inter-office communication

To:	Myron Pakush, P.E., District 12 Deputy Director
Attention:	Brian Blayney, P.E., District 12 Traffic Planning Engineer
From:	David L. Holstein, P.E., Administrator, Office of Roadway Engineering
By:	Brenton Bogard, P.E., Studies Engineer
Date:	June 22nd, 2015
Subject:	Interchange Modification Study (IMS) for CUY-271-8.14 (at Cedar/Brainard), PID 97676, dated March 2015

The Office of Roadway Engineering has reviewed the subject report and determined the proposed improvements at the interchange will not degrade operations on I-271. **The study meets ODOT requirements for an Interchange Modification Study (IMS) and therefore is approved.**

Improvements include:

Phase 1

- Widen and extend a second NB thru lane on Brainard Road through the I-271 SB exit intersection to be tapered back to one lane starting around Edenhall Drive.
  - NB approach from (T) to (T-T)
  - SB approach is (T-T). No proposed changes
  - WB approach is (L-LR). No proposed changes
- Widen and reconfigure lane assignments at I-271 NB Ramp intersection with Brainard Road:
  - NB approach from (TR-R) to (T-R-R)
  - SB approach is (L-T-T). Left turn storage improved
  - EB approach from (L-R) to (L-LR-R)
- Widen and reconfigure lane assignments at the Cedar Road and Brainard Road intersection:
  - NB approach from (L-T-R) to (L-T-TR) and improve storage
  - EB approach is (L-L-T-TR). No proposed changes
  - WB approach is (L-T-T-R). No proposed changes
  - SB approach from (L-L-T-R) to (L-L-TR-R) and improve storage

Phase 2

- Switch the NB entrance and exit to and from the NB I-271 express lanes just south of the I-271 & Cedar Rd./Brainard Rd. interchange in order to provide a longer weaving distance from the NB I-271 express lanes to the NB Cedar/Brainard exit ramp.
- Widen NB I-271 to extend NB exit ramp to Brainard Road and Cedar Road.
- Widen NB I-271 exit ramp to Cedar Road and Brainard Road to 2 lanes just past the exit gore.

If you have any questions, please call Brenton Bogard at (614) 752-5575.

DLH:BLB

c: FHWA (Naureen Dar); D-12 (Myron Pakush, Lou Hazapis);
CO (Rick Bruce, Mike Cronebach) - Reading File - File

Blayney, Brian

From: Blalock, Andy
Sent: Tuesday, June 23, 2015 2:13 PM
To: Bogard, Brenton
Cc: Dar, Naureen
Subject: RE: CUY-271-8.14 Cedar/Brainard PID 97676 IMS

Brent

I agree that this falls into the IOS category so no further FHWA review is required. Give me a call if you want to discuss further.

Andy Blalock
Field Operations Team Leader
Federal Highway Administration
200 N. High St. Rm. 328
Columbus, OH
TEL: 614-280-6823
FAX: 614-280-6876

From: Bogard, Brenton [mailto:Brenton.Bogard@dot.ohio.gov]
Sent: Tuesday, June 23, 2015 12:07 PM
To: Blalock, Andy (FHWA)
Cc: Dar, Naureen (FHWA)
Subject: CUY-271-8.14 Cedar/Brainard PID 97676 IMS

Andy,

As my voicemail stated the subject report was originally written as an IMS and has been approved by ODOT and it is our opinion that the improvements fall under an IOS.

I wanted to be sure that FHWA agreed that the modifications shown on page 39 of the IMS PDF fall under the IOS. The express lane entrance/exit will be reversed to allow a longer weave distance for express lane vehicles to exit at Cedar/Brainard. The merge, diverge, and weaves were all analyzed to make sure the changes operated satisfactorily.

O:\Roadway\Interchange Modification Studies\CUY-271-8.14 (Cedar-Brainard); PID 97676

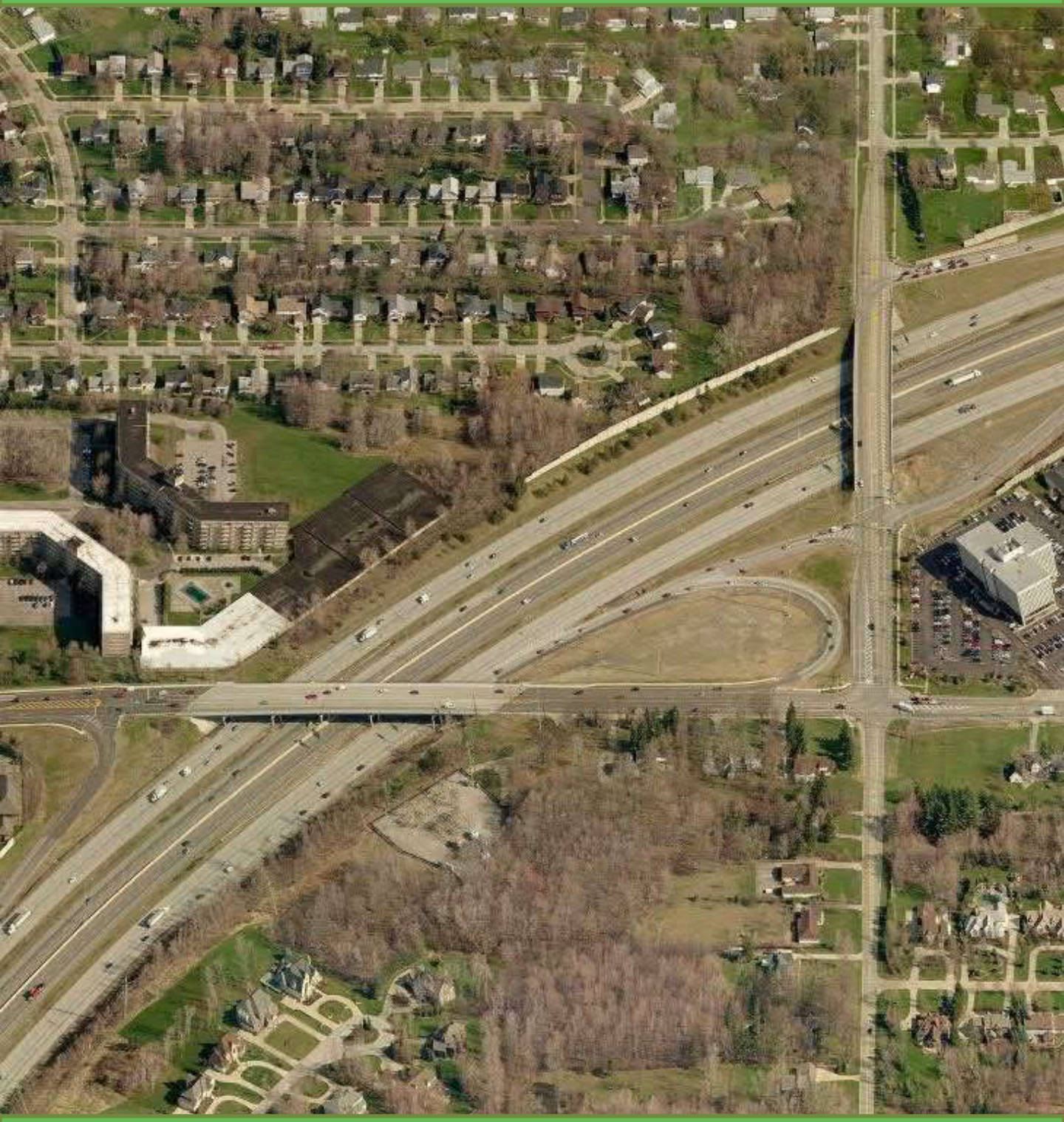
Feel free to give me a call to discuss.

Thanks,

Brenton Bogard, PE
Studies Engineer, Office of Roadway Engineering
Ohio Department of Transportation
1980 W. Broad Street, Mail Stop 1230
Columbus, OH 43223
✉brenton.bogard@dot.ohio.gov
☎614.752.5575

CUY-271-8.14

Interchange Modification Study (PID 97676)



March 2015

Interchange Modification Study

CUY-271-8.14

Cuyahoga County, OH

PID # 97676

Submitted To:

Ohio Department of Transportation – District 12
5500 Transportation Blvd
Garfield Heights, OH 44125

Prepared By:

Parsons Brinckerhoff
1660 West 2nd Street – Suite # 820
Cleveland, OH 44113

March 2015 (Revised June 2015)

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1.0 Executive Summary

The Ohio Department of Transportation (ODOT) in cooperation with the Federal Highway Administration (FHWA) is improving the safety and mobility of the Interstate 271 (I-271) interchange with Cedar Road/Brainard Road. A CUY-271-9.9/10.5 Safety Study dated July 25, 2014 was completed to evaluate the existing safety performance and identify potential countermeasures to reduce crashes and congestion throughout the study area.

The purpose of this study is to compare the future capacity performance of the No Build and Build Alternative and to reduce crashes within the study area.

A number of potential countermeasures were developed to improve the travel conditions within the study area. The findings from the CUY-271-9.9/10.5 Safety Study were focused on short and medium term countermeasures that improve safety performance. The recommended countermeasures will improve safety performance of I-271, Cedar Road, and Brainard Road. Longer term countermeasures should be considered once short and medium term countermeasures are implemented and evaluated for effectiveness. This approach is also consistent with FHWA's 8-point policy for Interchange Access Modification Studies.

The Build Alternative includes improvements to the northbound I-271 ramps and associated improvements to Brainard Road. This alternative will have phased construction. Phase 1 improvements will be limited to improvements that do not require construction adjacent to mainline I-271. Phase 2 improvements will construct a dual-lane northbound exit ramp to Cedar Road/Brainard Road. No improvements are proposed at the southbound I-271 ramp intersection on Cedar Road. Additional phase 2 improvements will consist of reversing the location of the crossover ramps that connect the local lanes and express lanes between Chagrin Boulevard and Cedar Road in the northbound direction.

In terms of interstate operations, an Interchange Modification Study (IMS) must show that the Build Alternative, at a minimum, will not degrade the interstate system's operation below the level of service (LOS) that would have existed in the design year for the No Build Alternative. The design guidelines recommend that an existing highway operate at LOS C or better. However, since the study area is within an urban area LOS D is acceptable with Metropolitan Planning Organization (MPO) and ODOT approval. The second edition of the NOACA Congestion Management System (CMS) Manual of Practice, dated October 2002, states that Level of Service (LOS) "D" will be the threshold for peak periods in urbanized areas and LOS "C" will be the threshold for peak periods in rural areas (Page i, Executive Summary). A level of service below LOS C is acceptable for the Build Alternative provided the level of service is not degraded from what it is in the No Build Alternative, or would be acceptable for a new build.

To provide a level of service comparison, the capacity calculations for the Build Alternative were compared to those for the No Build Alternative in the project's design year (2036). Based on the comparison analysis, every location's level of service will be improved or equal to that of the No Build Alternative throughout the study area with two exceptions:

- There are various weave segments where the No Build Alternative and the Build Alternative are LOS F. Degradation does not occur at these locations as there is no additional traffic at any of these weaves as a result of the Build Alternative.

- There is one location where the Build Alternative results in a higher volume of traffic on the northbound local lanes compared to the No Build, a result of switching the local and express crossover locations. In the No Build, the weave LOS is a C, and in the Build the weave LOS is an E. It is important to distinguish that the weaves occur on different freeway segments, on the express lanes versus on the local lanes in the No Build and Build Alternatives, respectively.

The proposed northbound dual-lane exit ramp to Cedar Road/Brainard Road improves the level of service from "F" to "A", eliminating congestion at this location.

In terms of safety, an IMS must demonstrate that safety will not be degraded when modifications are made to the Interstate System when compared to the existing configuration. A direct relationship often exists between congestion and crashes. The Build Alternative meets the recommended guidelines in ODOT's Location and Design Manual for level of service. With the exception described above, every location's level of service will be equal to that of the No Build Alternative throughout the study area.

For all the reasons noted above, this IMS is recommended for approval, based on satisfying the eight policy statements in the Interstate System Access Information Guide (August 2010).

2.0 Background

The Ohio Department of Transportation (ODOT) in cooperation with the Federal Highway Administration (FHWA) is improving the safety and mobility of the Cedar Road/Brainard Road/I-271 interchange (PID 97676). A safety study was completed by LJB in July 2014 to evaluate the existing safety performance and identify potential countermeasures to reduce crashes and congestion throughout the study area.

The Cedar Road/Brainard Road/I-271 interchange has been the focus of numerous studies. Improvements have been completed to relieve congestion and improve the safety within the study area (Cedar Road bridge widening, signal timing upgrades, delineation). A list of previous studies completed in the past twelve years is shown below:

- CUY-271-9.9/10.5 Safety Study (2014)
- Signal Progression Study (2014)
- Signal Timing Analysis (2013)
- Road Safety Audit (2012)
- Preliminary Engineering Study of NB I-271 Directional Ramp (2010)
- Brainard/Cedar Technical Memorandum (2009)
- I-271/Cedar/Brainard Access Point Modification Study (2002)

A Road Safety Audit (RSA) was conducted at the Cedar Road/Brainard Road interchange by the Northeast Ohio Area Coordinating Agency (NOACA) in 2012. The Executive Summary from the RSA is shown in Appendix A. The study area and associated crash data (279 crashes) was limited to the four signalized intersections included in this IMS – some mainline I-271 crashes not included in the safety analysis. The design year traffic volumes used in the RSA report were created by NOACA's traffic forecasting model.

The CUY-271-9.9/10.5 Safety Study was completed in July 2014 to evaluate the existing safety performance and identify potential countermeasures to reduce crashes and congestion throughout the study area. The proposed countermeasures includes modifications to the existing access points, including an additional lane for the I-271 NB off ramp, additional lanes along Brainard Road, and revised directional lane assignments.

3.0 Purpose and Need

The purpose of this study is to compare the future capacity performance of the No Build and Build alternatives and to reduce crashes within the study area. Furthermore, it will be verified that the proposed modifications to the intersections do not adversely affect or degrade the operational performance of the surrounding I-271 interstate system. The modifications proposed in the Safety Study will relieve congestion and reduce delay at the Cedar Road and Brainard Road intersection and adjacent intersections that compromise the I-271 interchange. As a result, the project will enhance the quality of life for residents and commuters as the Cedar/Brainard Road intersection and surrounding intersections become more reliable with the reduction in travel delays and improvements related to safety.

4.0 Study Area

I-271 is an interstate highway that runs north-south and passes through suburbs of Cleveland and Akron. It begins at Interstate 71 (I-71) in Medina, Ohio and extends north to Interstate 90 (I-90) in Willoughby Hills, Ohio. The study area lies within the jurisdiction of the following cities in Cuyahoga County, Ohio: Lyndhurst, Beachwood, Pepper Pike, and Mayfield Heights. The surrounding area is urbanized, and includes regional shopping centers and residential developments. The interchange is utilized by both local and regional traffic.

Adjacent interchanges along the I-271 corridor include US-322/Mayfield Road (2 miles north) and US-422/SR87/Chagrin Blvd (3 miles south). These locations mark the northern and southern limits of the study area. The study area is comprised of four signalized intersections that surround the I-271 and Cedar Road/Brainard Road interchange:

- Cedar Road & I-271 SB On Ramp
- Brainard Road & Cedar Road
- Brainard Road & I-271 NB On/Off Ramp
- Brainard Road & I-271 SB Off Ramp

An aerial view of the study area is shown in Figure 1. An aerial view of the I-271 interchange with Cedar Road/Brainard Road is shown in Figure 2.

Figure 1. Aerial view of Study Location Map.

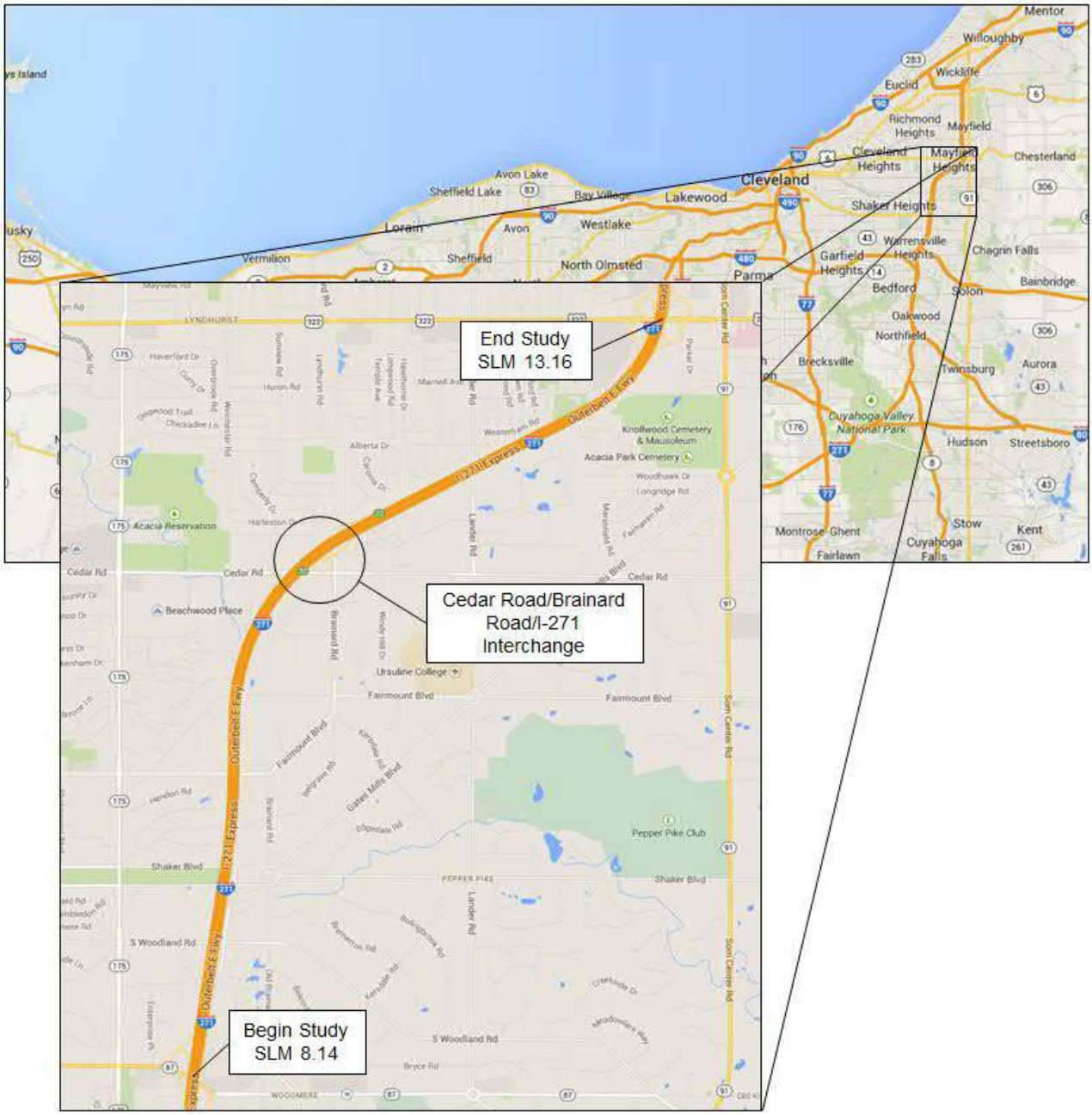


Figure 2. Aerial View of the Cedar Road/Brainard Road/I-271 Interchange.

