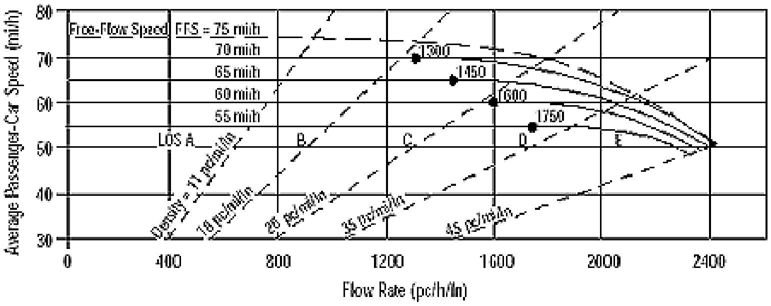
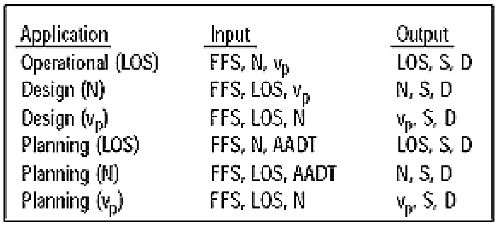
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	3/16/2007
Analysis Time Period	Concept B - PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4924 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1422	pc/h/ln
S	69.9	mi/h
D = v_p / S	20.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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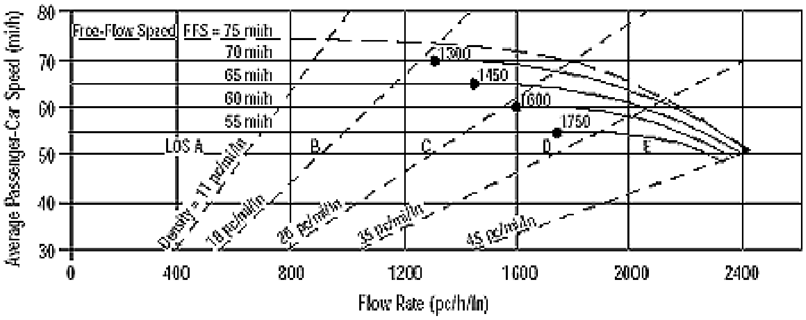
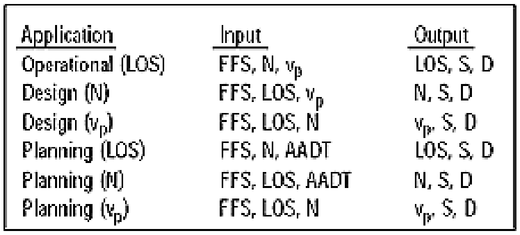
Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4996 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1443	pc/h/ln
S	69.9	mi/h
D = v_p / S	20.6	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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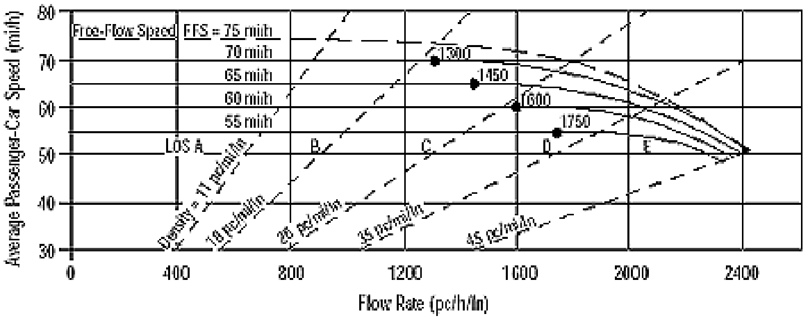
Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / *Site Information*

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	East of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6954 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs / Calc Speed Adj and FFS

Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	4		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2009	pc/h/ln
S	64.7	mi/h
D = v_p / S	31.1	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

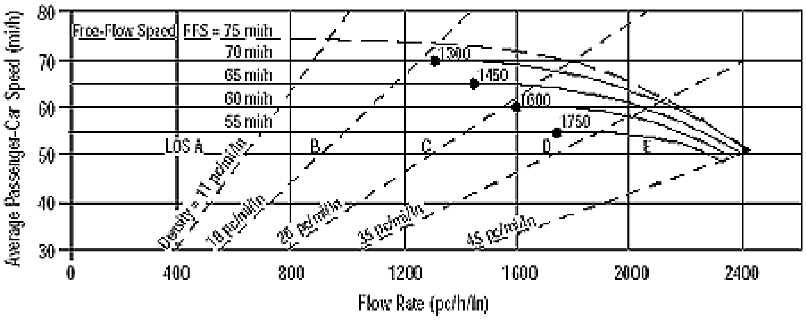
Glossary

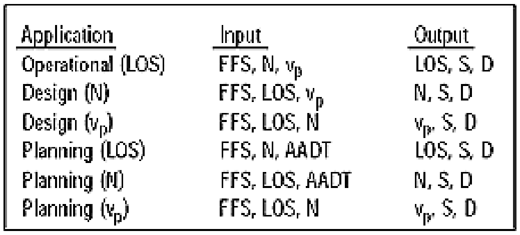
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Concept B - PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6560 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1895	pc/h/ln
S	66.6	mi/h
D = v_p / S	28.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6014	0.90	Level	7	0	0.966	1.00	6916
Ramp	1000	0.90	Level	7	0	0.966	1.00	1150
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.260 using Equation (Exhibit 25-11)

V_{12} = 2649 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6916	9000	No
V_{12}	2649	4400:All	No
$V_{FO} = V_F - V_R$	5766	9000	No
V_R	1150	4100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 18.0 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

Speed Estimation

D_s = 0.402 (Exhibit 25-19)

S_R= 49.8 mph (Exhibit 25-19)

S_0= 55.9 mph (Exhibit 25-19)

S = 53.4 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off		☐ Yes ☐ On ☐ No ☐ Off
L_{up} = ft		L_{down} = ft
Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 55.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	7108	0.90	Level	7	0	0.966	1.00	8174
Ramp	2444	0.90	Level	7	0	0.966	1.00	2811
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.260 using Equation (Exhibit 25-11)

V_{12} = 4205 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	8174	9000	No
V_{12}	4205	4400:All	No
$V_{FO} = V_F - V_R$	5363	9000	No
V_R	2811	4400	No

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$$

D_R = 31.4 (pc/ mi /ln)

LOS= D (Exhibit 25-4)

Speed Estimation

D_s = 0.421 (Exhibit 25-19)

S_R= 49.5 mph (Exhibit 25-19)

S_0= 56.5 mph (Exhibit 25-19)

S = 52.7 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	From Democrat Road
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5014	0.90	Level	8	0	0.962	1.00	5794
Ramp	1404	0.90	Level	8	0	0.962	1.00	1622
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.263 using Equation (Exhibit 25-5)

V_{12}= 1523 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7416	9000	No
V_{R12}	3145	4600:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 23.0 (pc/ mi /ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.322 (Exibit 25-19)

S_R= 50.8 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 49.8 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	From SB Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4664	0.90	Level	7	0	0.966	1.00	5364
Ramp	801	0.90	Level	7	0	0.966	1.00	921
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.350 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 1880 pc/h	V_{12} = pc/h

Capacity Checks				***Capacity Checks***			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}	6285	9000	No	$V_{FI}=V_F$		See Exhibit 25-14	
				V_{12}		4400:All	
V_{R12}	2801	4600:All	No	$V_{FO} = V_F - V_R$		See Exhibit 25-14	
				V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$
D_R = 20.6 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = C (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = 0.295 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 51.2 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 50.8 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5794	0.90	Level	7	0	0.966	1.00	6663
Ramp	870	0.90	Level	7	0	0.966	1.00	1000
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.260 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 2472 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6663	9000	No
V_{12}	2472	4400:All	No
$V_{FO} = V_F - V_R$	5663	9000	No
V_R	1000	4100	No

Merge Areas	Diverge Areas
Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 16.5 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= B (Exhibit 25-4)
Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.388 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 50.0 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 56.1 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 53.6 mph (Exhibit 25-15)

HCS2000™

Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 55.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6560	0.90	Level	7	0	0.966	1.00	7544
Ramp	1564	0.90	Level	7	0	0.966	1.00	1799
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.260 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 3293 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7544	9000	No
V_{12}	3293	4400:All	No
$V_{FO} = V_F - V_R$	5745	9000	No
V_R	1799	4400	No