5.0 Existing Conditions

5.1 Road Geometry and Access Locations

According to ODOT's functional roadway classification system, I-271 is classified as an urban interstate. Cedar Road and Brainard Road are classified as urban principal arterials in the study area.

The I-271 interchange with Cedar Road/Brainard Road provides access to the cities of Lyndhurst, Pepper Pike, Beachwood, and Mayfield Heights. The interchange is a hybrid interchange with a system of ramps that intersect with local roadways at signalized

intersections. As shown in Figure 2, the Cedar Road/Brainard Road/I-271 interchange is a split diamond interchange with an auxiliary Parclo B exit ramp (NB I-271 to WB Cedar Road).

The lane configuration along Cedar Road varies from 5 to 7 lanes within the study area while the lane configuration along Brainard Road varies from 3 to 6 lanes. Cedar Road and Brainard road intersect to form an at-grade intersection just southeast of the I-271 interchange. The three signalized intersections along Brainard Road are coordinated with one another. The Cedar Road & I-271 SB on ramp intersection is not coordinated with the Brainard Road system.

Table 1 summarizes the ADT, functional classification, existing number of lanes, and posted speed limits of the roadways within the study area.

Table 1. Existing Roadway Conditions

Study Location	ADT (vpd)	Functional Classification	Existing Number of Lanes	Posted Speed Limit
I-271	129,550 (2011)	Interstate	Express Lanes 2 to 3 Local Lanes 3 to 4	60 mph
Cedar Road (west of Brainard Road)	34,000 (2008)	Principal Arterial	5 to 6	35 mph
Cedar Road (east of Brainard Road)	24,000 (2008)	Collector	5	35 mph
Brainard Road (Cedar Road to I-271 NB Ramps)	18,000 (2008)	Principal Arterial	4 to 6	35 mph
Brainard Road (south of Cedar Road)	10,000 (2008)	Minor Arterial	4	35 mph
Brainard Road (north of I-271)	11,600 (2012)	Minor Arterial	3	35 mph

5.2 Physical Conditions

The terrain is generally flat throughout the study area. Cedar Road and Brainard Road intersect to form an at-grade intersection. I-271 experiences little change in grade, and passes under and over intersecting roadways.

5.2.1 Geometric Deficiencies

No design/geometric deficiencies were identified for the improvement areas. The study section adheres to the current state and federal design standards.

5.3 Crash Data

The crash analysis for this improvement was completed as part of the CUY-271-9.9/10.5 Safety Study. Crash data was compiled by ODOT for the I-271 interchange with Cedar Road/Brainard Road. The following data was obtained from the Safety Study.

A total of 445 crashes occurred within the study area during the three year crash analysis period, from January 1, 2009 to December 31, 2011. Of these crashes, thirty-six percent (159

total crashes) occurred along the I-271 corridor. The remaining sixty-four percent (286 total crashes) occurred on the surface streets and surrounding intersections.

Of the crashes that occurred on I-271, seventy-six percent (121 total crashes) were rear end crashes. Roughly thirty-one percent (50 total crashes) of these crashes resulted in injury. Of the crashes that occurred on the surface streets and associated intersections, sixty percent (172 total crashes) were rear end crashes. Twenty-six percent (74 total crashes) of the surface street crashes resulted in injury. Roughly thirty-four percent (96 total crashes) of these crashes occurred on wet pavement.

Of the 445 crashes that occurred throughout the study area, thirty percent (132 total crashes) occurred during the PM peak period. The highest percentage of crashes that occurred was rear end crashes, accounting for 66 percent of all total crashes throughout the study section. This crash frequency suggests that sudden slow-downs and congestion is a contributing factor to the safety performance of the study area.

A more detailed discussion of the crash data, including analysis by individual locations, can be found in the CUY-271-9.9/10.5 Safety Study, completed in July 2014. The crash analysis summary from the Safety Study is shown in Table 2.

Table 2. Crash Summary

Study Location	Total Crashes By Location	Rear-End (20.6%)	Angle/LT (21.7%)	S.S. Passing (6.9%)	Injury (23.8%)	TOD (7-10AM)	TPD (5-8PM)	ODOT RSI
Brainard Rd/I-271 NB Ramps	96	40 (41.7%)	43 (44.8%)	11 (11.5%)	33 (34.4%)	20%	24%	20538
Cedar Rd/I-271 SB Entrance Ramp	98	70 (71.4%)	2 (2.0%)	23 (23.5%)	20 (20.4%)	12%	17%	17706
Cedar Rd/Brainard Rd	58	36 (62.1%)	4 (6.9%)	15 (25.9%)	12 (20.7%)	14%	26%	18292
Brainard Rd/I-271 SB Exit Ramp	34	26 (76.5%)	2 (5.9%)	2 (5.9%)	9 (26.5%)	12%	15%	18952
I-271 NB Mainline	159	121 (76.1%)	-	25 (15.7%)	50 (31.4%)	9%	62%	21623
		(29.9%)	(3.4%)	(18.6%)	(23.9%)			

Data Source:CUY-271-9.9/10.5 Safety Study, July 25, 2014.

Crash Diagrams from the CUY-271-9.9/10.5 Safety Study can be found in Appendix B of this report.

5.4 Demographics

Demographic data for the study area were obtained from Cuyahoga County Geographic Information Systems (GIS) data and the U.S. Census Bureau. For additional demographic information, see the Environmental Justice information in Section 11.0.

5.5 Land Use

Land use within the project study area is highly urbanized. The area consists predominately of commercial properties, employment/office centers, residential subdivisions, and regional shopping centers. In addition, there are several community facilities, parks, and a large cemetery adjacent to the I-271 corridor.

6.0 Analysis Years

Opening Year for the CUY-271-8.14 project is 2016 with the Design Year established as 2036. Design Year traffic analyses are provided for the No Build Alternative and Build Alternative for the CUY-271-8.14 study area.

7.0 Alternatives Considered

The No-Build condition for the Cedar Road/Brainard Road/I-271 interchange assumed that no improvements were made to the existing interchange area.

This study analyzes the countermeasures from the CUY-271-9.9/10.5 Safety Study as it compares to the No Build condition. The conceptual plans of the proposed countermeasures are shown in Exhibits 1-3 which represent the Build alternative. The Build Alternative includes improvements to the northbound I-271 ramps and associated improvements to Brainard Road. This alternative will have phased construction. Phase 1 improvements will be limited to improvements that do not require construction adjacent to mainline I-271. Phase 2 improvements will construct a dual northbound exit ramp to Cedar Road/Brainard Road. Additional phase 2 improvements will consist of reversing the location of the crossover ramps that connect the local lanes and express lanes between Chagrin Boulevard and Cedar Road in the northbound direction.

An addition to the alternatives presented in the Safety Study is switching the local lane and express lane crossover locations. Switching the crossover locations provides for a greater weaving distance from the express lanes to the Cedar Road/Brainard Road exit. In the No Build Alternative, the traffic enters the express lanes as an add-lane and the lane subsequently drops from the express lanes where the traffic exits to the local lanes. However, in the Build Alternative, the traffic enters the local lanes as an add-lane and the lane subsequently drops from the local lanes where the traffic exits to the express lanes.

No improvements are proposed at the I-271 southbound ramp intersection on Cedar Road.

For the purpose of this report, it was not necessary to evaluate multiple alternatives. The Safety Study analyzed multiple countermeasures. The selected countermeasures are combined to create this Build Alternative. The IMS was initiated and based solely on the Build Alternative from the Safety Study.

8.0 Traffic Volumes

The Modeling and Forecasting Section of ODOT provided mainline certified traffic volumes and certified traffic volume forecasts for the ramps and side roads. This was done for Opening Year (2016) and Design Year (2036) as presented in Appendix C. The certified traffic was used to complete the evaluation of the No Build Alternative and the Build Alternative.

9.0 Traffic Analyses

Traffic conditions were analyzed for the No Build Alternative and the Build Alternative using ODOT certified traffic and standard traffic analysis procedures with the Highway Capacity Software 2010 (HCS 2010). AM and PM peak hour analyses were conducted for the 2036 Design Year.

Capacity analyses are performed to estimate the maximum amount of traffic that can be accommodated by a roadway while maintaining prescribed operational qualities. Levels of service were determined for freeway segments, ramp junctions, weave segments, and intersections for the No Build Alternative and the Build Alternative. Tables with level of service information are presented in the following sections. Graphics of the level of service at each freeway segment, ramp junction, weave segment, and intersection are included in Appendix D to show the effects of proposed improvements on the interstate system and the local road network. These graphics also show an overall comparison of operations between the No Build Alternative and the Build Alternative. The individual HCS analyses for the No Build Alternative and the Build Alternative are also provided in Appendix D.

9.1 Freeway Segment Analyses

The freeway segment level of service criteria as defined by the Transportation Research Board for freeway segment density is shown in Table 3.

Table 3. Freeway Segment Level of Service

Level of Service (LOS)	Freeway Segment Density (pc/mi/ln)
A	≤ 11
B	> 11 – 18
C	> 18 – 26
D	> 26 – 35
E	> 35 – 45
F	Demand exceeds capacity
	> 45

9.1.1 No Build Alternative Freeway Segments

The operating goal is to maintain LOS D or better for all roadway segments. As a result, degradation from the No Build condition to the Build condition only occurs when the level of service for the Build condition is LOS E or LOS F and it has a lower level of service than the No Build condition. For this reason, only the number of locations which have LOS E or LOS F are discussed below.

Twenty-four (24) freeway segments were analyzed for the No Build Alternative.

AM Peak
During the AM peak period, one (1) freeway segment operated at LOS F. The freeway segment operating at LOS F occurred on southbound I-271 – no improvements are proposed at the Cedar Road/Brainard Road interchange that impact southbound I-271 operations. In addition, two (2) freeway segments operated at LOS E. The remaining twenty-one (21) freeway segments operated at LOS D or better.

PM Peak
During the PM peak period, all twenty-four (24) freeway segments operated at LOS D or better.

9.1.2 Build Alternative Freeway Segments

Twenty-four (24) freeway segments were analyzed along the Build Alternative.

AM Peak
During the AM peak period, one (1) freeway segment operated at LOS F. The freeway segment operating at LOS F occurred on southbound I-271 – no improvements are proposed at the Cedar Road/Brainard Road interchange that impact southbound I-271 operations. By comparison, the level of service for this freeway segment in the No Build Alternative would also be LOS F. In addition, two (2) freeway segments operated at LOS E. The level of service for these freeway segments in the No Build Alternative would also be LOS E. The remaining twenty-one (21) freeway segments operated at LOS D or better.

PM Peak
During the PM peak period, all twenty-four (24) freeway segments operated at LOS D or better.

The freeway segment analysis for the No Build Alternative and the Build Alternative is presented in Table 4 and Table 5.

Table 4. Freeway Segment Analyses for the No Build/Build Condition (Northbound)

Ref	Figure(s)	Facility	Location (segment boundary from/to)	LOS			
				No Build-2036		Build-2036	
				AM Peak	PM Peak	AM Peak	PM Peak
F-1	1, 2	I-271 NB	Chagrin Blvd Overpass to Chagrin Blvd On Ramp	B	C	B	C
F-2a	1, 2	I-271 NB (4-lane)	Chagrin Blvd On Ramp to I-271 NB Crossover Ramp (to Express lanes)	B	C	B	C
F-2b	1, 2	I-271 NB (3-lane)	Chagrin Blvd On Ramp to I-271 NB Crossover Ramp (to Express lanes)	C	D	C	D
F-3	1, 2	I-271 NB (Express Lanes)	Chagrin Blvd overpass to I-271 NB Crossover Ramp (to Express lanes)	C	D	C	D
F-4	1, 2	I-271 NB	I-271 NB crossover Ramp (to Express lanes) to I-271 NB Crossover Ramp (to Local lanes)	B	C	C	C
F-5	1, 2	I-271 NB (Express Lanes)	I-271 NB crossover Ramp(to Express lanes) to I-271 NB Crossover Ramp (to Local lanes)	B	C	B	B
F-6	1, 2	I-271 NB	I-271 NB Crossover Ramp (to Local lanes) to Cedar/Brainard Rd Off Ramp	D	D	D	D
F-7	1, 2	I-271 NB (Express Lanes)	I-271 NB Crossover Ramp (to Local lanes) to Brainard Road overpass	B	B	B	B
F-8	1, 2	I-271 NB	Cedar/Brainard Rd Off Ramp to Brainard Rd On Ramp	B	C	B	C
F-9	1, 2	I-271 NB	Brainard Rd On Ramp to I-271 NB Crossover Ramp (to Local lanes)	C	D	C	D
F-10	1, 2	I-271 NB	I-271 NB Crossover Ramp (to Local lanes) to Mayfield Rd Off Ramp	C	D	C	D
F-11	1, 2	I-271 NB (Express Lanes)	I-271 NB Crossover Ramp (to Local lanes) to the Mayfield Rd overpass	B	B	B	B
F-12	1, 2	I-271 NB	Mayfield Rd Off Ramp to the Mayfield Rd overpass	B	D	B	D

Figure(s) number refers to Appendix D HCS Results.

Table 5. Freeway Segment Analyses for the No Build / Build Condition (Southbound)

Ref	Figure(s)	Facility	Location (segment boundary from/to)	LOS			
				No Build-2036		Build-2036	
				AM Peak	PM Peak	AM Peak	PM Peak
F-13	1, 2	I-271 SB	Mayfield Rd overpass to Mayfield Rd On Ramp	F	C	F	C
F-14	1, 2	I-271 SB	Mayfield Rd On Ramp to I-271 SB Crossover Ramp (to Express lanes)	D	C	D	C
F-15	1, 2	I-271 SB (Express Lanes)	Mayfield Rd overpass to I-271 SB Crossover Ramp (to Express Lanes)	C	B	C	B
F-16	1, 2	I-271 SB	I-271 SB Crossover Ramp (to Express lanes) to Brainard Rd Off Ramp	D	B	D	B
F-17	1, 2	I-271 SB	Brainard Rd Off Ramp to Cedar Rd On Ramp	C	B	C	B
F-18	1, 2	I-271 SB	Cedar Rd On Ramp to I-271 SB Crossover Ramp (to Express lanes)	E	D	E	D
F-19	1, 2	I-271 SB (Express Lanes)	Brainard Road overpass to Cedar Road overpass	D	B	D	B
F-20	1, 2	I-271 SB	I-271 SB Crossover Ramp (to Express lanes) to I-271 SB Crossover Ramp (to Local lanes)	D	C	D	C
F-21	1, 2	I-271 SB (Express Lanes)	I-271 SB Crossover Ramp (to Express lanes) to I-271 SB Crossover Ramp (to Local lanes)	C	B	C	B
F-22a	1, 2 (3-lane)	I-271 SB	I-271 SB Crossover Ramp (to Local lanes) to Chagrin Blvd Off Ramp	E	C	E	C
F-22b	1, 2 (4 lane)	I-271 SB	I-271 SB Crossover Ramp (to Local lanes) to Chagrin Blvd Off Ramp	D	C	D	C
F-23	1, 2	I-271 SB (Express Lanes)	I-271 SB Crossover Ramp (to Local lanes) to Chagrin Blvd Overpass	D	C	D	C
F-24	1, 2	I-271 SB	Chagrin Blvd Off Ramp to Chagrin Blvd Overpass	D	C	D	C

Figure(s) number refers to Appendix D HCS Results.

9.2 Ramp Junction Analyses

The ramp junction level of service criteria as defined by the Transportation Research Board for ramp junction density is shown in Table 6.

Table 6. Ramp Junction Level of Service

Level of Service (LOS)	Ramp Junction Density (pc/mi/ln)
A	≤ 10
B	> 10 – 20
C	> 20 – 28
D	> 28 – 35
E	> 35
F	Demand Exceeds Capacity

9.2.1 No Build Alternative Ramp Junctions

The operating goal is to maintain LOS D or higher for all ramp junctions. As a result, degradation from the No Build condition to the Build condition only occurs when the level of service for the Build condition is LOS E or LOS F and it has a lower level of service than the No Build condition. For this reason, only the number of locations which have LOS E or LOS F are discussed below.

Twenty (20) ramp junctions were identified for the No Build Alternative. Of these, ten (10) were merges and ten (10) were diverges. HCS analysis was not completed for six (6) of these junctions due to the presence of an add lane or a drop lane; these areas were analyzed as freeway segments.

AM Peak

During the AM peak period, one (1) diverge location operated at LOS F – the No Build (2036) scenario at the NB I-271 ramp at the Cedar/Brainard Road interchange. In addition, two (2) merge locations operated at LOS E. The remaining eleven (11) locations operated a LOS C or better.

PM Peak

During the PM peak period, one (1) diverge location operated at LOS F -- the No Build (2036) scenario at the NB I-271 ramp at the Cedar/Brainard Road interchange. The remaining thirteen (13) locations operated at LOS D or better.

9.2.2 Build Alternative Ramp Junctions

Twenty (20) ramp junctions were analyzed along the Build Alternative. Of these, ten (10) were merges and ten (10) were diverges. HCS analysis was not completed for six (6) of these junctions due to the presence of an add lane or a drop lane; these areas were analyzed as freeway segments.

AM Peak

During the AM peak period, two (2) merge locations operated at LOS E. The remaining twelve (12) locations operated a LOS D or better.

PM Peak

During the PM peak period, all fourteen (14) of the locations operated at LOS C or better.

The ramp junction analysis for the No Build Alternative and the Build Alternative is presented in Table 7.

Table 7. Ramp Junction Analyses for the No Build / Build Condition

Ref	Figure	Facility	Location	LOS No Build - 2036		LOS Build - 2036	
				AM Peak	PM Peak	AM Peak	PM Peak
R-1	1, 2	I-271 NB	Chagrin Blvd Off Ramp	A	B	A	B
R-2	1, 2	I-271 NB	I-271 NB Off Ramp between Chagrin Blvd & Cedar Rd	B	C	B	B
R-3	N/A	I-271 NB (Express Lanes)	I-271 NB (Express Lanes) On Ramp between Chagrin Blvd & Cedar Rd	R-3 not shown due to the presence of an Add Lane (*)			
R-4	N/A	I-271 NB (Express Lanes)	I-271 NB (Express Lanes) Off Ramp between Chagrin Blvd & Cedar Rd	R-4 not shown due to the presence of a Drop Lane (*)			
R-5	1, 2	I-271 NB	I-271 NB On Ramp between Chagrin Blvd & Cedar Rd	C	D	A	B
R-6	1, 2	I-271 NB	Cedar/Brainard Rd Off Ramp	F	F	A	A
R-7	1, 2	I-271 NB	Cedar Rd Off Ramp	B	C	B	C
R-8	1, 2	I-271 NB (Express Lanes)	I-271 NB (Express Lanes) Off Ramp between Brainard Rd & Mayfield Rd	A	B	A	B
R-9	1, 2	I-271 NB	I-271 NB On Ramp between Brainard Rd & Mayfield Rd	B	C	B	C
R-10	1, 2	I-271 NB	Mayfield Rd Off Ramp	Drop Lane (*)			
R-11	1, 2	I-271 SB	Mayfield Rd On Ramp	Add Lane (*)			
R-12	1, 2	I-271 SB	I-271 SB Off Ramp between Brainard Rd & Mayfield Rd	C	B	C	B
R-13	1, 2	I-271 SB (Express Lanes)	I-271 SB (Express Lanes) On Ramp between Brainard Rd & Mayfield Rd	C	B	C	B
R-14	1, 2	I-271 SB	Brainard Rd Off Ramp	C	B	C	B
R-15	1, 2	I-271 SB	Cedar Rd On Ramp	E	C	E	C
R-16	1, 2	I-271 SB	I-271 SB Off Ramp between Chagrin Blvd & Cedar Rd	C	C	C	C
R-17	1, 2	I-271 SB (Express Lanes)	I-271 SB (Express Lanes) On Ramp between Chagrin Blvd & Cedar Rd	Add Lane (*)			
R-18	1, 2	I-271 SB (Express Lanes)	I-271 SB (Express Lanes) Off Ramp between Chagrin Blvd & Cedar Rd	Drop Lane (*)			
R-19	1, 2	I-271 SB	I-271 SB On Ramp between Chagrin Blvd & Cedar Rd	E	C	E	C
R-20	1, 2	I-271 SB	Chagrin Blvd Off Ramp	C	B	C	B

Figure(s) number refers to Appendix D HCS Results. (*) Location was analyzed as a freeway segment.

9.3 Weave Segment Analyses

The weaving segment level of service criteria as defined by the Transportation Research Board for weaving segments density is shown in Table 8.

Table 8. Weave Segment Level of Service

Level of Service (LOS)	Weave Segment Density (pc/mi/ln)
A	0 – 10
B	> 10 – 20
C	> 20 – 28
D	> 28 – 35
E	> 35
F	Demand exceeds capacity

The weave analysis focused on movements to/from the Express Lanes and the Local Lanes on I-271. For the purpose of analysis, all traffic on the crossover between the Express and Local lanes were assumed to be destined to the exit ramp of the nearest interchange. This assumption is considered to be conservative indicating that LOS values calculated for these movements are to operate equal or better than summarized in this report.

9.3.1 No Build Alternative Weave Segments

The operating goal is to maintain LOS D or better for all weave segments. As a result, degradation from the No Build condition to the Build condition only occurs when the level of service for the Build condition is LOS E or LOS F and it has a lower level of service than the No Build condition. For this reason, only the number of locations which have LOS E or LOS F are discussed below. The certified traffic does not include weaving data for the crossovers between the express lanes and the general purpose lanes of I-271. For analysis purposes, it was assumed that every vehicle using the crossover lanes are destined to the next interchange (worst case scenario).

Six (6) weave segments were analyzed for the No Build Alternative.

AM Peak

During the AM peak period, four (4) weave segments operated at LOS F. The remaining two (2) locations operated at LOS C.

PM Peak

During the PM peak period, one (1) weave segment operated at LOS F and two (2) weave segments operated at LOS E. The remaining three (3) locations operated at LOS D or better.

9.3.2 Build Alternative Weave Segments

Six (6) weave segments were analyzed for the Build Alternative.

The crossover locations were switched to provide for a greater weaving distance from the express lanes to the Cedar Road/Brainard Road exit. In the No Build Alternative, the traffic enters the express lanes as an add-lane and the lane subsequently drops from the express

lanes where the traffic exits to the local lanes. However, in the Build Alternative, the traffic enters the local lanes as an add-lane and the lane subsequently drops from the local lanes where the traffic exits to the express lanes. This weave is identified as W-2. It is important to distinguish that weave W-2 occurs on different freeway segments, on the express lanes versus on the local lanes in the No Build and Build Alternatives, respectively.

AM Peak
During the AM peak period, four (4) weave segments operated at LOS F. One (1) weave segment operated at LOS C. One (1) weave segment (W-1) resulted in an undefined LOS because the actual weave length exceeded the maximum weave length. As a result, the location was treated as an isolated merge and diverge area.

In the No Build, W-2 LOS is a C, and in the Build the weave LOS is also a C.

PM Peak
During the PM peak period, one (1) weave segment operated at LOS F and two (2) weave segments operated at LOS E. One (1) weave segment (W-1) resulted in an undefined LOS because the actual weave length exceeded the maximum weave length. As mentioned, this location was treated as an isolated merge and diverge area. The remaining two (2) locations operated at LOS D or better.

In the No Build, W-2 LOS is a C, and in the Build the weave LOS is an E.

The weave segment analysis for the No Build Alternative and the Build Alternative is presented in Table 9.

There are various weave segments that operate at LOS E and LOS F. There is one weave location where the Build Alternative results in a higher volume of traffic when compared to the No Build, dropping the level of service from a LOS C to a LOS E. This occurs as a result of switching the crossover ramps that connect the local lanes and express lanes between Chagrin Boulevard and Cedar Road in the northbound direction.

Table 9. Weave Segment Analyses for the No Build / Build Condition

Ref	Figure(s)	Facility	Location (segment boundary from/to)	LOS			
				No Build - 2036		Build - 2036	
				AM Peak	PM Peak	AM Peak	PM Peak
W-1	1, 2	I-271 NB	Chagrin Blvd On Ramp to I-271 NB Crossover Ramp (to Express lanes)	C	E	-	-
W-2	1, 2	I-271 NB (Express Lanes)	I-271 NB Crossover (to Express lanes) to I-271 NB Crossover Ramp (to Local lanes)	C	C	-	-
W-2	1, 2	I-271 NB (Express Lanes)	I-271 NB Crossover (to Local lanes) to I-271 NB Crossover Ramp (to Express lanes)	-	-	C	E
W-3	1, 2	I-271 NB	I-271 NB Crossover Ramp (to Local lanes) to Cedar Rd Off Ramp	F	F	F	F
W-4	1, 2	I-271 SB	Mayfield Rd On Ramp to I-271 SB Crossover Ramp (to Express lanes)	F	C	F	C
W-5	1, 2	I-271 SB	Cedar Rd On Ramp to I-271 SB Crossover Ramp (to Express lanes)	F	E	F	E
W-6	1, 2	I-271 SB	I-271 SB Crossover Ramp (to Local lanes) to Chagrin Blvd Off Ramp	F	D	F	D

Figure(s) number refers to Appendix D HCS Results.

9.4 Intersection Analyses

The average vehicle delay calculation at each intersection is assigned a level of service ranging from LOS A, the best, to LOS F, the worst or failure. LOS D is considered acceptable. The intersection level of service criteria as defined by the Transportation Research Board for signalized intersections is shown in Table 10.

Table 10. Intersection Level of Service

Level of Service (LOS)	Signalized Intersection Control Delay per Vehicle (seconds)
A	≤ 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

Note: Control Delay assumes v/c ratio ≤ 1.0. If v/c ratio > 1.0, LOS F.

9.4.1 No Build Alternative Intersection Analyses

A total of four (4) intersections were analyzed in the No Build Alternative.

AM Peak
During the AM peak period, one (1) intersection operated at LOS D, two (2) intersections operated at LOS E, and one (1) intersection operated at LOS F.

PM Peak
During the PM peak period, three (3) intersections operated at LOS E while one (1) intersection operated at LOS F.

9.4.2 Build Alternative Intersection Analyses
A total of four (4) intersections were analyzed in the Build Alternative.

AM Peak
During the AM peak period, one (1) intersection operated at LOS F. The remaining three (3) intersections operated at LOS C. The volume to capacity (v/c) ratio for the signalized intersections on the Brainard Road corridor do not exceed 1.0 – constrained analysis is not applicable to the study area.

PM Peak
During the PM peak period, two (2) intersections operated at LOS D, one (1) intersection operated at LOS E, and one (1) intersection operated at LOS F.

The intersection analysis for the No Build Alternative and Build Alternative is presented in Table 11.

The Cedar Road and I-271 SB on-ramp intersection operates at an LOS F where no work is being proposed at this time. By comparison, the level of service for this intersection in the No Build Alternative would also be LOS F.

Table 11. Intersection Analyses for the No Build / Build Condition

Ref	Figure(s)	Intersection	LOS			
			No Build - 2036		Build - 2036	
			AM Peak	PM Peak	AM Peak	PM Peak
I-1	3, 4	Cedar Rd & I-271 SB On Ramp	F	F	F	F
I-2	3, 4	Brainard Rd & Cedar Rd	E	E	C	E
I-3	3, 4	Brainard Rd & I-271 NB On/Off Ramp	E	E	C	D
I-4	3, 4	Brainard Rd & I-271 SB Off Ramp	D	E	C	C

Figure(s) number refers to Appendix D HCS Results.

The Build Alternative for the Brainard Rd & I-271 NB On/Off Ramps (I-3) presents a condition that HCS has limitations on modeling. The HCS model does not allow the NB right turn movement to overlap with the I-271 ramp movement, therefore the level of service will be equal to or better than the HCS output. Analysis of downstream locations NB along I-271 will not be affected.

9.5 Turn Lane Storage Lengths

Turn lane lengths were calculated at the Cedar Road and Brainard Road intersections based on the methodology of ODOT's Location and Design Manual section 401-9 criteria using the certified traffic volumes. Existing and recommended lane sizing lengths are summarized in Table 12**.** Appendix E includes the storage length calculation worksheets.

Table 12. Turn Lane Storage Lengths for the Build Lanes

INTERSECTION MOVEMENT	EXISTING	ODOT STORAGE		NO BLOCK DISTANCE		RECOMMENDED LENGTH
		AM PEAK HOUR	PM PEAK HOUR	AM PEAK HOUR	PM PEAK HOUR	
BRAINARD @ CEDAR RD						
EB LEFT (DUAL)	1350'-650'	320'	515'	NA[1]	NA[1]	No change
WB LEFT	140'	115'	115'	395'	640'	No change
WB RIGHT	420'	220'	595'	395'	640'	No change[2]
NB LEFT	410'	210'	200'	165'	190'	No change
SB LEFT (DUAL)	450'-350'	585'	395'	775'	640'	450'-330'[3]
SB RIGHT	350'	825'	690'	NA[4]	NA[4]	365'[3]
BRAINARD @ NB I-271 RAMP						
EB LEFT	460'	320'	385'	515'[8]	330'[8]	750'
EB LEFT-RIGHT	-	-	-			Add lane
EB RIGHT	THRU	820'	635'	265'	335'	250'
NB RIGHT (DUAL)	440'	400'	675'	200'	485'	400'-400'[5]
SB LEFT	390'	210'	200'	885'	780'	460'[3]
BRAINARD @ SB I-271 EXIT RAMP						
WB LEFT	370'	610'	375'	555'	550'	No change[6]
CEDAR @ SB I-271 ENTRANCE RAMP						
EB RIGHT	265'	1900'	1900'	1515'	1850'	No change
WB LEFT (DUAL)	640'-1400'	645'	995'	1850'	1850'	No change[7]

Note 1 – Inside through lane from the I-271 ent. ramp intersection drops as a left turn only lane, through blockage is not applicable
Note 2 - A right turn overlap phase for westbound right with southbound split phase minimizes the need for the entire storage length.
Note 3 – Turn lane extends to the upstream signalized intersection
Note 4 – Curbside through lane from the I-271 exit ramp intersection drops as a right turn only lane, thru blockage is not applicable
Note 5- Turn lane provided for the entire length of the roadway segment
Note 6 - Residual queue spillback for the left turn movement can be accommodated on the ramp without impacting mainline IR-271.
Note 7 – The outside left turn lane (adjacent to through lane) extends to the upstream signalized intersection
Note 8 – Through blockage reduced by 250' to account for a short EB right turn lane of 250'.

Brainard Road and I-271 NB ramps intersection: The proposed dedicated EB right turn lane is a short 250 foot lane. To ensure through blockage does not affect left turn vehicles during AM peak, the storage for turn lanes on this eastbound approach were calculated as single lane per movement. The short right turn lane is accounted for by reducing the through blockage for left turn lane by 250 feet.

The northbound I-271 exit loop ramp to westbound Cedar Road carries significant traffic, hence this movement has a dedicated lane from I-271, whereas the additional exit ramp lane from the mainline will be delineated for Brainard Road/eastbound Cedar road traffic.

10.0 Cost Estimate

The cost estimates for the Build Alternative were developed for the CUY-271-9.9/10.5 Safety Study and are included in this report. Cost estimates were broken down into two parts: (1) Brainard Rd improvements and (2) the I-271 NB off ramp (which requires the acquisition of right-of-way). Preliminary construction estimates were developed along with right-of-way costs, engineering design costs, and contingency costs. The total cost for the Brainard Rd improvements is $2.41 million in 2015 dollars. The total cost for the I-271 NB off ramp addition is $5.06 million in 2015 dollars. The total project cost is $7.47 million in 2015 dollars. A detailed breakdown of the project costs, including inflation, can be seen in Appendix F.

The cost estimates discussed in this IMS do not include the cost for switching the express lane crossover ramps.

11.0 Environmental Overview

An environmental overview of the IMS study area was undertaken using Geographic Information Systems (GIS) data obtained from Cuyahoga County, various other online sources, and a windshield survey of the project area. The area examined includes a corridor 0.5 mile to either side of the existing right-of-way along the approximate 5.0 mile corridor of I-271 from the interchange of I-271 at Chagrin Boulevard (US-422) to the interchange of I-271 at Mayfield Road (US-322).

Cultural Resources

History/Architecture

Due to the size of the project area a comprehensive survey for historic/architectural and archaeological sites was not conducted. The project area was reviewed using Cuyahoga County GIS data and the U.S. Department of Interior, National Register of Historic Places (NRHP) website.

There are two properties listed on the NRHP in the project study area, the W.A. Thorp House and the Frances and Chester Bolton House. The Thorp House appears to have been razed. The property address is now the site of the Marshall Lincoln Superstore. The Bolton House is shown on the NRHP list as having a restricted address. For this reason, it is not known if this resource is in the study area.