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 23.6 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= C (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = (Exibit 25-19)	D_s = 0.330 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 50.7 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 55.9 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 53.5 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	From Democrat Road
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp ☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	Terrain S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	Downstream Adj Ramp ☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4924	0.90	Level	8	0	0.962	1.00	5690
Ramp	2030	0.90	Level	8	0	0.962	1.00	2346
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.172 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 981 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	8036	9000	No
V_{R12}	3327	4600:All	No

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$
D_R = 24.1 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = C (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = 0.340 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 50.6 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 49.1 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	From SB Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2012

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off		☐ Yes ☐ On ☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4996	0.90	Level	7	0	0.966	1.00	5745
Ramp	1204	0.90	Level	7	0	0.966	1.00	1385
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.292 using Equation (Exhibit 25-5)

V_{12}= 1680 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7130	9000	No
V_{R12}	3065	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 22.5 (pc/ mi /ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.315 (Exibit 25-19)

S_R= 50.9 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 50.1 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Single Point Interchange*
Agency or Co.	*Clinard Engineering*	Area Type	*All other areas*
Date Performed	*6/25/2008*	Jurisdiction	*Shelby County*
Time Period	*Concept B - AM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	0	0	3	0	0	2	3	0	2	3	0
Lane group	L			L			L	T		L	T	
Volume, V (vph)	378			642			440	1320		426	800	
% Heavy vehicles, %HV	8			8			6	6		6	6	
Peak-hour factor, PHF	1.00			1.00			1.00	1.00		1.00	1.00	
Pretimed (P) or actuated (A)	P			P			P	P		P	P	
Start-up lost time, l_1	2.0			2.0			2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0			2.0			2.0	2.0		2.0	2.0	
Arrival type, AT	3			3			3	3		3	3	
Unit extension, UE	3.0			3.0			3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0			0.0			0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0			0			0			0		
Lane width	12.0			12.0			12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0			0			0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	02	03	04	NB Only	SB Only	07	08
Timing	G = 15.0	G =	G =	G =	G = 25.0	G = 15.0	G =	G =
	Y = 5	Y =	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 70.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	378			642			440	1320		426	800	
Lane group capacity, c	695			978			1180	1748		708	1049	
v/c ratio, X	0.54			0.66			0.37	0.76		0.60	0.76	
Total green ratio, g/C	0.21			0.21			0.36	0.36		0.21	0.21	
Uniform delay, d_1	24.5			25.1			16.7	19.8		24.8	25.8	

Progression factor, PF	1.000			1.000			1.000	1.000		1.000	1.000	
Delay calibration, k	0.50			0.50			0.50	0.50		0.50	0.50	
Incremental delay, d_2	3.0			3.4			0.9	3.1		3.8	5.3	
Initial queue delay, d_3												
Control delay	27.5			28.6			17.6	22.9		28.6	31.1	
Lane group LOS	C			C			B	C		C	C	
Approach delay	27.5			28.6			21.6			30.2		
Approach LOS	C			C			C			C		
Intersection delay	25.9			X_C = 0.73			Intersection LOS			C		

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Single Point Interchange*
Agency or Co.	*Clinard Engineering*	Area Type	*All other areas*
Date Performed	*6/25/2008*	Jurisdiction	*Shelby County*
Time Period	*Concept B - PM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	0	0	3	0	0	2	3	0	2	3	0
Lane group	L			L			L	T		L	T	
Volume, V (vph)	418			358			757	873		458	490	
% Heavy vehicles, %HV	8			8			6	6		6	6	
Peak-hour factor, PHF	1.00			1.00			1.00	1.00		1.00	1.00	
Pretimed (P) or actuated (A)	P			P			P	P		P	P	
Start-up lost time, l_1	2.0			2.0			2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0			2.0			2.0	2.0		2.0	2.0	
Arrival type, AT	3			3			3	3		3	3	
Unit extension, UE	3.0			3.0			3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0			0.0			0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0			0			0			0		
Lane width	12.0			12.0			12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0			0			0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	02	03	04	NB Only	SB Only	07	08
Timing	G = 15.0	G =	G =	G =	G = 20.0	G = 10.0	G =	G =
	Y = 5	Y =	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 60.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	418			358			757	873		458	490	
Lane group capacity, c	811			1141			1101	1631		551	816	
v/c ratio, X	0.52			0.31			0.69	0.54		0.83	0.60	
Total green ratio, g/C	0.25			0.25			0.33	0.33		0.17	0.17	
Uniform delay, d_1	19.4			18.3			17.3	16.2		24.2	23.2	

Progression factor, PF	*1.000*			*1.000*			*1.000*	*1.000*		*1.000*	*1.000*	
Delay calibration, k	*0.50*			*0.50*			*0.50*	*0.50*		*0.50*	*0.50*	
Incremental delay, d_2	*2.3*			*0.7*			*3.5*	*1.3*		*13.6*	*3.3*	
Initial queue delay, d_3												
Control delay	*21.7*			*19.0*			*20.8*	*17.5*		*37.8*	*26.4*	
Lane group LOS	*C*			*B*			*C*	*B*		*D*	*C*	
Approach delay	*21.7*			*19.0*			*19.0*			*31.9*		
Approach LOS	*C*			*B*			*B*			*C*		
Intersection delay	*23.0*			$X_C = 0.66$			Intersection LOS			*C*		

HCS2000™ DETAILED REPORT

General Information

Analyst	*Brian Gaffney*
Agency or Co.	*Clinard Engineering Associates*
Date Performed	*5/29/2008*
Time Period	*Concept B - AM*

Site Information

Intersection	*Democrat&Ramps*
Area Type	*All other areas*
Jurisdiction	*Memphis*
Analysis Year	*2012*
Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	2	1	1	2	0	1	0	1	0	0	0
Lane group	L	T	R	L	TR		L		R			
Volume, V (vph)	68	942	193	150	504	134	108		361			
% Heavy vehicles, %HV	0	0	0	0	0	0	0		0			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90			
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P		P			
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Arrival type, AT	3	3	3	3	3		3		3			
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0		3.0			
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000			
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0		0.0			
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		
Lane width	12.0	12.0	12.0	12.0	12.0		12.0		12.0			
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N		N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0		0			
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = 10.0	G = 30.0	G =	G =	G = 5.0	G =	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y =	Y =	Y =

Duration of Analysis, T = *0.25* Cycle Length, C = *60.0*

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	76	1047	214	167	709		120		401			
Lane group capacity, c	1124	1805	1077	301	1748		150		538			
v/c ratio, X	0.07	0.58	0.20	0.55	0.41		0.80		0.75			
Total green ratio, g/C	0.75	0.50	0.67	0.17	0.50		0.08		0.33			

Uniform delay, d_1	2.5	10.6	3.8	23.0	9.4		27.0		17.7			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.1	1.4	0.4	7.2	0.7		34.7		9.1			
Initial queue delay, d_3												
Control delay	2.6	11.9	4.3	30.2	10.1		61.7		26.8			
Lane group LOS	A	B	A	C	B		E		C			
Approach delay	10.2			13.9			34.8					
Approach LOS	B			B			C					
Intersection delay	16.1			$X_C = 0.65$			Intersection LOS			B		

HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Democrat&Ramps*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Concept B - PM*	Analysis Year	*2012*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	2	1	1	2	0	1	0	1	0	0	0
Lane group	L	T	R	L	TR		L		R			
Volume, V (vph)	271	584	606	329	744	331	88		226			
% Heavy vehicles, %HV	0	0	0	0	0	0	0		0			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90			
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P		P			
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Arrival type, AT	3	3	3	3	3		3		3			
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0		3.0			
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000			
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0		0.0			
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		
Lane width	12.0	12.0	12.0	12.0	12.0		12.0		12.0			
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N		N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0		0			
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = 15.0	G = 25.0	G =	G =	G = 5.0	G =	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y =	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 60.0		

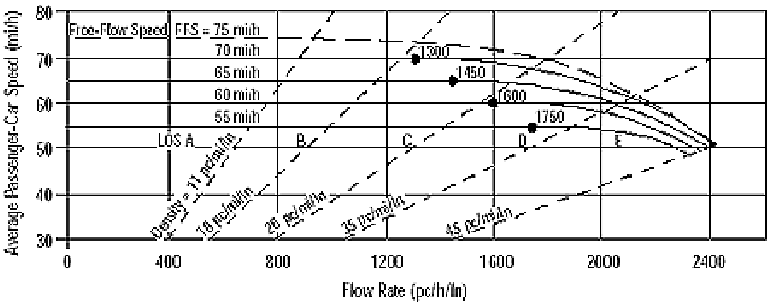
Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	301	649	673	366	1195		98		251			
Lane group capacity, c	1658	1504	942	451	1435		150		673			
v/c ratio, X	0.18	0.43	0.71	0.81	0.83		0.65		0.37			
Total green ratio, g/C	0.75	0.42	0.58	0.25	0.42		0.08		0.42			

Uniform delay, d_1	5.2	12.4	8.9	21.2	15.6		26.7		12.1			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.2	0.9	4.6	14.7	5.8		20.0		1.6			
Initial queue delay, d_3												
Control delay	5.5	13.4	13.5	35.8	21.4		46.7		13.7			
Lane group LOS	A	B	B	D	C		D		B			
Approach delay	12.0			24.8			22.9					
Approach LOS	B			C			C					
Intersection delay	18.7			$X_C = 0.74$			Intersection LOS			B		

2032 CAPACITY ANALYSIS
(PROPOSED)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	3/16/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6357 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1836	pc/h/ln
S	67.4	mi/h
D = v_p / S	27.2	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

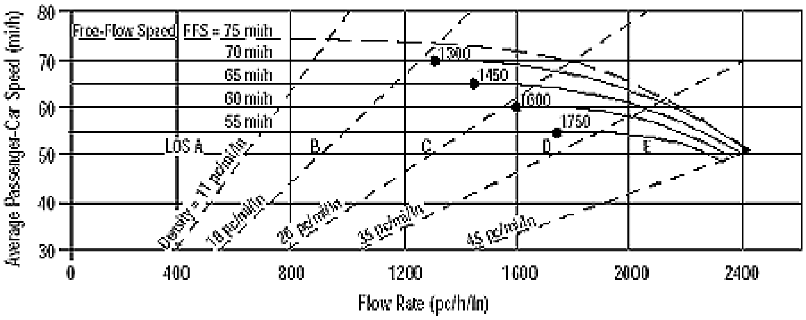
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

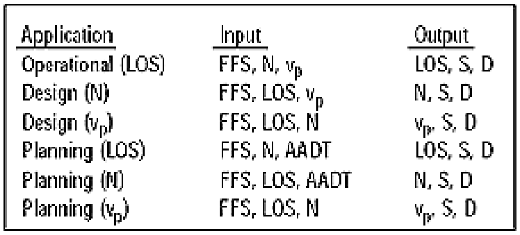
Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™ Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5604 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs / Calc Speed Adj and FFS

Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	4		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1619	pc/h/ln
S	69.3	mi/h
D = v_p / S	23.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

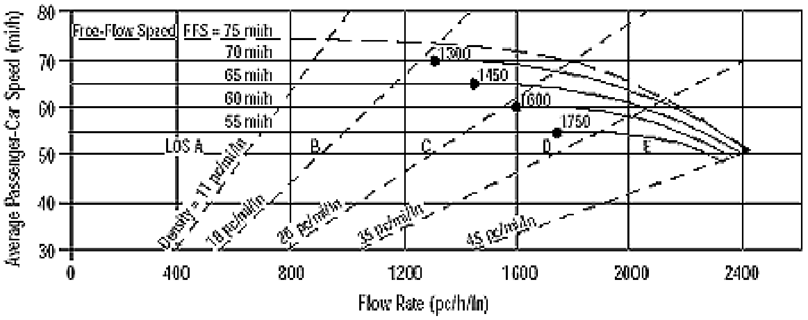
Glossary

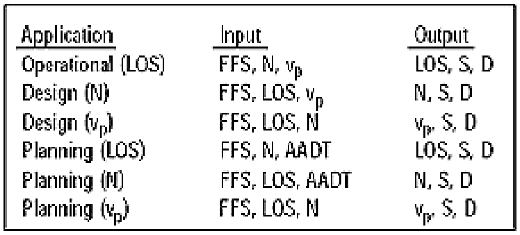
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	3/16/2007
Analysis Time Period	Concept B - AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5157 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1490	pc/h/ln
S	69.8	mi/h
D = v_p / S	21.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

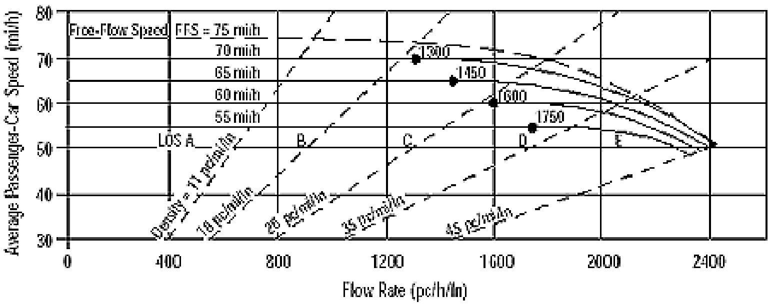
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4643 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1341	pc/h/ln
S	70.0	mi/h
D = v_p / S	19.2	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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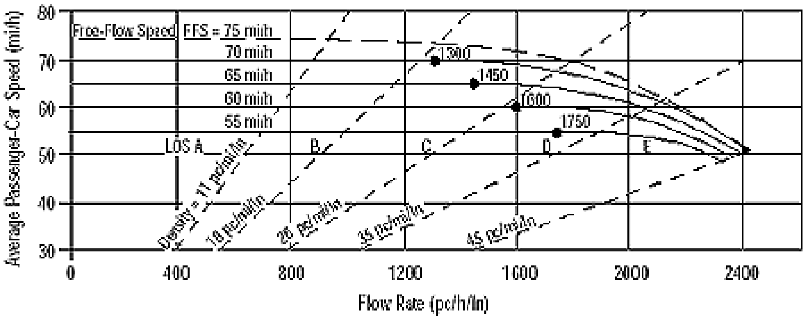
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information		***Site Information***	
Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	East of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6842 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

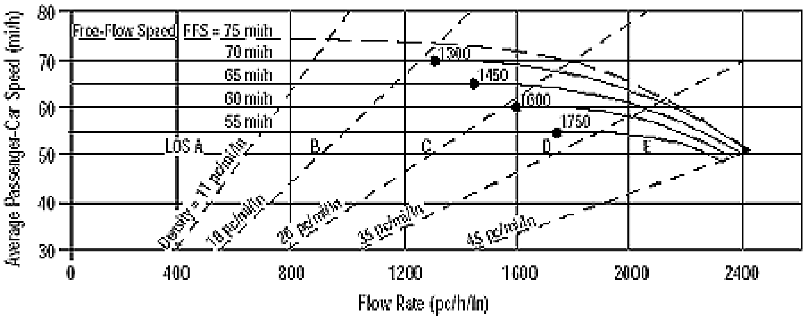
f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

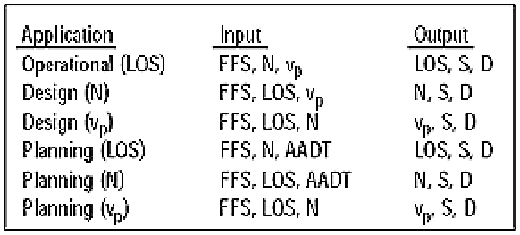
Speed Inputs			**Calc Speed Adj and FFS**		
Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	4		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures			**Design (N)**	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1977	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	65.3	mi/h	S	mi/h
D = v_p / S	30.3	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary		**Factor Location**	
N - Number of lanes	S - Speed	E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Concept B - AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	East of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7576 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2189	pc/h/ln
S	60.4	mi/h
D = v_p / S	36.2	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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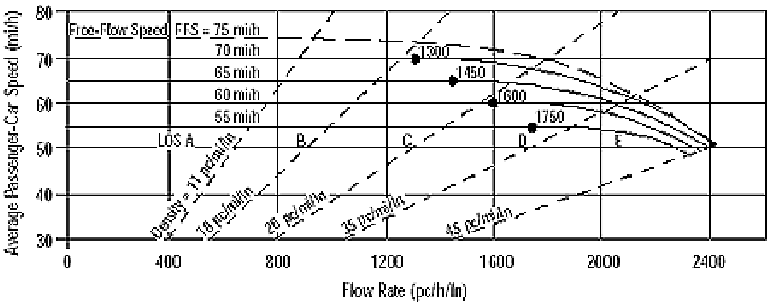
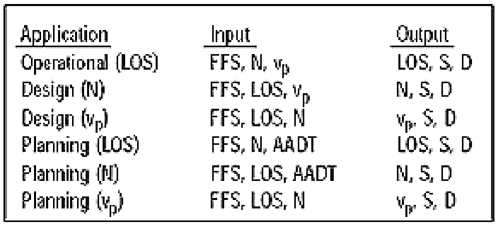
BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	West of Airways Blvd
Date Performed	3/16/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6022 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1740	pc/h/ln
S	68.5	mi/h
D = v_p / S	25.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