In addition to the two NRHP listed properties, there are approximately 2,070 properties 50 years old or older within the study boundary that could be potentially eligible for listing on the NRHP. The large majority of these properties are located north of Cedar Road and west of I-271. Refer to Exhibit 4 for the locations of all properties 50 years old or older.

Archaeology

The project area is highly urbanized. For this reason, the likelihood that an archaeological site exists within the study boundary is low; however, the discovery of archaeological sites cannot

be ruled out until all undisturbed areas to be acquired have been surveyed. No archaeological sites within the project area were found on the NRHP.

Wetlands, Streams, Watercourses

Within the project study area numerous waters of the U.S. and wetlands were identified from the Cuyahoga County GIS dataset. Refer to Exhibit 5 for the locations of the wetlands, streams and watercourses located in the project. Most of the streams identified were found outside of the project study area east of I-271 and appear to be tributaries to the Chagrin River. West of the project corridor Euclid Creek intersects the project corridor.

A few small wetlands were also identified on the projects southern terminus. A review of the Natural Resource Conservation Service (NRCS) Soil Survey Map for the project area indicates the majority of the project area consists of non-hydric soils. Two small areas contain soils denoted as being 85 percent hydric. The areas are represented on Exhibit 6 by the symbols Ho (Holly silt loam) and Ct (Condit silty clay loam). Ho is found in approximately 0.2 percent of the project area and Ct is found in approximately 0.5 percent of the project area. Refer to Exhibit 6 for the NRCS Soil Survey Map.

A comprehensive survey of the project study area would be necessary to verify any wetlands, streams, or watercourses identified.

Floodplains

The project study area is located on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) 39035C0113E, 39035C0114E, 39035C0118E, 39035C0207E, 39035C0226E, 39035C0227E, and 39035C0228E. As seen on the GIS Floodplain Map, Exhibit 7, there are no encroachments on the regulatory floodway (Zone AE) within the study area; however, there are encroachments associated with the 100-year floodplain (Zone A).

Hazardous Materials

Within the project study area, a total of 15 Underground Storage Tank (UST) and 10 hazardous material sites were identified. No toxic release facilities or brownfield sites were identified. The majority of the UST sites are located near the southern end of the project study area. Refer to Tables 13 and 14 for the locations of the hazardous materials sites and UST sites found within the project study area. Refer to Exhibit 8 for a map depicting the site locations of the hazardous material sites and UST sites found.

Table 13. Hazardous Material Sites in the Project Study Area

Map Key	Facility Name	Address	City
A	Marshall Ford Lincoln	6200 Mayfield Road	Mayfield Heights
B	Michelle Cleaners	6228 Mayfield Road	Mayfield Heights
C	Midas Auto	6288 Mayfield Road	Mayfield Heights
D	Lube Stop	6668 Mayfield Road	Mayfield Heights
E	Chagrin Cleaners & Tailors	27313 Chagrin Boulevard	Woodmere
F	Village Auto Wash	27330 Chagrin Boulevard	Beachwood

Table 13. Hazardous Material Sites in the Project Study Area (Continued)

Map Key	Facility Name	Address	City
G	BH Coin Laundry	27621 Chagrin Boulevard	Woodmere
H	Bill's Discount Cleaners	27730 Chagrin Boulevard	Beachwood
I	Drapery Masters Coit	3445 Richmond Road	Beachwood
J	National Tire and Battery	3550 Park East Drive	Beachwood

Source: Google Earth 2014/Windshield Survey

Table 14. UST Sites in the Project Study Area

Map Key	Facility #	Facility Name	Address	City
1	18000113	Ohio Bell Telephone Co.	3445 Richmond Road	Beachwood
2	18002290	25705 Chagrin Beachwood, LLC	25705 Chagrin Boulevard	Beachwood
	18002290	25705 Chagrin Beachwood, LLC	25705 Chagrin Boulevard	Beachwood
	18002290	25705 Chagrin Beachwood, LLC	25705 Chagrin Boulevard	Beachwood
3	18001662	True North #315	26100 Chagrin Boulevard	Beachwood
	18001662	True North #315	26100 Chagrin Boulevard	Beachwood
	18001662	True North #315	26100 Chagrin Boulevard	Beachwood
4	18008951	Mooney's Gulf Service	27000 Chagrin Boulevard	Orange Village
	18008951	Mooney's Gulf Service	27000 Chagrin Boulevard	Orange Village
	18008951	Mooney's Gulf Service	27000 Chagrin Boulevard	Orange Village
5	18000469	True North # 346	27010 Chagrin Boulevard	Orange village
	18000469	True North # 346	27010 Chagrin Boulevard	Orange village
	18000469	True North # 346	27010 Chagrin Boulevard	Orange village
6	18000628	Speedway #3321	27939 Chagrin Boulevard	Woodmere
	18000628	Speedway #3321	27939 Chagrin Boulevard	Woodmere
	18000628	Speedway #3321	27939 Chagrin Boulevard	Woodmere
7	18010881	Cleveland Clinic	3175 Science Park Drive	Beachwood
8	18007520	Cleveland Clinic	3050 Science Park Drive	Beachwood
9	18000264	Cleveland Clinic	25875 Science Park Drive	Beachwood
10	18002670	Cleveland Clinic	25900 Science Park Drive	Beachwood
11	18000583	True North (Tony's Shell)	6411 Mayfield Road	Beachwood
12	18001632	Mayfield Corners, LLC (Sunmart)	6665 Mayfield Road	Mayfield Heights
	18001632	Mayfield Corners, LLC (Sunmart)	6665 Mayfield Road	Mayfield Heights

Table 14. UST Sites in the Project Study Area (Continued)

Map Key	Facility #	Facility Name	Address	City
	18001632	Mayfield Corners, LLC (Sunmart)	6665 Mayfield Road	Mayfield Heights
13	18002138	7-Eleven Store #36235	6680 Mayfield Road	Mayfield Heights
	18002138	7-Eleven Store #36235	6680 Mayfield Road	Mayfield Heights
	18002138	7-Eleven Store #36235	6680 Mayfield Road	Mayfield Heights
	18002138	7-Eleven Store #36235	6680 Mayfield Road	Mayfield Heights
14	18009541	Hillcrest Hospital	6780 Mayfield Road	Mayfield Heights
	18009541	Hillcrest Hospital	6780 Mayfield Road	Mayfield Heights
15	18011168	Costco Gasoline	1409 Golden Gate Boulevard	Mayfield Heights
	18011168	Costco Gasoline	1409 Golden Gate Boulevard	Mayfield Heights
	18011168	Costco Gasoline	1409 Golden Gate Boulevard	Mayfield Heights
	18011168	Costco Gasoline	1409 Golden Gate Boulevard	Mayfield Heights

Source: Cuyahoga County GIS Dataset

Threatened and Endangered Species

Per the U.S. Fish and Wildlife Endangered Species (USFWS) website, five federally listed threatened, endangered, candidate or proposed species exist within Cuyahoga County. These include:

- Indiana bat (Myotis sodalis) - Endangered
- Northern long-eared bat (Myotis septentrionalis) – Proposed as Endangered
- Kirtland's Warbler (Dendroica kirtlandii) – Endangered
- Piping plover (Charadrius melodus) - Endangered
- Red Knot (Rufa) (Calidris canutus rufa) – Proposed as Threatened

A review of the Cuyahoga County GIS data indicates there are no threatened or endangered species habitats in the project area; however, the area does contain several large wooded tracts that could contain suitable summer roosting habitat for the Indiana bat and Northern long-eared bat.

Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, directs Federal agencies to take the appropriate and necessary steps to identify and address disproportionately high and adverse effects of Federal

projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.

Environmental Justice protected minority populations are defined as African American, Hispanic, Asian or Native American/Alaskan Native. Low-income populations are defined as any person whose median household income is at or below the Department of Health and Human Services (DHHS) poverty guidelines.

As shown in Table 15, there are several areas with minority concentrations located within the project area. The largest of these is on the south end of the project area in census tracts 1948 and 1311.02. In these tract areas, African Americans represent 61.9 percent and 23.2 percent of total population, respectively. A smaller, yet still relevant, minority population can also be found on the projects north end in census tracts 14722.02 and 1721.03. Refer to Table 15 for a breakdown of minority populations in the project area by census tract. The bold text represents the census areas that have a higher concentration of minority or low income population. Refer to Exhibit 9 for the locations of the project area census tracts and Exhibit 10 for locations of the minority concentrations in the project area.

Table 15. Minority Population Data by Census Tracts

	Total Population	White Total Percent	African American Total Percent	Hispanic Total Percent	Native American/ Alaskan Native Total Percent
Cuyahoga County	1,280,122	826,959 64.6	386,597 12.5	66,566 5.2	3,840 0.3
CT 1311.02	3,362	2,465 73.3	**780** **23.2**	16 0.5	3 0.1
CT 1311.04	4,302	3,503 81.4	324 7.5	104 2.4	2 0
CT 1702.02	3,898	3,581 91.9	207 5.3	49 1.3	0 0
CT 1721.02	3,782	3,325 87.9	227 6.0	66 1.7	12 0.3
CT 1721.03	4,914	3,175 64.6	**851** **17.3**	119 2.4	3 0.1
CT 1722.01	3,719	3,351 90.1	140 3.8	63 1.7	1 0
CT1722.02	4,115	3,207 77.9	**611** **14.8**	80 1.9	3 0.1
CT 1791.01	3,105	3,059 98.5	272 8.8	44 1.4	1 0
CT 1948	884	261 29.5	**547** **61.9**	33 3.7	0 0
CT 1949	3,323	2,562 77	**480** **14.4**	52 1.6	2 0.1

Source: U.S. Census Bureau Data Set QT-P3 2000

As shown on Exhibit 11 there are also pockets of low-income populations located near the projects north and south termini. These areas are located within census tracts 1948, 1721.02, and 1722.02. Refer to Table 16 for the 2014 DHHS poverty guidelines.

Table 16. 2014 DHHS Poverty Guidelines

Persons in Family/Household	Poverty Guideline
1	$11,670
2	$15,730
3	$19,790
4	$23,850
5	$27,970
6	$31,970
7	$36,030
8	$40,090
For families/households with more than 8 persons, add $4,060 for each additional person.	

Source: Dept. Health and Human Services

Section 4(f) and Section 6(f)

Section 4(f) provides regulations governing the 'use' of land from publicly owned parks, recreation areas, wildlife and waterfowl refuges, as well as public or private historic sites for Federal highway projects.

A survey and eligibility determination for each of the 2,070 identified historic resources would be necessary to determine if Section 4(f) would apply. A resource merely has to be deemed eligible for listing on the NRHP for Section 4(f) to apply. It does not have to be listed on the NRHP.

No wildlife or waterfowl refuge areas are located in the project area; however, there are several parks/recreation areas within the project study boundary. Brainard Park, Beachwood City Park East, the Mayfield Heights City Park, the Acacia Reservation Metropark, and the Mayfield Heights Recreational Park are all located within the 0.5 mile study area west of the I-271 right-of-way. Both the Beachwood City Park East and the Mayfield Heights Recreation Park are located adjacent to the right-of-way of I-271.

One park was identified on the National Park Service Land and Water Conservation Fund (LWCF) grant list, and is thus protected under Section 6(f). This park is listed as the Mayfield Heights Park. The LWCF list does not specify to which of the two Mayfield Heights Parks the funds apply.

Refer to Exhibit 12 for the locations of all Section 4(f) and Section 6(f) resource including potential historic Section 4(f) resources.

Other

Although not a category scoped for environmental review, it should be noted that the Knollwood Cemetery and Mausoleum is located immediately adjacent to northbound I-271, north of Woodhawk Drive and south of Marsol Road.

12.0 Conclusion and Recommendations

The CUY-271-8.14 (PID 97676) study was initiated due to safety concerns with the interchange area. The proposed countermeasures were recommended in the CUY-271-9.9/10.5 Safety Study and are intended to address these issues, and improve traffic operations within the study area. The cities of Lyndhurst and Mayfield Heights support these improvements. Letters of support from the two cities are included in Appendix G.

The Build Alternative includes improvements to the northbound I-271 ramps and associated improvements to Brainard Road. This alternative will have phased construction. Phase 1 improvements will be limited to improvements that do not require construction adjacent to mainline I-271. Phase 2 improvements will construct a dual northbound exit ramp to Cedar Road/Brainard Road.

No improvements are proposed at the I-271 southbound ramp intersection on Cedar Road.

The Build Alternative provides the necessary changes that are expected to mitigate crashes on northbound I-271 and on Brainard Road. The I-271 northbound exit to Cedar Road/Brainard Road will improve from LOS F to LOS A by adding a second exit lane. The added capacity is needed to accommodate 2036 traffic projections. Furthermore, the HCS results show that the level of service along the interstate remains acceptable throughout the study area, with the exception of a weave location during the PM peak period.

- The Build Alternative results in a higher volume of traffic on the northbound local lanes compared to the No Build, a result of switching the local and express crossover locations. In the No Build, the weave LOS is a C, and in the Build the weave LOS is an E. It is important to distinguish that the weaves occur on different freeway segments, on the express lanes versus on the local lanes in the No Build and Build Alternatives, respectively.

The second edition of the NOACA Congestion Management System (CMS) Manual of Practice, dated October 2002, states that Level of Service (LOS) "D" will be the threshold for peak periods in urbanized areas and LOS "C" will be the threshold for peak periods in rural areas (Page i, Executive Summary). A copy of the document can be found at:
http://www.noaca.org/modules/showdocument.aspx?documentid=3333

For all the reasons noted above, this IMS is recommended for approval, based on satisfying the eight policy statements in the Interstate System Access Information Guide (August 2010).

Exhibit 1

Build Alternative – Phase 1 (view 1 of 2)

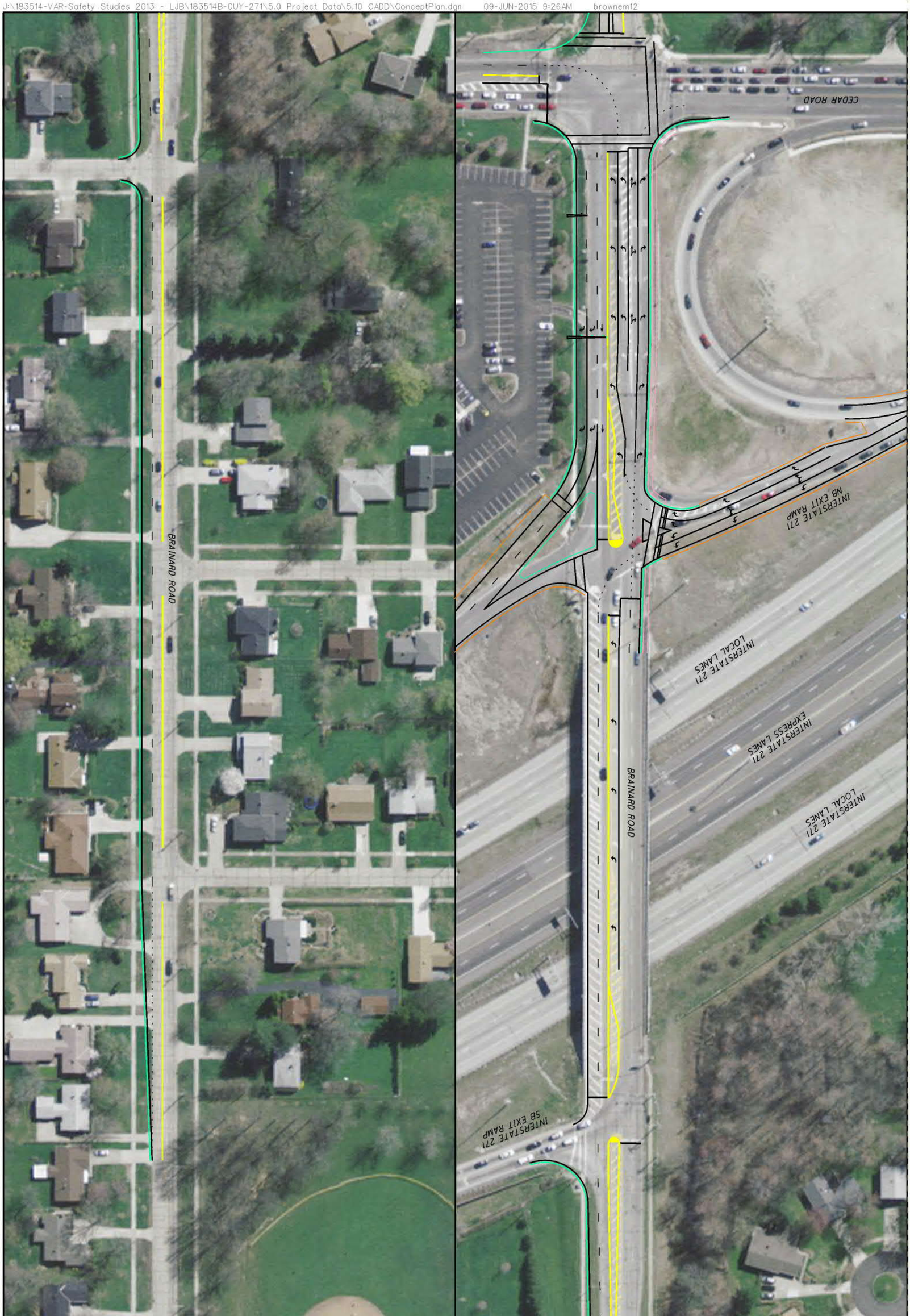
J:\183514-VAR-Safety Studies 2013 - LJB\183514B-CUY-271\5.0 Project Data\5.10 CADD\ConceptPlan.dgn 27-MAR-2015 10:51AM macmillanbl