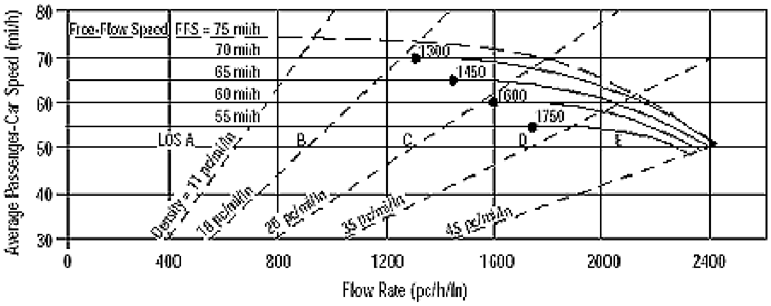
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

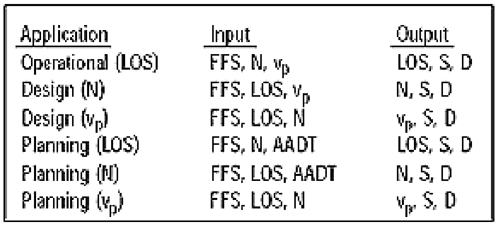
Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™ Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Concept B - PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	West of Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6559 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1895	pc/h/ln
S	66.6	mi/h
D = v_p / S	28.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

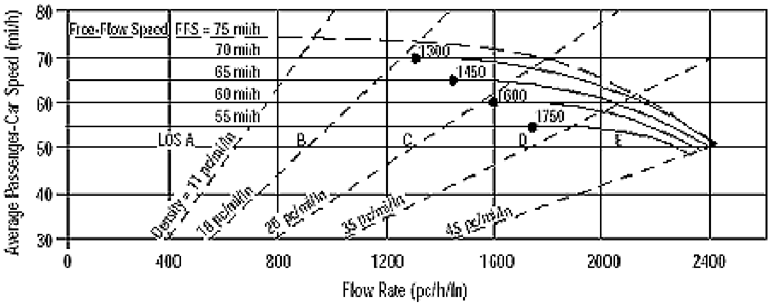
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™ Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	3/16/2007
Analysis Time Period	Concept B - PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4978 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1438	pc/h/ln
S	69.9	mi/h
D = v_p / S	20.6	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

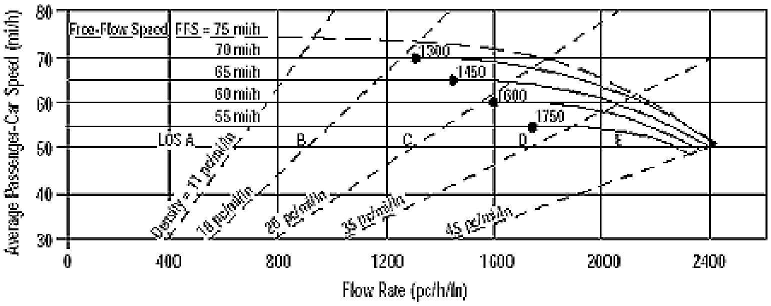
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

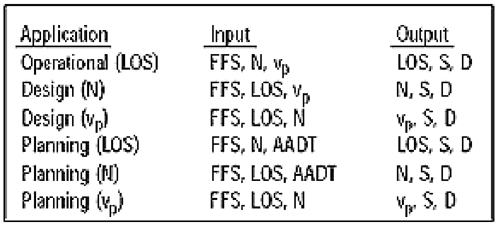
Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

HCS2000™ Version 4.1d

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	1/23/2007
Analysis Time Period	Concept B - PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	Airways Blvd
Jurisdiction	Shelby County
Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5115 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1478	pc/h/ln
S	69.9	mi/h
D = v_p / S	21.2	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

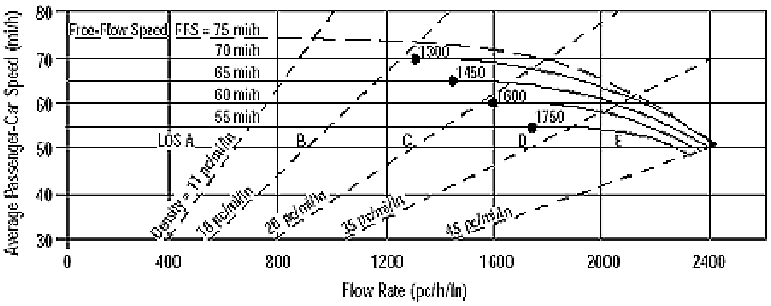
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	East of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7414 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2142	pc/h/ln
S	61.7	mi/h
D = v_p / S	34.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

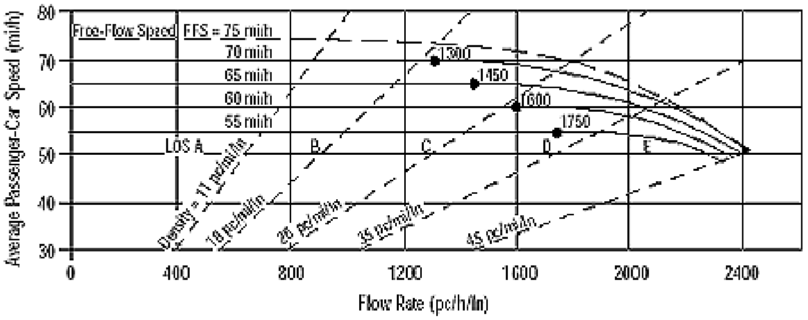
Glossary

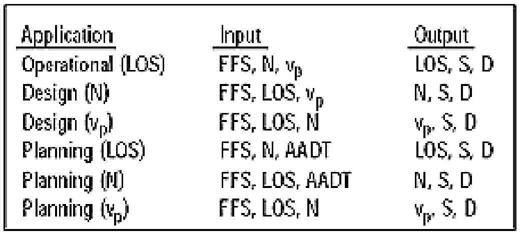
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information / Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	East of Airways Blvd
Date Performed	1/23/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6992 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs / Calc Speed Adj and FFS

Lane Width	12.0	ft	f_{LW}		mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}		mi/h
Interchange Density	0.50	I/mi	f_{ID}		mi/h
Number of Lanes, N	4		f_N		mi/h
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

LOS and Performance Measures / Design (N)

Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2020	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	64.5	mi/h	S	mi/h
D = v_p / S	31.3	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6357	0.90	Level	7	0	0.966	1.00	7311
Ramp	1200	0.90	Level	7	0	0.966	1.00	1380
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.260 using Equation (Exhibit 25-11)

V_{12} = 2922 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7311	9000	No
V_{12}	2922	4400:All	No
$V_{FO} = V_F - V_R$	5931	9000	No
V_R	1380	4100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 20.4 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

Speed Estimation

D_s = 0.422 (Exhibit 25-19)

S_R= 49.5 mph (Exhibit 25-19)

S_0= 55.7 mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

HCS2000™ Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / *Site Information*

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 55.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	7576	0.90	Level	7	0	0.966	1.00	8712
Ramp	2933	0.90	Level	7	0	0.966	1.00	3373
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.260 using Equation (Exhibit 25-11)

V_{12} = 4761 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	8712	9000	No
V_{12}	4761	4400:All	Yes
$V_{FO} = V_F - V_R$	5339	9000	No
V_R	3373	4400	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 36.2 (pc/ mi /ln)

LOS= F (Exhibit 25-4)

Speed Estimation

D_s = 0.472 (Exhibit 25-19)