CUY-271-8.14 PID 97676	EXHIBIT 1 BUILD ALTERNATIVE PHASE 1	0 50 25 100 HORIZONTAL SCALE IN FEET

Exhibit 2

Build Alternative – Phase 1 (view 2 of 2)

J:\183514-VAR-Safety Studies 2013 - LJB\183514B-CUY-271\5.0 Project Data\5.10 CADD\ConceptPlan.dgn 09-JUN-2015 9:26AM brownem12



SHEET 2	CUY-271-8.14 PID 97676	EXHIBIT 2 BUILD ALTERNATIVE PHASE 1

0 50
25 100
HORIZONTAL SCALE IN FEET

N

Exhibit 3

Build Alternative – Phase 2

INTERSTATE 271 LOCAL LANES

INTERSTATE 271 EXPRESS LANES

INTERSTATE 271 EXPRESS LANES

INTERSTATE 271 LOCAL LANES

INTERSTATE 271 LOCAL LANES

INTERSTATE 271 EXPRESS LANES

INTERSTATE 271 LOCAL LANES

INTERSTATE 271 EXPRESS LANES

INTERSTATE 271 LOCAL LANES

INTERSTATE 271 NB EXIT RAMP

CEDAR ROAD

BRAINARD ROAD

BRAINARD ROAD

HORIZONTAL SCALE IN FEET

0 50 100 200

EXHIBIT 3
BUILD CONDITION PHASE 2

CUY-271-8.14
PID 97676

E
3

10-JUN-2015 2:30PM brownem12

J:\183514-VAP-Safety Studies 2013 - LJB\183514B-CUY-271\5.0 Project Data\5.10 CADD\Build.dgn 10-JUN-2015 2:30PM brownem12

EXISTING CONDITION

PROPOSED CONDITION

I-271 NB EXPRESS/LOCAL LANES CROSSOVER LOCATIONS

CALCULATED VM
CHECKED SAK

CUY-271-8.14
IMS (PID 97676)