S_R= 48.9 mph (Exhibit 25-19)

S_0= 56.5 mph (Exhibit 25-19)

S = 52.1 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	From Democrat Road
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D, V_R, V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5157	0.90	Level	8	0	0.962	1.00	5959
Ramp	1685	0.90	Level	8	0	0.962	1.00	1947
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.222 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 1324 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7906	9000	No
V_{R12}	3271	4600:All	No

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 23.8 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = C (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation

Merge	Diverge
M_S = 0.334 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 50.7 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 49.3 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

HCS2000™ Version 4.1d

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	From SB Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - AM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp ☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	Terrain S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	Downstream Adj Ramp ☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4643	0.90	Level	7	0	0.966	1.00	5339
Ramp	961	0.90	Level	7	0	0.966	1.00	1105
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.327 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 1748 pc/h	V_{12} = pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}	6444	9000	No
V_{R12}	2853	4600:All	No

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = 21.0 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = C (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = 0.299 (Exibit 25-19)	D_s = (Exhibit 25-19)
S_R= 51.1 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 50.7 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off		☐ Yes ☐ On ☐ No ☐ Off
L_{up} = ft	S_{FF} = 55.0 mph S_{FR} = 45.0 mph	L_{down} = ft
Vu = veh/h	Sketch (show lanes, L_A, L_D,V_R,V_f)	VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6022	0.90	Level	7	0	0.966	1.00	6925
Ramp	1044	0.90	Level	7	0	0.966	1.00	1201
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.260 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 2689 pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6925	9000	No
V_{12}	2689	4400:All	No
$V_{FO} = V_F - V_R$	5724	9000	No
V_R	1201	4100	No

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 18.4 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= B (Exhibit 25-4)
Speed Estimation	**Speed Estimation**
M_S = (Exibit 25-19)	D_s = 0.406 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 49.7 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 56.0 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 53.4 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information **Site Information**

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
L_{up} = ft
Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 55.0 mph
Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
L_{down} = ft
VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6992	0.90	Level	7	0	0.966	1.00	8041
Ramp	1877	0.90	Level	7	0	0.966	1.00	2159
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.260 using Equation (Exhibit 25-11)

V_{12} = 3688 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	8041	9000	No
V_{12}	3688	4400:All	No
$V_{FO} = V_F - V_R$	5882	9000	No
V_R	2159	4400	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 27.0 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

Speed Estimation

D_s = 0.362 (Exhibit 25-19)

S_R= 50.3 mph (Exhibit 25-19)

S_0= 55.7 mph (Exhibit 25-19)

S = 53.1 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	From Democrat Road
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4978	0.90	Level	8	0	0.962	1.00	5752
Ramp	2436	0.90	Level	8	0	0.962	1.00	2815
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.114 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 654 pc/h	V_{12} = pc/h

Capacity Checks (Merge)

	Actual	Maximum	LOS F?
V_{FO}	8567	9000	No
V_{R12}	3469	4600:All	No

Capacity Checks (Diverge)

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F) (Merge)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.0 (pc/ mi /ln)

LOS = C (Exhibit 25-4)

Level of Service Determination (if not F) (Diverge)

$D_R = 4.252 + 0.0086\, V_{12} - 0.0009\, L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation (Merge)

M_S = 0.356 (Exibit 25-19)

S_R= 50.4 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 48.3 mph (Exhibit 25-14)

Speed Estimation (Diverge)

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	From SB Airways Blvd
Date Performed	3/19/2007	Jurisdiction	Shelby County
Analysis Time Period	Concept B - PM	Analysis Year	2032

Project Description I-240 Interchange @ Airways Boulevard

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5115	0.90	Level	7	0	0.966	1.00	5882
Ramp	1444	0.90	Level	7	0	0.966	1.00	1661
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.258 using Equation (Exhibit 25-5)

V_{12}= 1517 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7543	9000	No
V_{R12}	3178	4600:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 23.2 (pc/ mi /ln)

LOS = C (Exhibit 25-4)

Speed Estimation

M_S = 0.325 (Exibit 25-19)

S_R= 50.8 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 49.7 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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HCS2000™ DETAILED REPORT

General Information		**Site Information**	
Analyst	*Brian Gaffney*	Intersection	*Single Point Interchange*
Agency or Co.	*Clinard Engineering*	Area Type	*All other areas*
Date Performed	*6/25/2008*	Jurisdiction	*Shelby County*
Time Period	*Concept B - AM*	Analysis Year	*2032*
		Project ID	*I-240 @ Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	0	0	3	0	0	2	3	0	2	3	0
Lane group	L			L			L	T		L	T	
Volume, V (vph)	454			770			528	1583		511	960	
% Heavy vehicles, %HV	8			8			6	6		6	6	
Peak-hour factor, PHF	1.00			1.00			1.00	1.00		1.00	1.00	
Pretimed (P) or actuated (A)	P			P			P	P		P	P	
Start-up lost time, l_1	2.0			2.0			2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0			2.0			2.0	2.0		2.0	2.0	
Arrival type, AT	3			3			3	3		3	3	
Unit extension, UE	3.0			3.0			3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0			0.0			0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0			0			0			0		
Lane width	12.0			12.0			12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0			0			0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	02	03	04	NB Only	SB Only	07	08
Timing	G = 15.0	G =	G =	G =	G = 25.0	G = 15.0	G =	G =
	Y = 5	Y =	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 70.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	454			770			528	1583		511	960	
Lane group capacity, c	695			978			1180	1748		708	1049	
v/c ratio, X	0.65			0.79			0.45	0.91		0.72	0.92	
Total green ratio, g/C	0.21			0.21			0.36	0.36		0.21	0.21	
Uniform delay, d_1	25.1			26.0			17.2	21.4		25.6	26.9	

Progression factor, PF	1.000			1.000			1.000	1.000		1.000	1.000	
Delay calibration, k	0.50			0.50			0.50	0.50		0.50	0.50	
Incremental delay, d_2	4.7			6.4			1.2	8.3		6.3	13.6	
Initial queue delay, d_3												
Control delay	29.9			32.4			18.4	29.6		31.8	40.5	
Lane group LOS	C			C			B	C		C	D	
Approach delay	29.9			32.4			26.8			37.5		
Approach LOS	C			C			C			D		
Intersection delay	31.3			X_C = 0.88			Intersection LOS			C		

HCS2000™ DETAILED REPORT

General Information		**Site Information**	
Analyst	*Brian Gaffney*	Intersection	*Single Point Interchange*
Agency or Co.	*Clinard Engineering*	Area Type	*All other areas*
Date Performed	*6/25/2008*	Jurisdiction	*Shelby County*
Time Period	*Concept B - PM*	Analysis Year	*2032*
		Project ID	*I-240 @ Airways Blvd*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	0	0	3	0	0	2	3	0	2	3	0
Lane group	L			L			L	T		L	T	
Volume, V (vph)	502			430			908	1047		550	588	
% Heavy vehicles, %HV	8			8			6	6		6	6	
Peak-hour factor, PHF	1.00			1.00			1.00	1.00		1.00	1.00	
Pretimed (P) or actuated (A)	P			P			P	P		P	P	
Start-up lost time, l_1	2.0			2.0			2.0	2.0		2.0	2.0	
Extension of effective green, e	2.0			2.0			2.0	2.0		2.0	2.0	
Arrival type, AT	3			3			3	3		3	3	
Unit extension, UE	3.0			3.0			3.0	3.0		3.0	3.0	
Filtering/metering, I	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
Initial unmet demand, Q_b	0.0			0.0			0.0	0.0		0.0	0.0	
Ped / Bike / RTOR volumes	0			0			0			0		
Lane width	12.0			12.0			12.0	12.0		12.0	12.0	
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N	0	N
Parking maneuvers, N_m												
Buses stopping, N_B	0			0			0	0		0	0	
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	02	03	04	NB Only	SB Only	07	08
Timing	G = 15.0	G =	G =	G =	G = 20.0	G = 10.0	G =	G =
	Y = 5	Y =	Y =	Y =	Y = 5	Y = 5	Y =	Y =
Duration of Analysis, T = 0.25					Cycle Length, C = 60.0			

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	502			430			908	1047		550	588	
Lane group capacity, c	811			1141			1101	1631		551	816	
v/c ratio, X	0.62			0.38			0.82	0.64		1.00	0.72	
Total green ratio, g/C	0.25			0.25			0.33	0.33		0.17	0.17	
Uniform delay, d_1	20.0			18.6			18.4	17.0		25.0	23.7	

Progression factor, PF	1.000			1.000			1.000	1.000		1.000	1.000	
Delay calibration, k	0.50			0.50			0.50	0.50		0.50	0.50	
Incremental delay, d_2	3.5			1.0			7.1	2.0		37.9	5.5	
Initial queue delay, d_3												
Control delay	23.5			19.6			25.4	18.9		62.9	29.1	
Lane group LOS	C			B			C	B		E	C	
Approach delay	23.5			19.6			22.0			45.4		
Approach LOS	C			B			C			D		
Intersection delay	28.5			X_C = 0.80			Intersection LOS			C		

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HCS2000™ DETAILED REPORT

General Information		***Site Information***	
Analyst	*Brian Gaffney*	Intersection	*Democrat&Ramps*
Agency or Co.	*Clinard Engineering Associates*	Area Type	*All other areas*
Date Performed	*5/29/2008*	Jurisdiction	*Memphis*
Time Period	*Concept B - AM*	Analysis Year	*2032*
		Project ID	*I-240 @ Airways Boulevard*

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	*2*	*2*	*1*	*1*	*2*	*0*	*1*	*0*	*1*	*0*	*0*	*0*
Lane group	*L*	*T*	*R*	*L*	*TR*		*L*		*R*			
Volume, V (vph)	*83*	*1130*	*231*	*83*	*605*	*160*	*129*		*434*			
% Heavy vehicles, %HV	*0*	*0*	*0*	*0*	*0*	*0*	*0*		*0*			
Peak-hour factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*		*0.90*			
Pretimed (P) or actuated (A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*		*P*			
Start-up lost time, l_1	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*		*2.0*			
Extension of effective green, e	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*		*2.0*			
Arrival type, AT	*3*	*3*	*3*	*3*	*3*		*3*		*3*			
Unit extension, UE	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*		*3.0*		*3.0*			
Filtering/metering, I	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*			
Initial unmet demand, Q_b	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*		*0.0*		*0.0*			
Ped / Bike / RTOR volumes	*0*		*0*	*0*		*0*	*0*		*0*	*0*		
Lane width	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*		*12.0*		*12.0*			
Parking / Grade / Parking	*N*	*0*	*N*	*N*	*0*	*N*	*N*	*0*	*N*	*N*		*N*
Parking maneuvers, N_m												
Buses stopping, N_B	*0*	*0*	*0*	*0*	*0*		*0*		*0*			
Min. time for pedestrians, G_p	*3.2*			*3.2*			*3.2*			*3.2*		

Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = *15.0*	G = *25.0*	G =	G =	G = *5.0*	G =	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y =	Y =	Y =
Duration of Analysis, T = *0.25*						Cycle Length, C = *60.0*		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	*92*	*1256*	*257*	*92*	*850*		*143*		*482*			
Lane group capacity, c	*1478*	*1504*	*942*	*451*	*1457*		*150*		*673*			
v/c ratio, X	*0.06*	*0.84*	*0.27*	*0.20*	*0.58*		*0.95*		*0.72*			
Total green ratio, g/C	*0.75*	*0.42*	*0.58*	*0.25*	*0.42*		*0.08*		*0.42*			

Uniform delay, d_1	3.1	15.7	6.2	17.8	13.5		27.4		14.6			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.1	5.6	0.7	1.0	1.7		62.0		6.4			
Initial queue delay, d_3												
Control delay	3.2	21.3	6.9	18.8	15.2		89.4		21.0			
Lane group LOS	A	C	A	B	B		F		C			
Approach delay	17.9			15.6			36.6					
Approach LOS	B			B			D					
Intersection delay	20.9			$X_C = 0.78$			Intersection LOS			C		

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HCS2000™ DETAILED REPORT

General Information		**Site Information**	
Analyst	Brian Gaffney	Intersection	Democrat&Ramps
Agency or Co.	Clinard Engineering Associates	Area Type	All other areas
Date Performed	5/29/2008	Jurisdiction	Memphis
Time Period	Concept B - PM	Analysis Year	2032
		Project ID	I-240 @ Airways Boulevard

Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N_1	2	2	1	1	2	0	1	0	1	0	0	0
Lane group	L	T	R	L	TR		L		R			
Volume, V (vph)	325	696	725	394	893	398	106		271			
% Heavy vehicles, %HV	0	0	0	0	0	0	0		0			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90		0.90			
Pretimed (P) or actuated (A)	P	P	P	P	P	P	P		P			
Start-up lost time, l_1	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Extension of effective green, e	2.0	2.0	2.0	2.0	2.0		2.0		2.0			
Arrival type, AT	3	3	3	3	3		3		3			
Unit extension, UE	3.0	3.0	3.0	3.0	3.0		3.0		3.0			
Filtering/metering, I	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000			
Initial unmet demand, Q_b	0.0	0.0	0.0	0.0	0.0		0.0		0.0			
Ped / Bike / RTOR volumes	0		0	0		0	0		0	0		
Lane width	12.0	12.0	12.0	12.0	12.0		12.0		12.0			
Parking / Grade / Parking	N	0	N	N	0	N	N	0	N	N		N
Parking maneuvers, N_m												
Buses stopping, N_B	0	0	0	0	0		0		0			
Min. time for pedestrians, G_p	3.2			3.2			3.2			3.2		

Phasing	Excl. Left	EW Perm	03	04	NB Only	06	07	08
Timing	G = 10.0	G = 30.0	G =	G =	G = 5.0	G =	G =	G =
	Y = 5	Y = 5	Y =	Y =	Y = 5	Y =	Y =	Y =
Duration of Analysis, T = 0.25						Cycle Length, C = 60.0		

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Adjusted flow rate, v	361	773	806	438	1434		118		301			
Lane group capacity, c	1470	1805	1077	301	1722		150		538			
v/c ratio, X	0.25	0.43	0.75	1.46	0.83		0.79		0.56			
Total green ratio, g/C	0.75	0.50	0.67	0.17	0.50		0.08		0.33			

Uniform delay, d_1	6.4	9.5	6.7	25.0	12.9		27.0		16.4			
Progression factor, PF	1.000	1.000	1.000	1.000	1.000		1.000		1.000			
Delay calibration, k	0.50	0.50	0.50	0.50	0.50		0.50		0.50			
Incremental delay, d_2	0.4	0.7	4.8	222.4	4.9		32.9		4.2			
Initial queue delay, d_3												
Control delay	6.8	10.3	11.4	247.4	17.7		59.9		20.6			
Lane group LOS	A	B	B	F	B		E		C			
Approach delay	10.1			71.5			31.6					
Approach LOS	B			E			C					
Intersection delay	39.4			$X_C = 0.89$			Intersection LOS			D		

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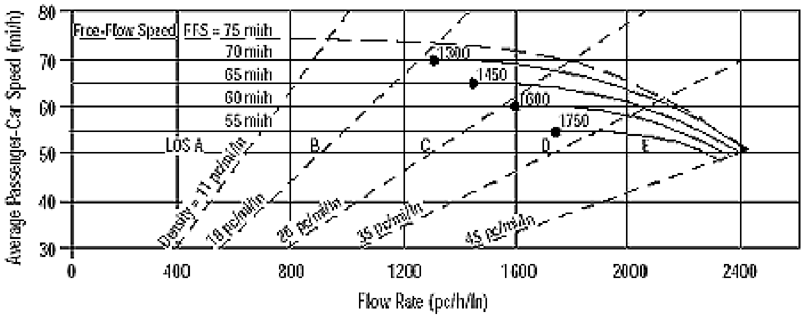
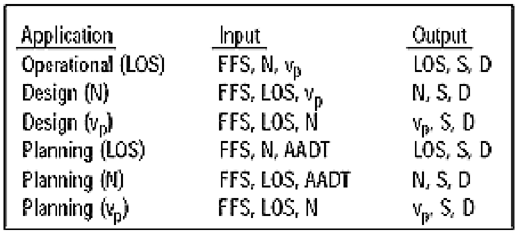
2012 CAPACITY ANALYSIS
LAMAR AVE & MILL BRANCH
(PROPOSED)