1
1

Exhibit 4

History/Architecture Properties 50 Years Old or Older Location Map

Exhibit 4. History/Architecture Properties 50 Years Old or Older Location Map

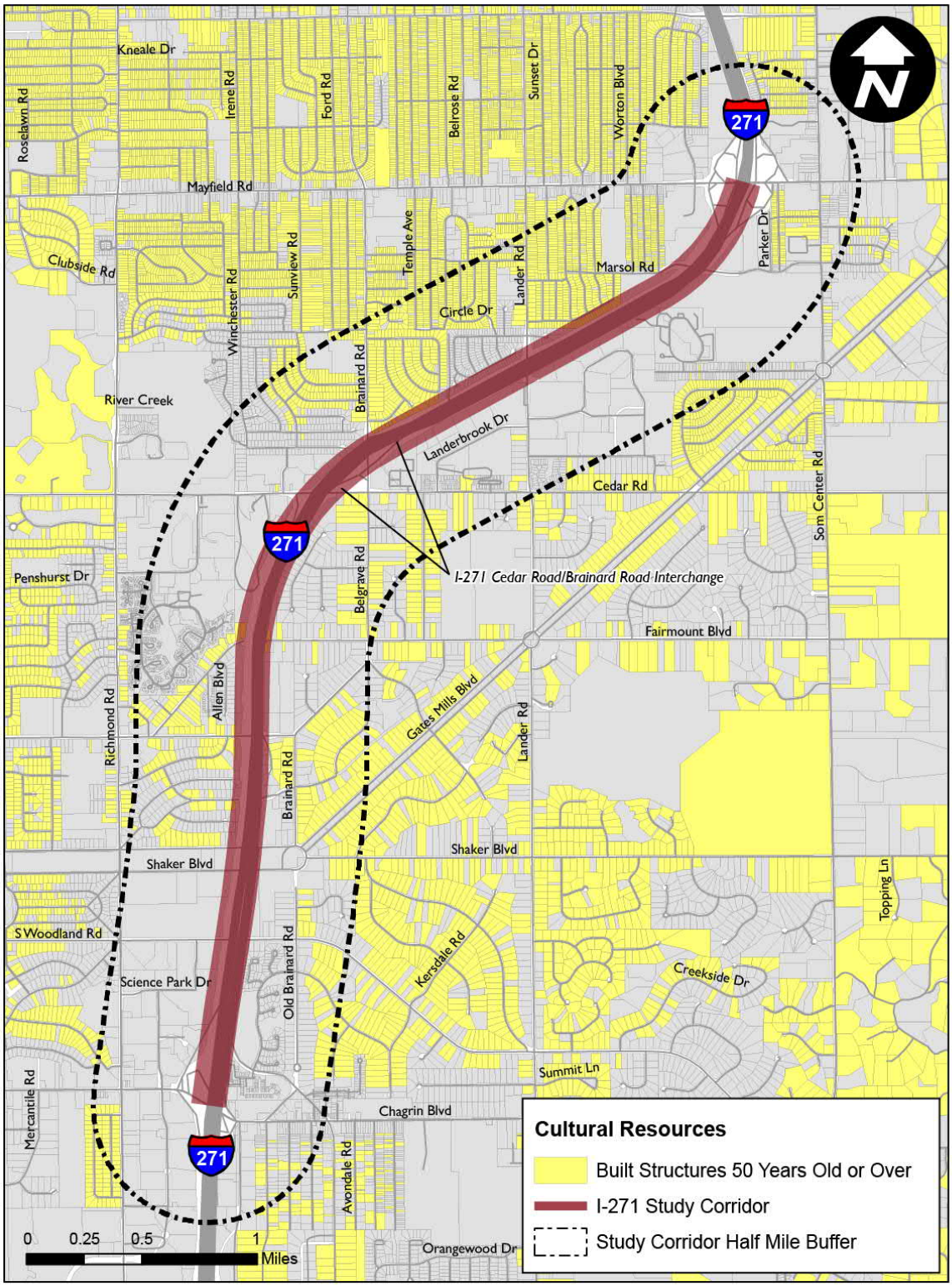


Exhibit 5

Wetlands, Streams, and Watercourse Location Map

Exhibit 5. Wetlands, Streams and Watercourses Location Map

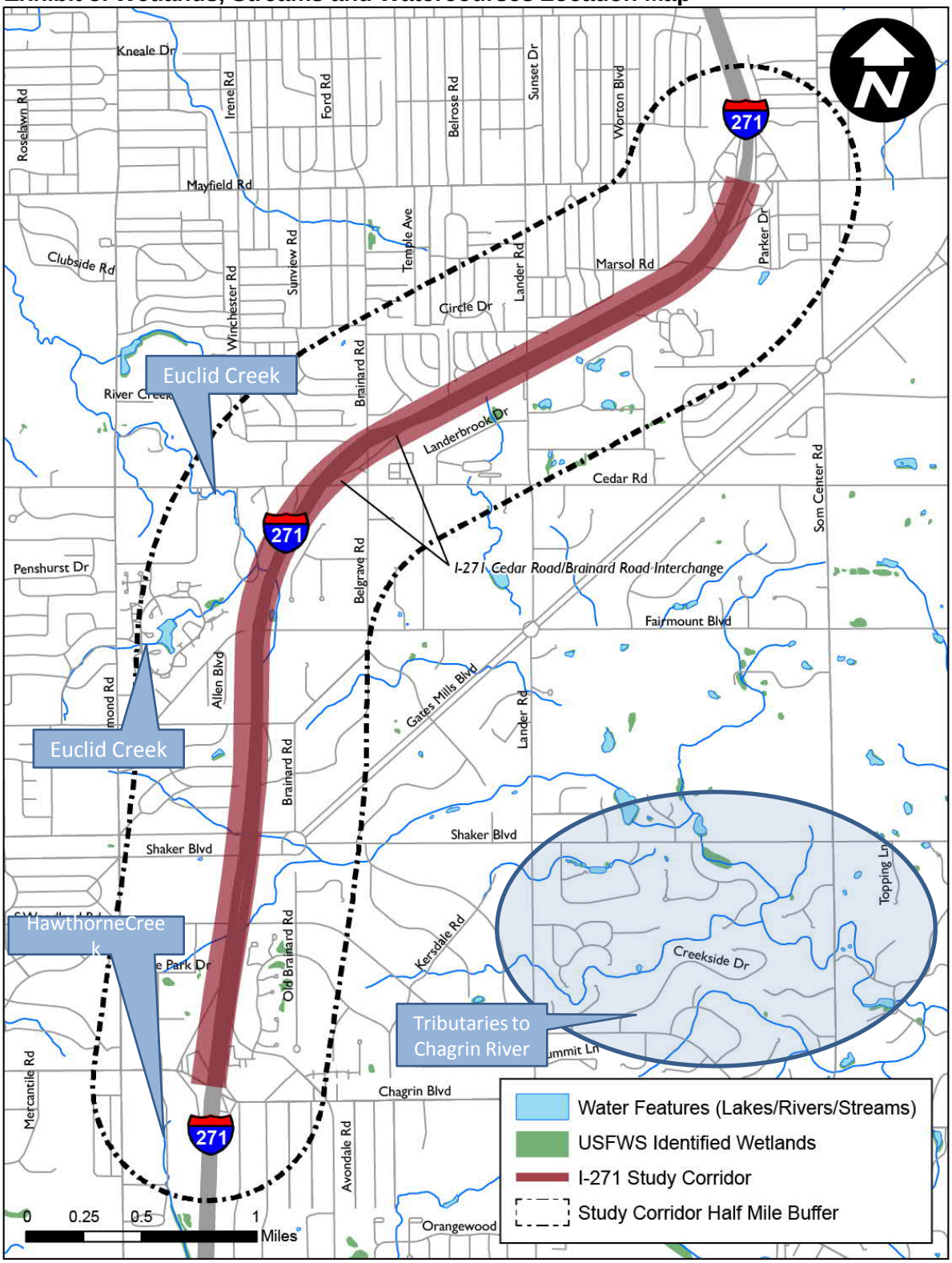


Exhibit 6

NRCS Soil Survey Map

Exhibit 6. NRCS Soil Survey Map

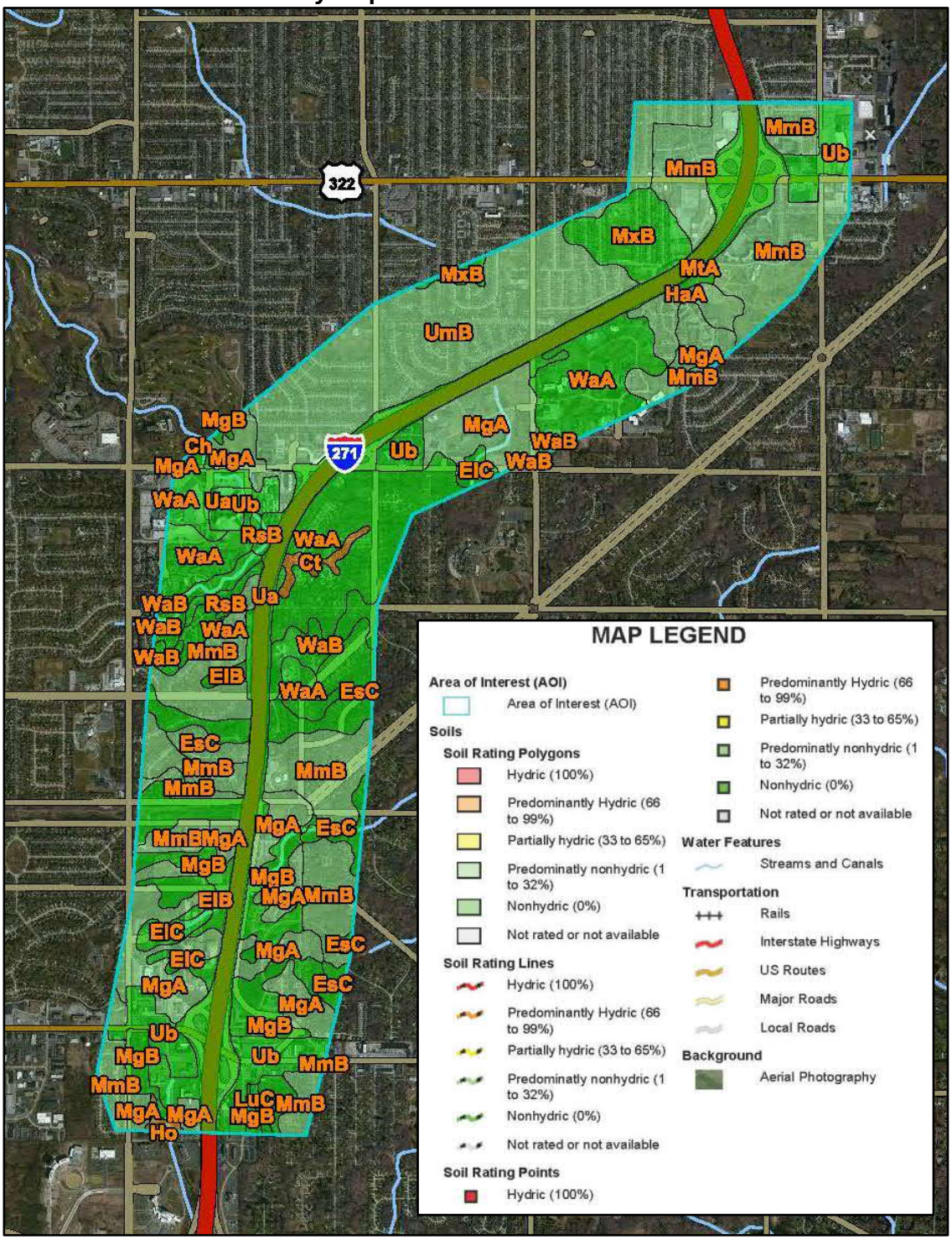


Exhibit 7

Floodplain Location Map

Exhibit 7. Floodplain Location Map

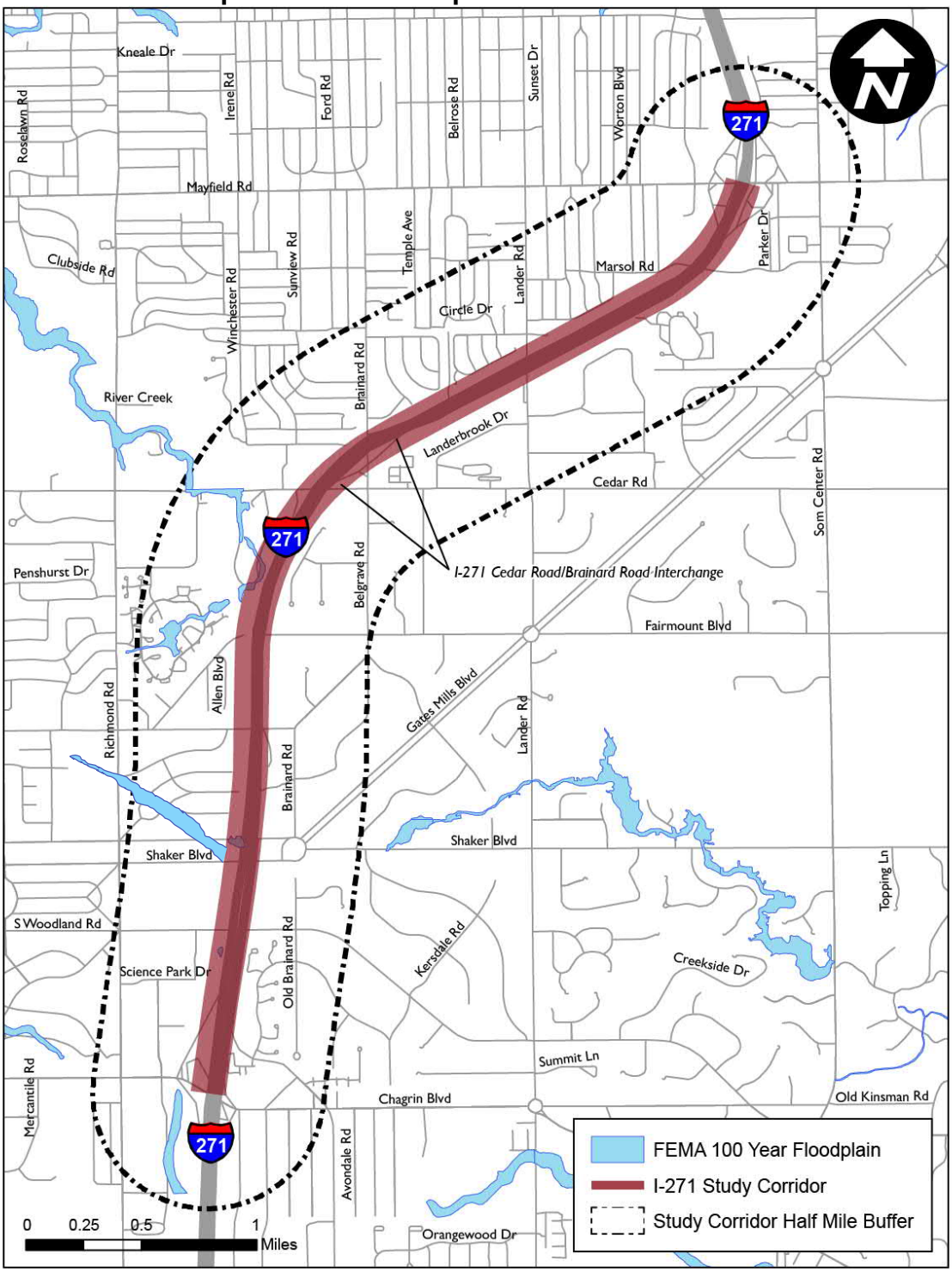


Exhibit 8

Hazardous Materials and UST Site Location Map

Exhibit 8. Hazardous Materials and UST Sites Location Map

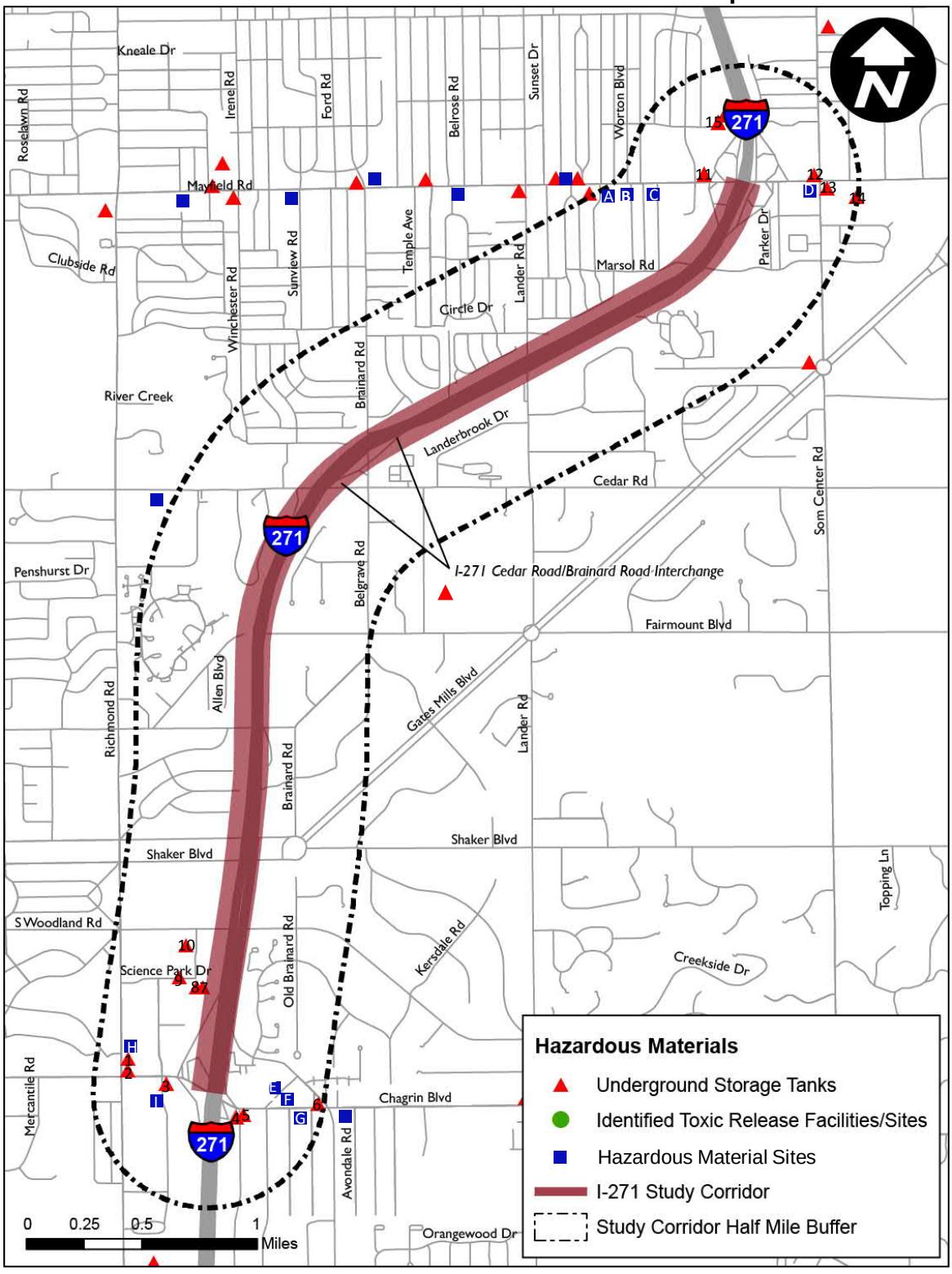


Exhibit 9

Project Area Census Tract Location Map

Exhibit 9. Project Area Census Tract Location Map

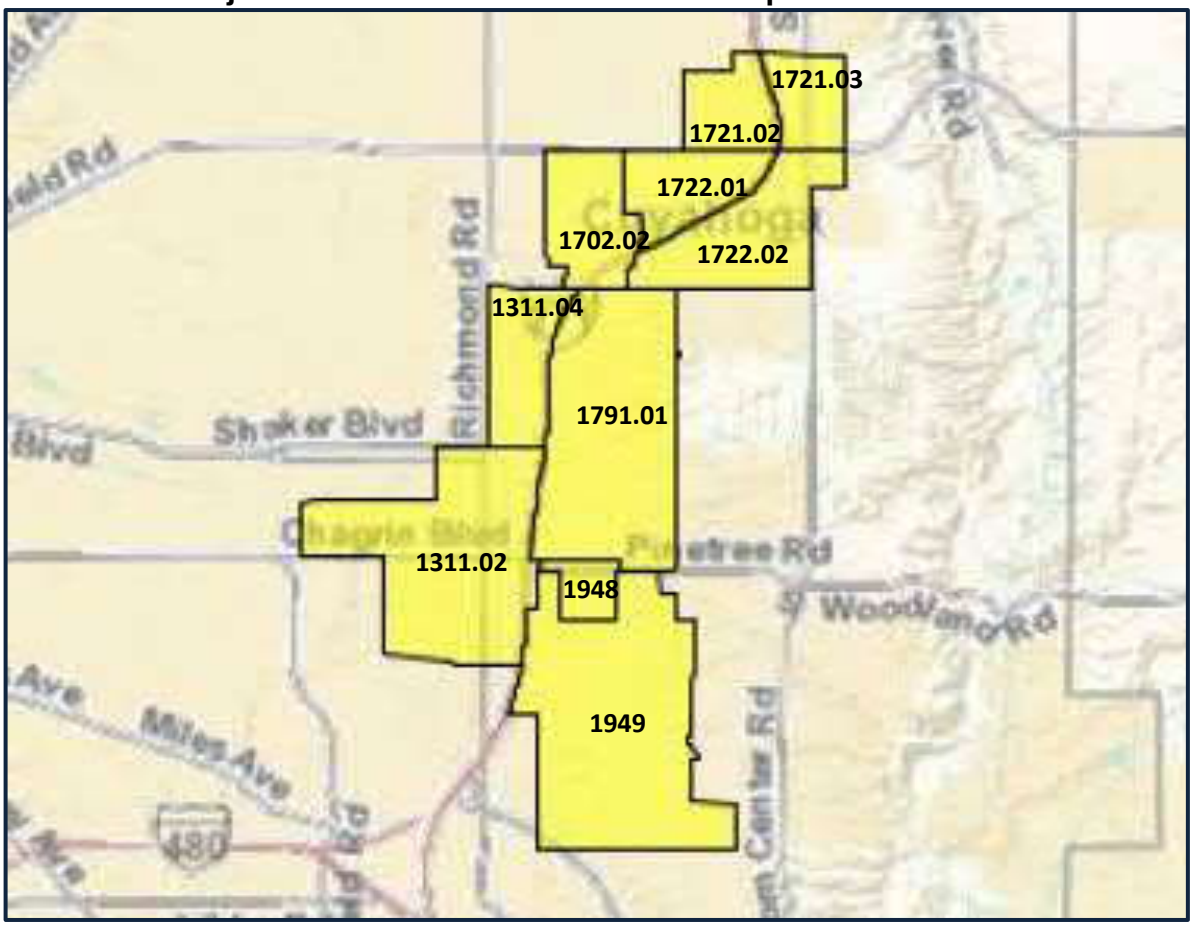


Exhibit 10

Minority Concentrations Location Map

Exhibit 10. Minority Concentrations Location Map

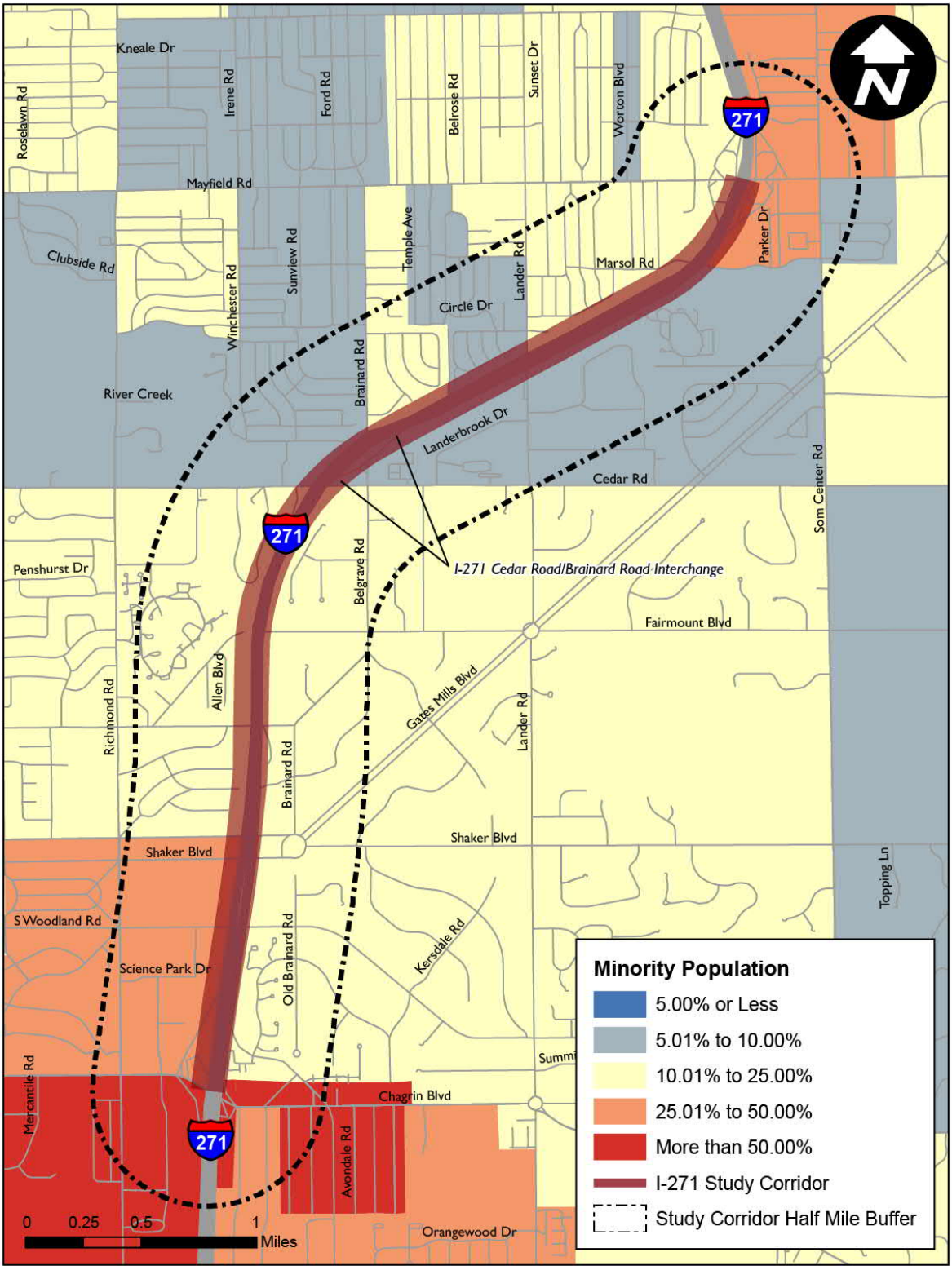


Exhibit 11

Low-Income Populations Location Map

Exhibit 11. Low-Income Populations Location Map

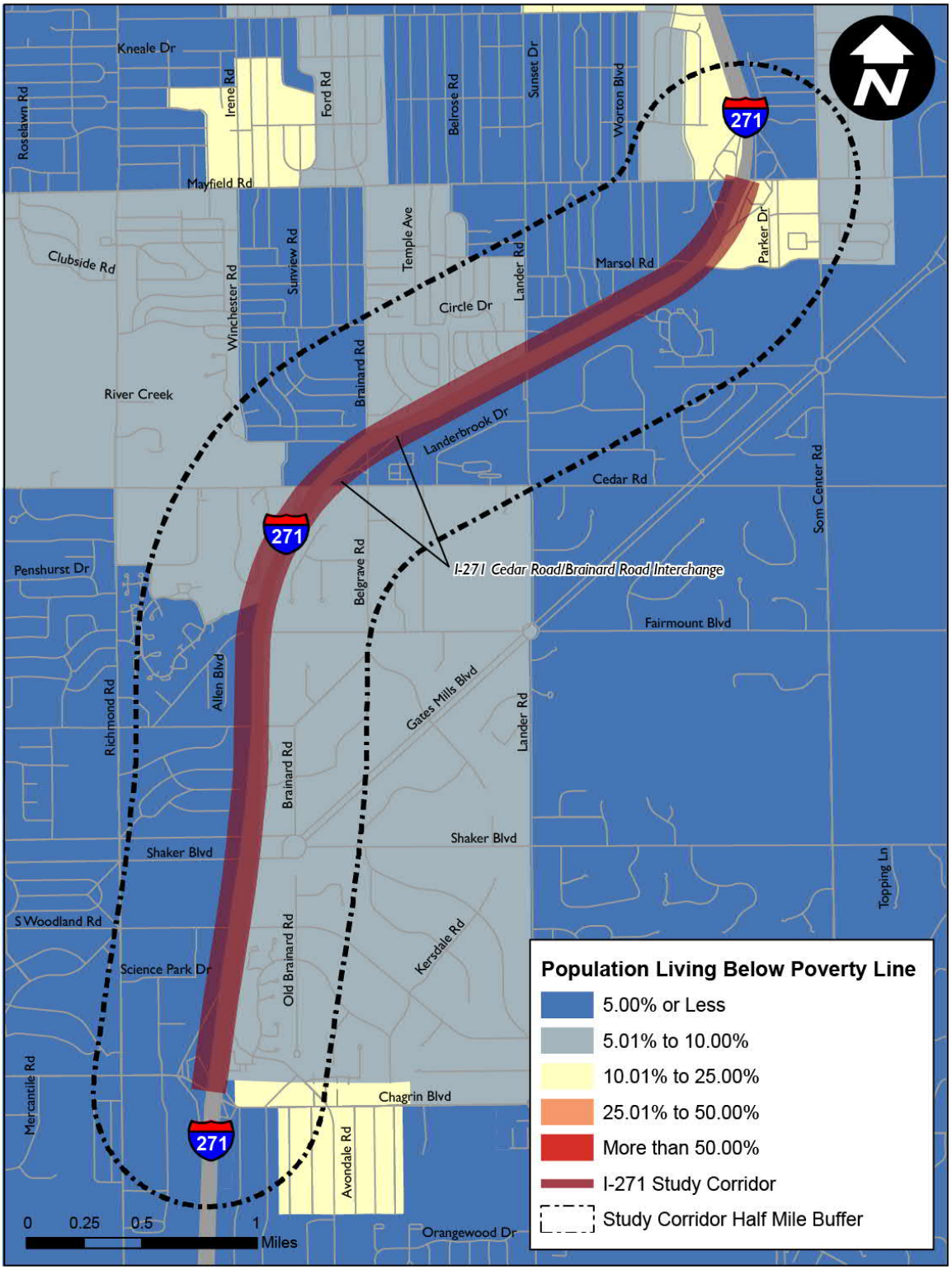
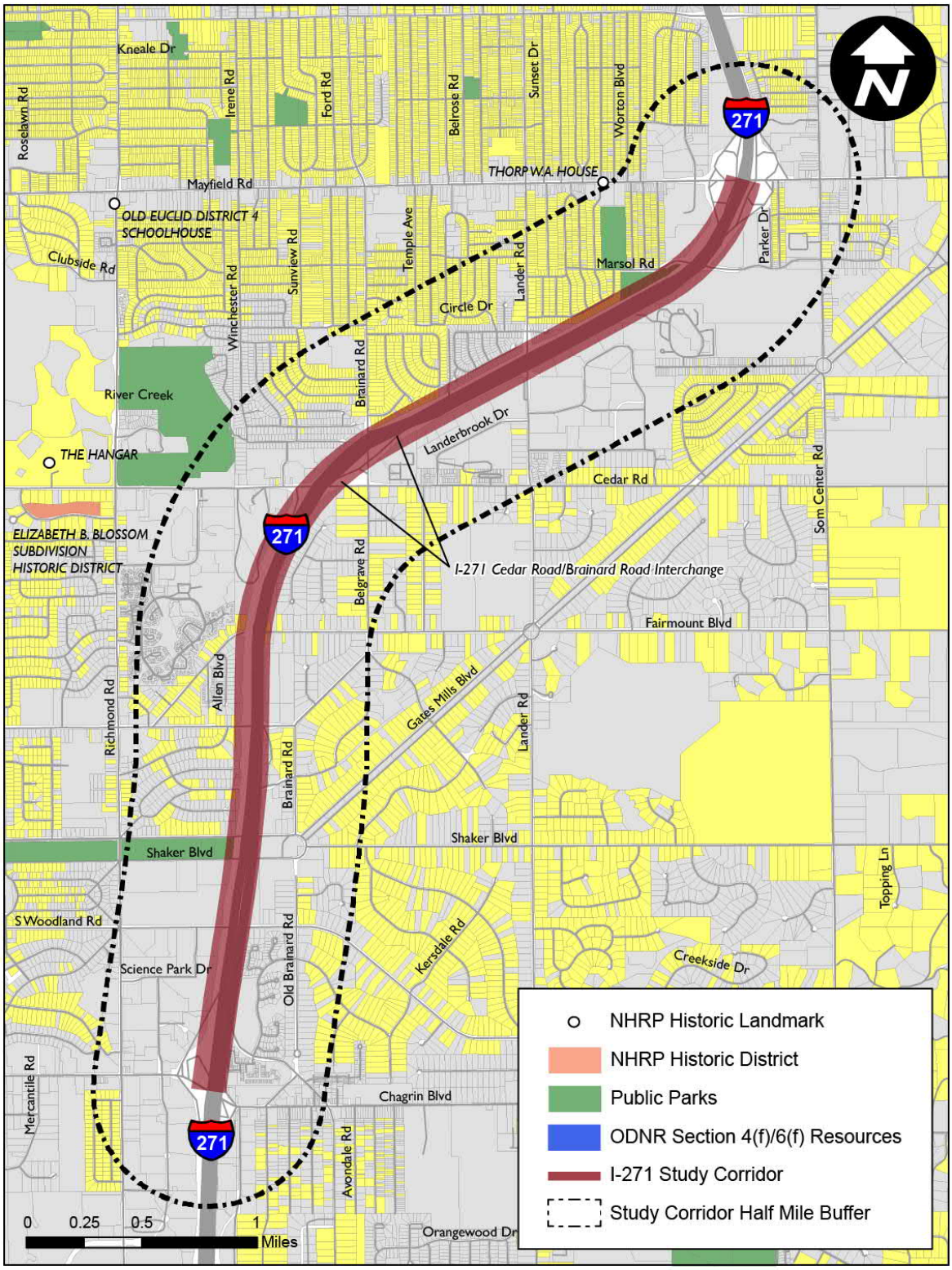