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Proposed AM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4913 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1419	pc/h/ln
S	69.9	mi/h
D = v_p / S	20.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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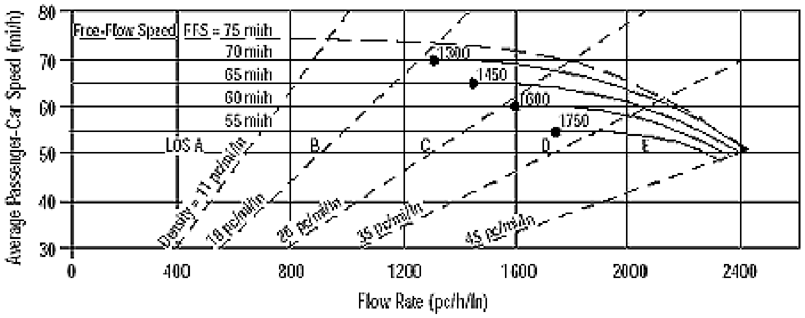
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Proposed AM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4252 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1228	pc/h/ln
S	70.0	mi/h
D = v_p / S	17.5	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h
S		mi/h
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

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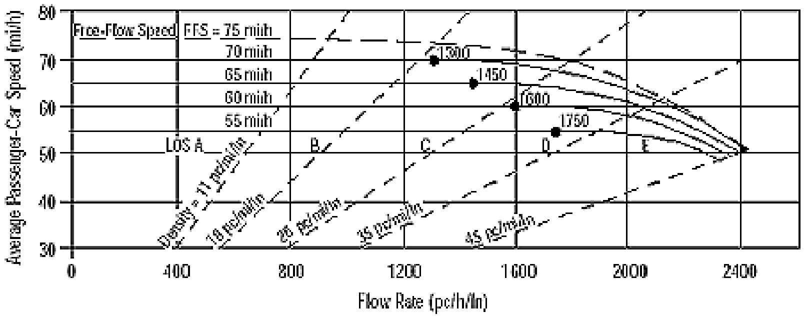
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Proposed PM

Site Information

Highway/Direction of Travel	I-240 Eastbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5067 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1464	pc/h/ln
S	69.9	mi/h
D = v_p / S	20.9	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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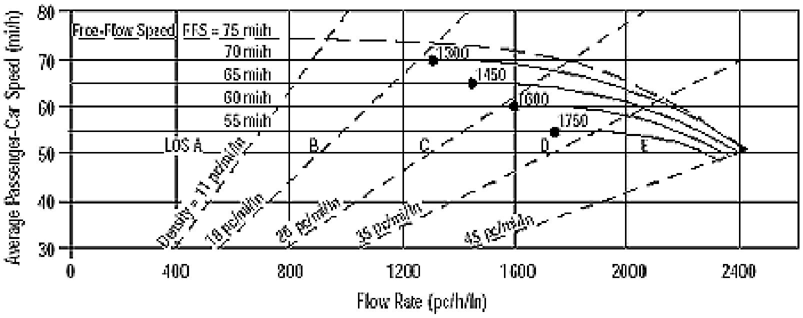
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney
Agency or Company	Clinard Engineering
Date Performed	10/17/2008
Analysis Time Period	Proposed PM

Site Information

Highway/Direction of Travel	I-240 Westbound
From/To	At Mill Branch Interchange
Jurisdiction	Shelby County
Analysis Year	2012

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5427 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1568	pc/h/ln
S	69.6	mi/h
D = v_p / S	22.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5465	0.90	Level	8	0	0.962	1.00	6315
Ramp	1213	0.90	Level	4	0	0.980	1.00	1375
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.436 using Equation (Exhibit 25-11)

V_{12} = 3529 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	6315	9000	No
V_{12}	3529	4400:All	No
$V_{FO} = V_F - V_R$	4940	9000	No
V_R	1375	2100	No

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$$

D_R = 34.6 (pc/ mi /ln)

LOS= D (Exhibit 25-4)

Speed Estimation

D_s = 0.422 (Exhibit 25-19)

S_R= 49.5 mph (Exhibit 25-19)

S_0= 58.8 mph (Exhibit 25-19)

S = 53.2 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		***Site Information***	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed AM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D, V_R, V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	4913	0.90	Level	8	0	0.962	1.00	5677
Ramp	1101	0.90	Level	4	0	0.980	1.00	1248
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.062 using Equation (Exhibit 25-5)

V_{12}= 351 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6925	9000	No
V_{R12}	1599	4600:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$$

D_R = 17.4 (pc/ mi /ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.340 (Exhibit 25-19)

S_R= 50.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 47.2 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6200	0.90	Level	8	0	0.962	1.00	7164
Ramp	773	0.90	Level	4	0	0.980	1.00	876
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.436 using Equation (Exhibit 25-11)

V_{12} = 3618 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7164	9000	No
V_{12}	3618	4400:All	No
$V_{FO} = V_F - V_R$	6288	9000	No
V_R	876	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 35.4 (pc/ mi /ln)

LOS= E (Exhibit 25-4)

Speed Estimation

D_s = 0.377 (Exhibit 25-19)

S_R= 50.1 mph (Exhibit 25-19)

S_0= 57.3 mph (Exhibit 25-19)

S = 53.4 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed PM	Analysis Year	2012

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp	Terrain	Downstream Adj Ramp
☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5067	0.90	Level	8	0	0.962	1.00	5855
Ramp	727	0.90	Level	4	0	0.980	1.00	824
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= 0.115 using Equation (Exhibit 25-5)	P_{FD} = using Equation (Exhibit 25-11)
V_{12}= 672 pc/h	V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6679	9000	No
V_{R12}	1496	4600:All	No

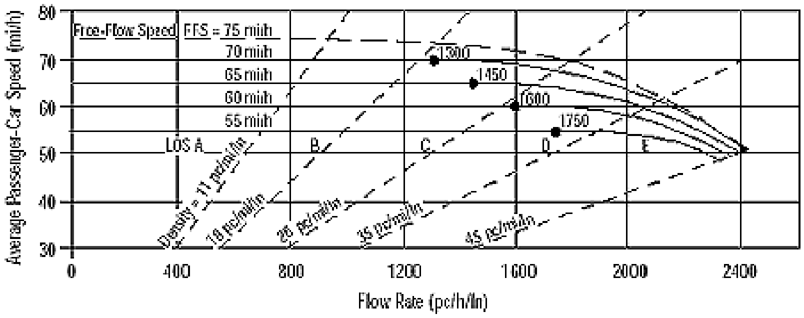
	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$
D_R = 16.8 (pc/ mi /ln)	D_R = (pc/ mi /ln)
LOS = B (Exhibit 25-4)	LOS= (Exhibit 25-4)

Speed Estimation	Speed Estimation
M_S = 0.338 (Exhibit 25-19)	D_s = (Exhibit 25-19)
S_R= 50.6 mph (Exhibit 25-19)	S_R= mph (Exhibit 25-19)
S_0= N/A mph (Exhibit 25-19)	S_0= mph (Exhibit 25-19)
S= 47.5 mph (Exhibit 25-14)	S = mph (Exhibit 25-15)

2032 CAPACITY ANALYSIS
LAMAR AVE & MILL BRANCH
(PROPOSED)

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5197 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1501	pc/h/ln
S	69.8	mi/h
D = v_p / S	21.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

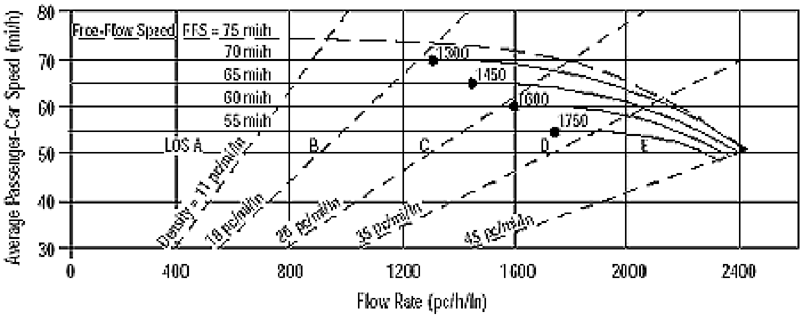
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4327 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1250	pc/h/ln
S	70.0	mi/h
D = v_p / S	17.9	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