Exhibit 12

Section 4(f) and 6(f) Location Map

Exhibit 12. Section 4(f) and Section 6(f) Location Map



Appendix A

Road Safety Audit

Road Safety Audit
for the Intersection of
Cedar Road and Brainard Road
and
I-271 Interchange with Brainard Road and Cedar Road

Cities of
Lyndhurst, Pepper Pike, Mayfield Heights, and Beachwood
Ohio

February 2013

Authors
Maher Holozadah, Senior Transportation Engineer
Sahar Tawfiq, Transportation Engineer

Contributors
The Road Safety Audit Team

Prepared by
Northeast Ohio Areawide Coordinating Agency
1299 Superior Avenue
Cleveland Ohio 44114

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

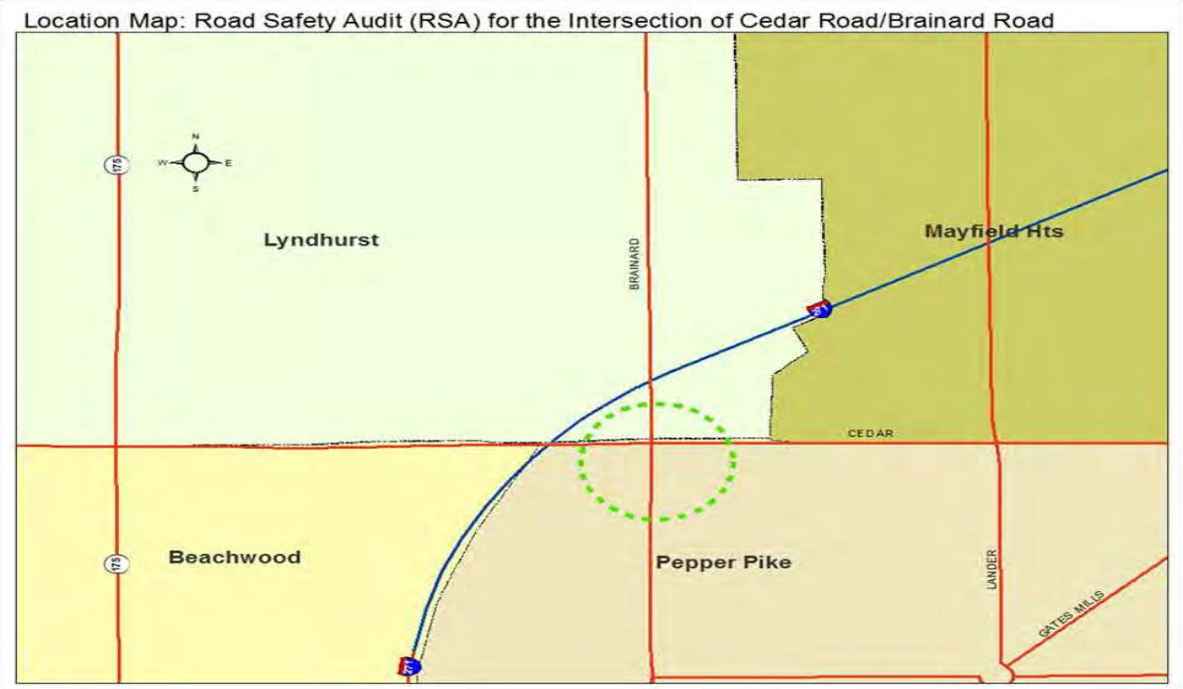
1) Title & Subtitle Road Safety Audit for the Intersection of Cedar Road and Brainard Road at the I-271 Interchange in the Cities of Lyndhurst and Pepper Pike	**2) NOACA Report No.** **TR-13-02**
3) Author(s) Maher Holozadah, Senior Transportation Engineer; and Sahar Tawfiq, Transportation Engineer	**4) Report Date** **February 2013**
5) Performing Organization Name & Address Northeast Ohio Areawide Coordinating Agency 1299 Superior Avenue, Cleveland, OH 44114-3204 Phone: (216) 241-2414 FAX: (216) 621-3024 Website: www.noaca.org	**6) Project Task No.** **6251-02** **7) NOACA Contract/Grant No.** **ODOT/FHWA**
8) Sponsoring Agency Name & Address Ohio Department of Transportation 1980 W. Broad St., Box 899 Columbus, OH 43216-0899	**9) Type of Report & Period Covered** **10) Sponsoring Agency Code**
11) Supplementary Notes Federal funding for this project was provided by the Federal Highway Administration and administered by the Ohio Department of Transportation.	
12) Abstracts This study report is for a Road Safety Audit conducted for the intersection of Cedar Road and Brainard Road and the I-271 Interchange in the City of Lyndhurst. The purpose of the audit is to examine the existing conditions at this and adjacent freeway ramp intersections, and suggest short-term, low-cost and longer-term, higher-cost safety improvement solutions	
13) Key Words & Document Analysis **A. Descriptors** Road Safety Audit, Cedar Road, Brainard Road, I-271 Interchange, City of Lyndhurst, City of Pepper Pike, City of Mayfield Heights, and City or Beachwood **B. Identifiers/Open Ended Terms** RSA, Safety Study	
14) Availability Statement 1. On the NOACA website 2. In hard copy and electronic print	**15) No. Pages: 62** **16) Price** **Cost of Reproduction**

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

Executive Summary

The Road Safety Audit (RSA) for the intersection of Cedar Road and Brainard Road in the Cities of Lyndhurst and Pepper Pike (Figure 1) is one of several audits conducted by the Northeast Ohio Areawide Coordinating Agency (NOACA) as part of NOACA's safety studies program for State Fiscal Years 2012 and 2013 (FY2012 and FY2013). The intersection was identified as a high-crash location based on NOACA's 2009 Crash Report titled *Accident Characteristics & Intersection Accident Analysis*, and ranks number 38 on the list. It ranks number 108th on ODOT's Urban Freeway Safety Analyst List. This intersection has a particularly unusual geographic environment. It is located within the expanse of a vast, spread-out interchange with ramps straddling Cedar Road and Brainard Road (Figure 2). In addition to serving local traffic, the intersection is also used as a pass-through by regional traffic entering and exiting the I-271 Freeway in the area. Furthermore, the pattern of traffic movements is greatly influenced by many local traffic generators and a peculiar set of freeway ramp connections serving the area.

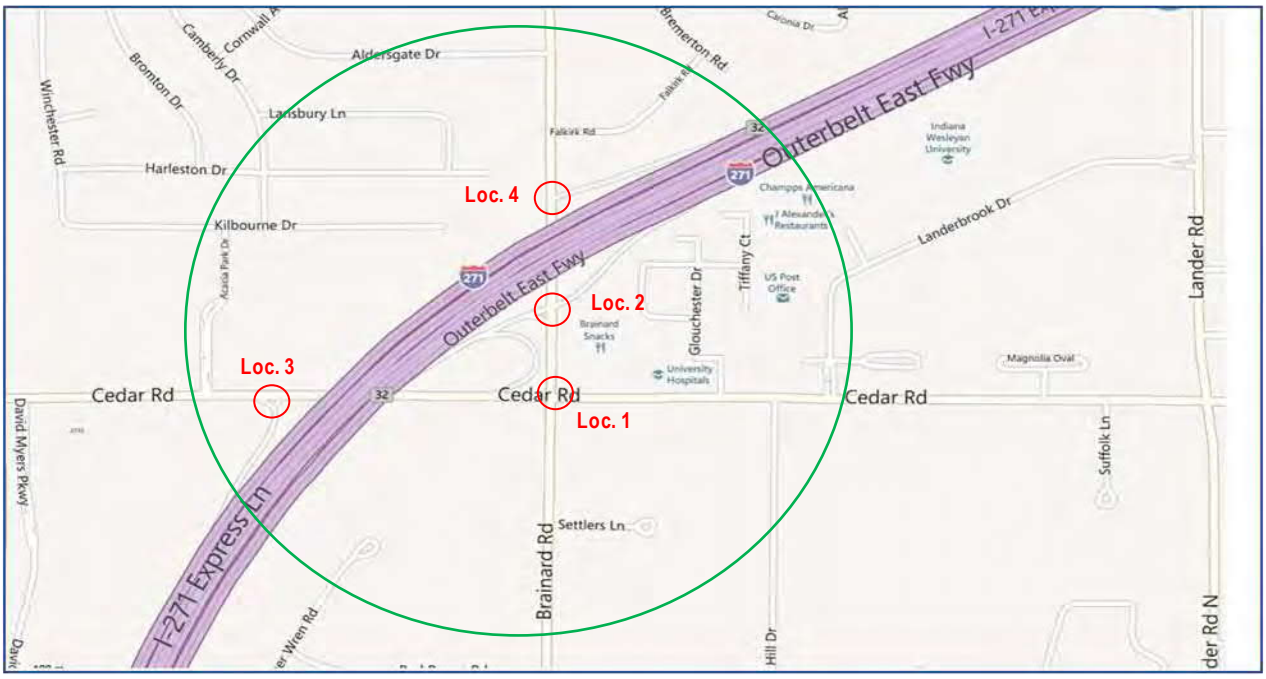
Figure 1



Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

The purpose of this RSA is to have an independent road safety audit team (RSA team) examine the particulars of this intersection and other nearby roadway intersections with the I-271 Interchange ramps to enable the RSA team to make suggestions for short-term, low-cost safety improvements, as well as possible long-term, higher-cost improvements. The various intersections were referenced as Location 1, Location 2, Location 3, and Location 4, shown in Figure 2.

Figure 2: Intersection Identification Labels



The RSA team, therefore, recommends the following low-cost, short-term; low-cost, medium-term; medium-cost, longer term, and higher-cost, long-term improvements to increase the overall level of safety at this intersection. Stakeholders and municipalities affected by the prevailing traffic conditions are encouraged to evaluate the various high-cost, long-term, major, capital improvement scenarios presented in this study report that are outside the scope of ordinary safety improvements in order to identify a preferred alternative and to establish a more comprehensive solution.

Suggested high-cost, long-term improvements presented in this study that are outside the scope of ordinary safety improvements (greater than $5,000,000 in total cost), and are not fundable with safety funds, are conceptual in nature and require further analysis and evaluation. Stakeholders and municipalities affected by the prevailing traffic conditions are encouraged to evaluate these high-cost, long-term conceptual alternatives and identify a preferred alternative that provides a comprehensive solution to improve access in addition to improving safety. Stakeholders and municipalities may wish to consider establishing a special improvement district to fund studies to evaluate improvement alternatives, and ultimately, perhaps, fund or contribute toward funding the design and construction of a preferred alternative.

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

The main recommendations, described separately for each location, are:

Location 1: Cedar Road/Brainard Road

- Conduct a traffic signal progression study to coordinate the timing and phasing of the traffic control signals along Brainard Road to facilitate better traffic flow and reduce delay
- Perform capacity analysis to:
  - Provide a shorter cycle length
  - Examine introducing a phasing sequence that includes a phase for an exclusive, protected left-turn movement from the Brainard Road northbound approach to eliminate potential conflicts of traffic movements
  - Examine introducing a leading and lagging protected left-turn phase on the Brainard Road southbound approach to provide for serving this heavy left-turn traffic movement twice during the phase in the A.M peak period
  - Examine and consider converting the exclusive through-lane on the Brainard Road southbound approach to a through- and right-turn lane (Diagram 1-1)

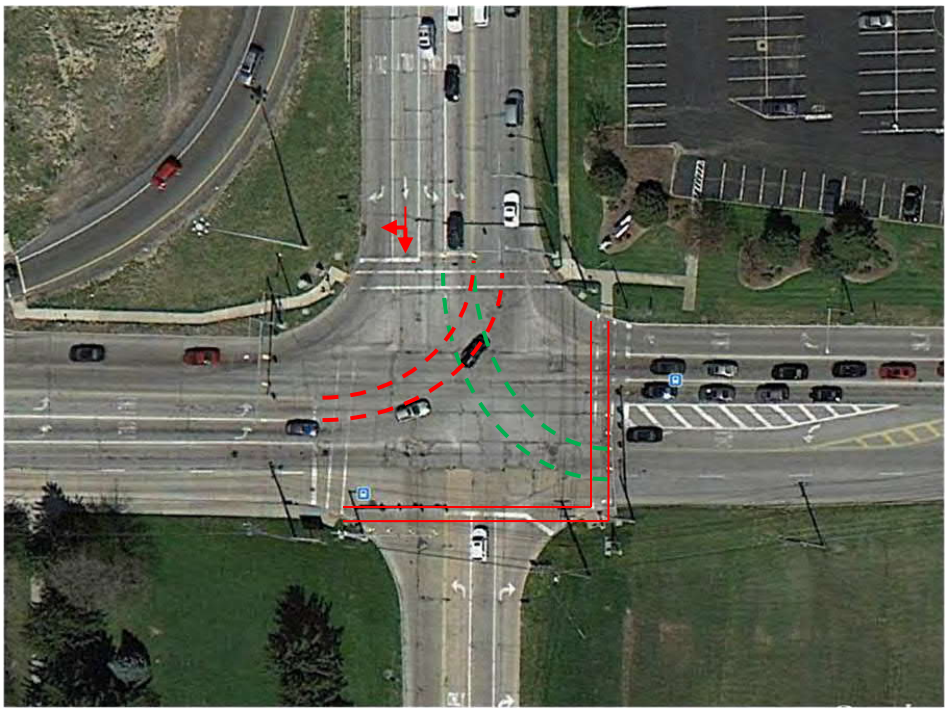


Diagram 1-1: Cedar Road/Brainard Road

- Provide more pronounced dashed lane-extension lines through the intersection to help traffic avoid encroaching upon adjacent turn lanes, and to help drivers stay more closely in their travel paths
- Examine the width of the Cedar Road receiving lanes on the east side of Brainard Road and widen, if necessary, to ensure availability of adequate curvature for the installation of lane-extension lines (Diagram 1-1) to enable a smoother transition for the left-turn traffic movements, and to encourage the use of the outermost left-turn lane on the southbound approach of Brainard Road which currently appears to be underutilized

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

- Examine whether the present heavier use of the innermost left-turn lane of the Brainard Road southbound approach at Cedar Road compared with the lighter use of the outermost left-turn lane is due to a real or perceived narrowness of the roadway, the narrowing of Cedar Road to one lane after a short distance from the end of the initial two receiving lanes, or due to a need to stay in the innermost left-turn lane in order to turn left again into driveways of businesses or establishments located on the northern side of Cedar Road
- Improve the pavement sub-grade and surface conditions on all approaches of the intersection as well as within it to improve friction and to provide a better surface conducive to receiving lane-marking paint for a longer lasting, more durable lane demarcation
- Improve pavement markings where needed
- Set back the stop bar for the exclusive left-turn lane on the Cedar Road westbound approach.
- Delete the present pedestrian crosswalk across Cedar Road located on the west side of the intersection (west of Brainard Road) and emphasize the one on the east side of the intersection (east of Brainard Road). The heavy right-turn traffic movements inhibit pedestrians from attempting to cross the road at this location, even during the recall pedestrian crossing phase. Ensure there will be pedestrian crossings on the remaining 3 of the 4 approaches. Provide a pedestrian crosswalk across Brainard Road, on the south side of Cedar Road. Provide needed sidewalks and pedestrian ramps
- Consider combining elements from the I-271--Cedar/Brainard Access-Point Modification Study with recommendations and suggested safety improvements presented in this RSA report to develop a more comprehensive and common approach toward addressing the issues identified in the two study reports
- Consider adding an exit ramp from the I-271 northbound mainline connected directly to Cedar Road eastbound to: (a) Prevent backups presently reoccurring on the freeway mainline near the gore area of the Cedar Road/Brainard Road exit ramp; and (b) Alleviate the impact of the present pattern of heavy traffic volumes, particularly during the morning peak period, on the capacities and safe operation of the intersections of Brainard Road with the I-271 northbound exit and entrance ramps, and Brainard Road with Cedar Road