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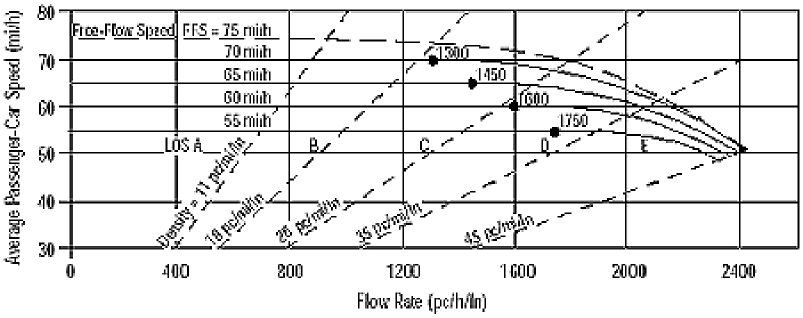
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed PM	Analysis Year	2032

Site Information

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5256 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1518	pc/h/ln
S	69.8	mi/h
D = v_p / S	21.8	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

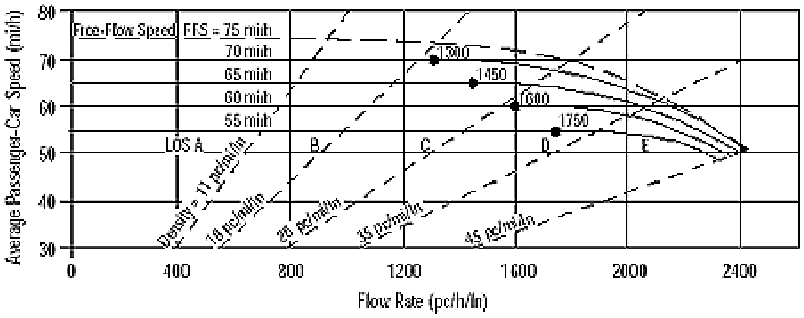
Glossary

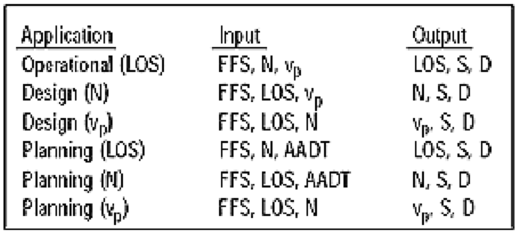
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits23-8, 23-10
E_T - Exhibits 23-8, 23-10, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

BASIC FREEWAY SEGMENTS WORKSHEET





Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Site Information

Analyst	Brian Gaffney	Highway/Direction of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	From/To	At Mill Branch Interchange
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5745 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width	12.0	ft
Rt-Shoulder Lat. Clearance	6.0	ft
Interchange Density	0.50	I/mi
Number of Lanes, N	4	
FFS (measured)	70.0	mi/h
Base free-flow Speed, BFFS		mi/h

Calc Speed Adj and FFS

f_{LW}		mi/h
f_{LC}		mi/h
f_{ID}		mi/h
f_N		mi/h
FFS	70.0	mi/h

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1660	pc/h/ln
S	69.1	mi/h
D = v_p / S	24.0	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h
S	mi/h
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits23-8, 23-10	f_{LW} - Exhibit 23-4
E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
f_p - Page 23-12	f_N - Exhibit 23-6
LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp ☐ Yes ☐ On ☐ No ☐ Off L_{up} = ft Vu = veh/h	Terrain S_{FF} = 55.0 mph S_{FR} = 45.0 mph Sketch (show lanes, L_A, L_D,V_R,V_f)	Downstream Adj Ramp ☐ Yes ☐ On ☐ No ☐ Off L_{down} = ft VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5604	0.90	Level	8	0	0.962	1.00	6476
Ramp	1272	0.90	Level	4	0	0.980	1.00	1442
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	***Estimation of v_{12}***
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 25-2 or 25-3)	L_{EQ} = (Equation 25-8 or 25-9)
P_{FM}= using Equation (Exhibit 25-5)	P_{FD} =0.436 using Equation (Exhibit 25-11)
V_{12}= pc/h	V_{12} = 3637 pc/h

Capacity Checks ***Capacity Checks***

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7		$V_{FI}=V_F$	6476	9000	No
				V_{12}	3637	4400:All	No
V_{R12}		4600:All		$V_{FO} = V_F - V_R$	5034	9000	No
				V_R	1442	2100	No

Level of Service Determination (if not F)	***Level of Service Determination (if not F)***
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$
D_R = (pc/ mi /ln)	D_R = 35.5 (pc/ mi /ln)
LOS = (Exhibit 25-4)	LOS= E (Exhibit 25-4)

Speed Estimation	***Speed Estimation***
M_S = (Exibit 25-19)	D_s = 0.428 (Exhibit 25-19)
S_R= mph (Exhibit 25-19)	S_R= 49.4 mph (Exhibit 25-19)
S_0= mph (Exhibit 25-19)	S_0= 58.7 mph (Exhibit 25-19)
S= mph (Exhibit 25-14)	S = 53.1 mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed AM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S $_{FF}$ = 55.0 mph S$_{FR}$ = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5197	0.90	Level	8	0	0.962	1.00	6005
Ramp	1160	0.90	Level	4	0	0.980	1.00	1315
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12}

Merge Areas

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.053 using Equation (Exhibit 25-5)

V_{12}= 321 pc/h

Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	7320	9000	No
V_{R12}	1636	4600:All	No

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 17.6 (pc/ mi /ln)

LOS = B (Exhibit 25-4)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

M_S = 0.341 (Exhibit 25-19)

S_R= 50.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 46.3 mph (Exhibit 25-14)

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Westbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	6559	0.90	Level	8	0	0.962	1.00	7579
Ramp	814	0.90	Level	4	0	0.980	1.00	923
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= using Equation (Exhibit 25-5)

V_{12}= pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}		See Exhibit 25-7	
V_{R12}		4600:All	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/ mi /ln)

LOS = (Exhibit 25-4)

Speed Estimation

M_S = (Exibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} =0.436 using Equation (Exhibit 25-11)

V_{12} = 3825 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$	7579	9000	No
V_{12}	3825	4400:All	No
$V_{FO} = V_F - V_R$	6656	9000	No
V_R	923	2100	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = 37.1 (pc/ mi /ln)

LOS= E (Exhibit 25-4)

Speed Estimation

D_s = 0.381 (Exhibit 25-19)

S_R= 50.0 mph (Exhibit 25-19)

S_0= 56.9 mph (Exhibit 25-19)

S = 53.2 mph (Exhibit 25-15)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information ***Site Information***

Analyst	Brian Gaffney	Freeway/Dir of Travel	I-240 Eastbound
Agency or Company	Clinard Engineering	Junction	Mill Branch
Date Performed	10/17/2008	Jurisdiction	Shelby County
Analysis Time Period	Proposed PM	Analysis Year	2032

Project Description I-240 @ Airways Blvd

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{up} = ft

Vu = veh/h

Terrain

S_{FF} = 55.0 mph S_{FR} = 45.0 mph

Sketch (show lanes, L_A, L_D,V_R,V_f)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

L_{down} = ft

VD = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	v=V/PHF f_{HV} f_p
Freeway	5256	0.90	Level	8	0	0.962	1.00	6074
Ramp	766	0.90	Level	4	0	0.980	1.00	868
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 25-2 or 25-3)

P_{FM}= 0.109 using Equation (Exhibit 25-5)

V_{12}= 664 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
V_{FO}	6942	9000	No
V_{R12}	1532	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 17.0 (pc/ mi /ln)

LOS = B (Exhibit 25-4)

Speed Estimation

M_S = 0.339 (Exhibit 25-19)

S_R= 50.6 mph (Exhibit 25-19)

S_0= N/A mph (Exhibit 25-19)

S= 47.0 mph (Exhibit 25-14)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 25-8 or 25-9)

P_{FD} = using Equation (Exhibit 25-11)

V_{12} = pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$V_{FI}=V_F$		See Exhibit 25-14	
V_{12}		4400:All	
$V_{FO} = V_F - V_R$		See Exhibit 25-14	
V_R		See Exhibit 25-3	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.0009\ L_D$

D_R = (pc/ mi /ln)

LOS= (Exhibit 25-4)

Speed Estimation

D_s = (Exhibit 25-19)

S_R= mph (Exhibit 25-19)

S_0= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

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