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

Location 2: Brainard Road and I-271 northbound Exit Ramp-northbound Entrance Ramp

- Remove all obstructions to the line of site, especially a part of the fence protecting against vandalism on the Brainard Road Bridge parapet over I-271, and nearby shrubberies that block the line of vision of vehicle drivers stopped at the traffic control signal for the I-271 northbound exit ramp and looking to their left to check for oncoming southbound traffic on Brainard Road
- Set back the stop bar for the exclusive left-turn bay on Brainard Road southbound approach
- Improve pavement conditions, especially any crumbling or rutted pavements, to provide for better traction, smoother ride, and a pavement condition conducive to proper and longer lasting marking
- Consider providing dual right-turn bays on the I-271 northbound exit ramp at Brainard Road to increase the storage capacity and increase the volume of traffic flow through the intersection during the green interval, to lessen traffic backups that often reach the freeway mainline
- Consider building a marginal road from Brainard Road to Lander Road commencing at the opposite side of the I-271 northbound exit ramp, aligned with the exit ramp through-lane and relatively alongside the I-271 northbound entrance ramp, to help take traffic directly to Landerbrook Drive and Lander Haven Drive. This marginal Road will carry or service traffic bound for Landerbrook Drive and Lander Haven Drive and will alleviate the traffic demand on the Cedar Road/Brainard Road intersection caused by the zigzag traffic movement pattern created by traffic exiting I-271 at the northbound exit ramp to Brainard Road, which then turns right to proceed to Cedar Road to turn left to reach Lander Road and Landerbrook Drive and Lander Haven Drive (Diagrams 2-2 and 2-3)
- Consider adding a northbound I-271 exit ramp connected directly to eastbound Cedar Road to prevent backups presently reoccurring on the I-271 freeway mainline near the mouth of the northbound Brainard Road/Cedar Road exit ramp, and to alleviate the impact of heavy traffic volumes, particularly during the morning peak period, on the intersections of the Brainard Road/I-271 northbound exit ramp, and Brainard Road/Cedar Road
- Restripe the stop line for the southbound approach and make it perpendicular to the curb of the roadway instead of the present slanted stop line
- Add overhead lane use signs on the Brainard Road Bridge over I-271. The present sign is erected on the bridge parapet and cannot be seen by traffic coming from the I-271 southbound exit ramp
- Remove the pedestrian crosswalk across Brainard Road. It is very unlikely pedestrians will cross to or from the southern side of the Brainard Road Bridge. That side of the Bridge is not connected with or serviced by any sidewalks. Maintain the pedestrian crosswalk across the I-271 northbound entrance ramp, as pedestrians will more likely use it because the sidewalk on the northern side of the bridge is connected to sidewalks along Brainard Road
- Reexamine the presently closed outer through-lane on northbound Brainard Road. This through-lane may be reinstated if a tapered northbound receiving lane is built on Brainard Road north of the I-271 southbound exit ramp. The tapered through lane may also serve traffic that exits at the I-271 southbound exit ramp and turns right to go north from an exclusive right-turn bay recommended for the exit ramp (see recommendations for Location 4)
- Make the southbound left-turn movement a 'lag' not 'lead' movement

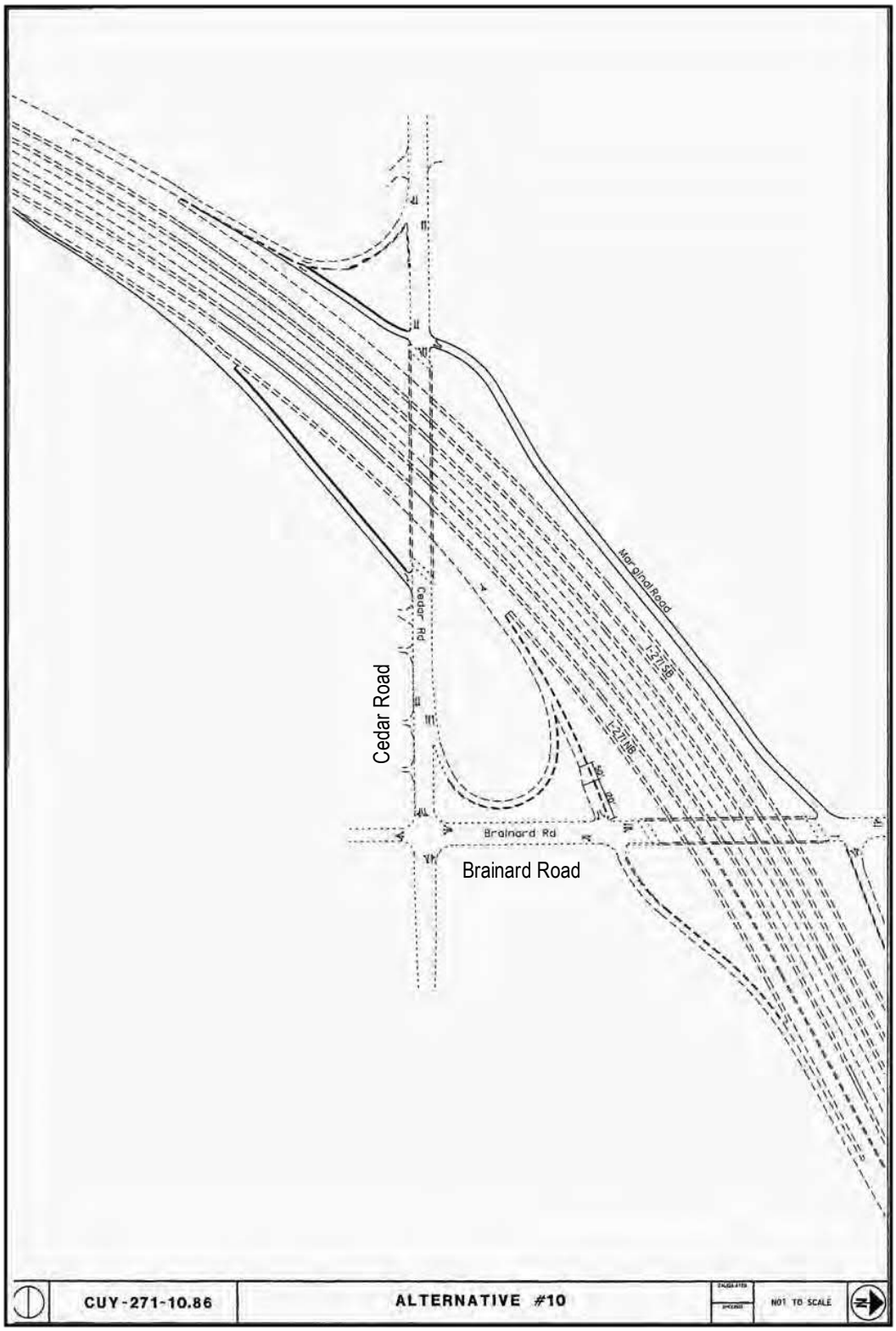
Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

Location 3: Cedar Road/I-271 Southbound Entrance Ramp

- Improve the curb and curvature near the Bridge. Move the curb back and increase its curvature to permit vehicles in the inner left-turn bay on the Cedar Road westbound approach to transition more easily to the I-271 southbound entrance ramps without encroaching on the adjacent left-turn lane extension line in order to minimize the potential for sideswipe passing crashes
- Emphasize or highlight the island and extension line markings
- Revisit *'Alternative 10'* that was presented in the *'I-271 Access Point Modification Study'* prepared for ODOT and completed in 2002, and shown here as Exhibit A, which provides for, retains, or reinstates a free-flow entrance ramp to I-271 southbound at the Cedar Road eastbound approach
- Consider combining or integrating elements from the various alternatives presented in the I-271--Cedar/Brainard Access-Point Modification Study, particularly *Alternative 10* (Exhibit A), with the overall suggested safety improvements and recommendations presented in this RSA report to provide long term solutions for the issues identified in the two study reports
- Install additional overhead lane assignment signs on the Cedar Road Bridge over I-271 similar to but in advance of those that exist near the westbound approach at the I-271 southbound entrance ramp
- Consider adding an entrance ramp from Brainard Road to I-271 southbound (Diagram E-1) if the minimum required spacing between consecutive ramps can be achieved, and provided that there will not be any or a significant increase in traffic flow to the freeway that might degrade its operation

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

Exhibit-A: Alternative #10 presented in the '*I-271--Cedar/Brainard Access Point Modification Study*' prepared by Burgess & Niple in 2002 for ODOT District-12 under PID #21029



Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

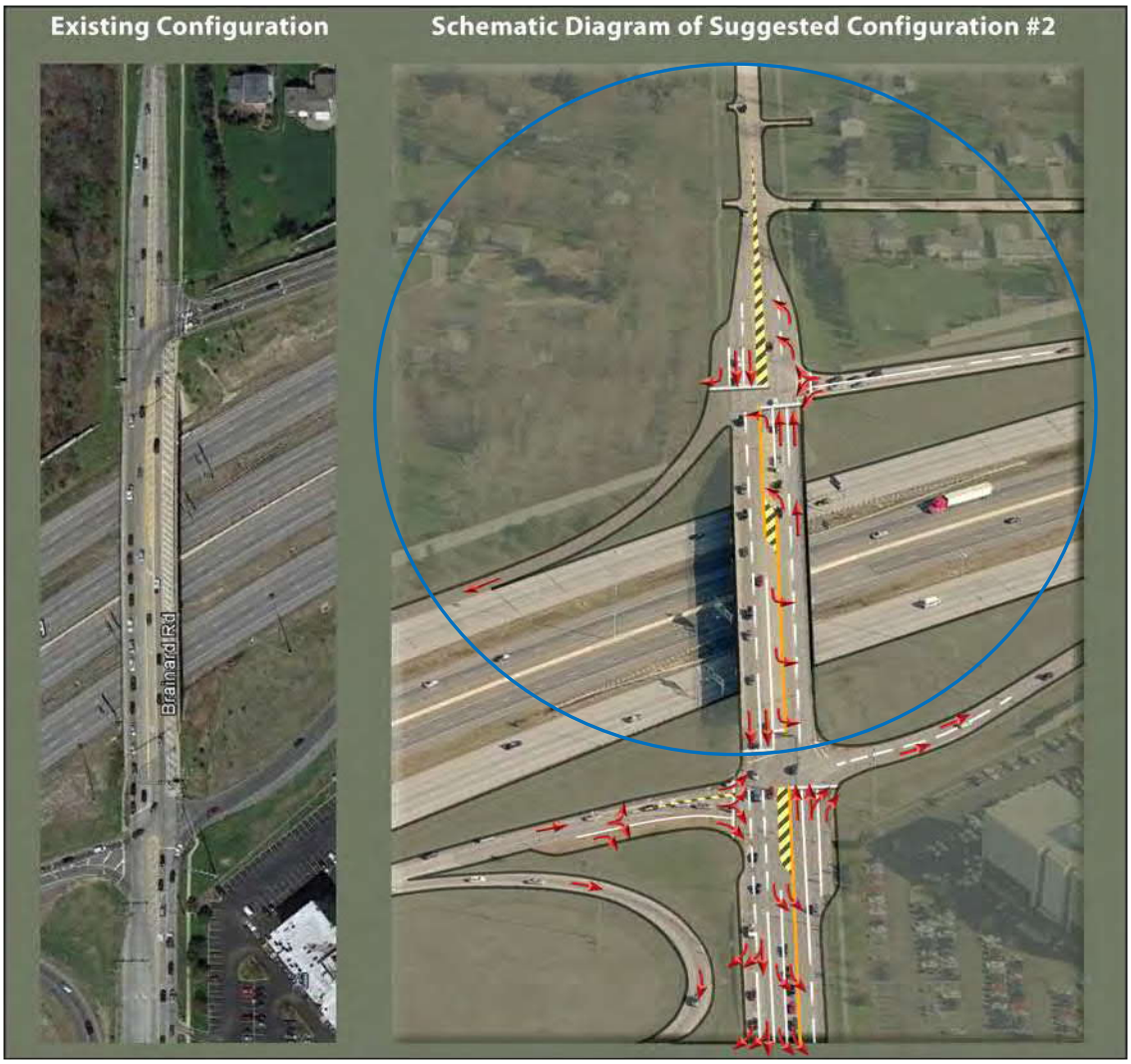


Diagram E-1: Suggested entrance ramp to I-271 southbound from Brainard Road

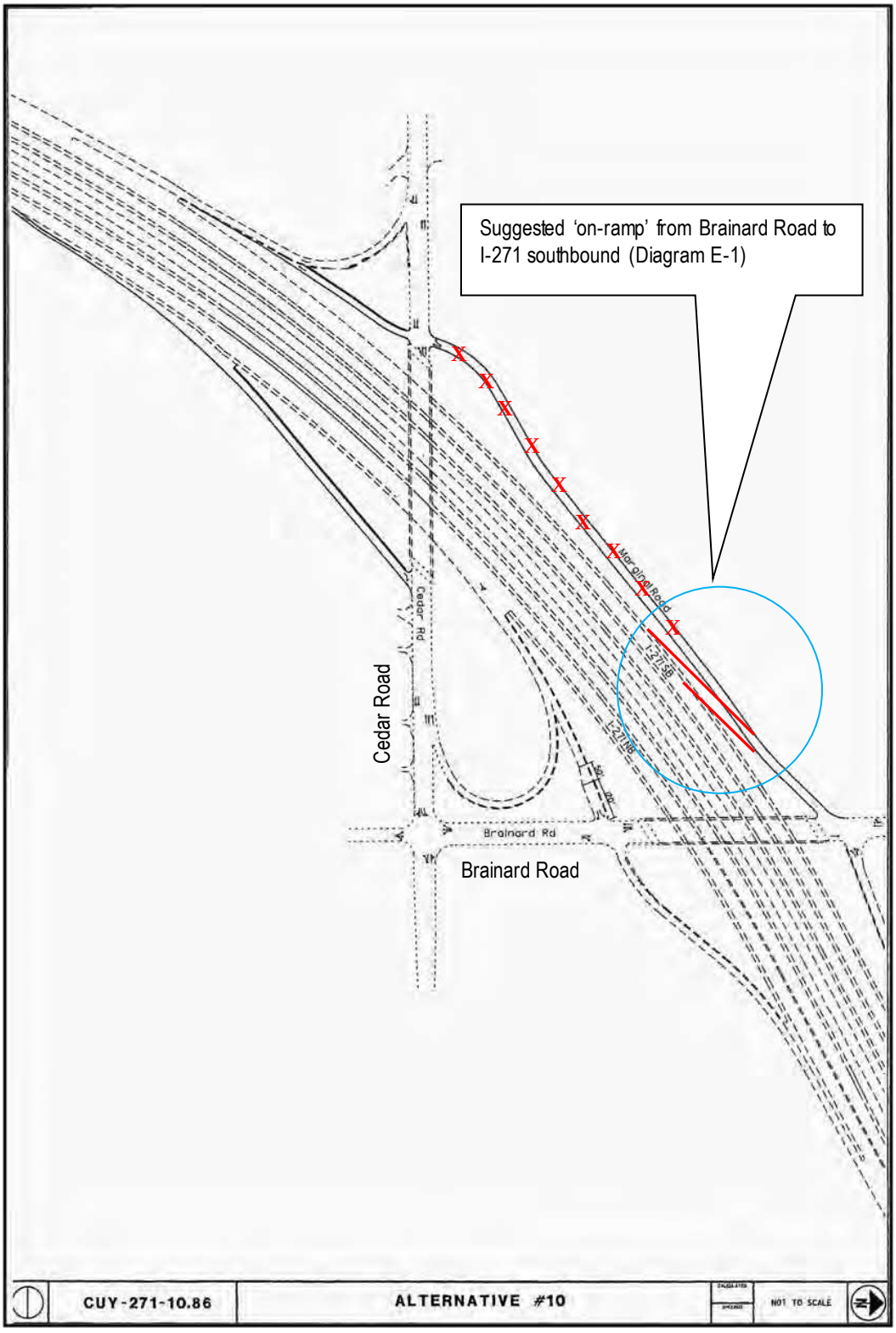
Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

Location 4: Brainard Road/I-271 Southbound Exit Ramp

- Place overhead lane assignment signs on the bridge as the sign erected on the bridge parapet is not visible to traffic exiting at the I-271 southbound exit ramp and turning left to go south on Brainard
- Re-examine the need for the "no-turn-on-red" sign posted opposite the exit ramp, and based on the results of the examination consider removing the 'no-turn-on-red' signage
- Consider adding an exclusive right-turn bay on the exit ramp and convert the present through- and left-turn lane to an exclusive left-turn lane to make it a second left-turn lane for a dual left-turn configuration
- Build a long taper, through-lane on Brainard Road in the northbound direction to receive traffic from the outer through lane on the bridge after opening it to traffic as it is currently closed by hatching
- Place destination signs on the exit ramp to help drivers occupy the respective lane for the respective destination
- Consider adding an entrance ramp to I-271 southbound commencing at the Brainard Road/I-271 southbound exit ramp, as shown in Appended Exhibit-A and Diagram E-1
- Reexamine the viability and feasibility of adding a marginal road, running parallel to I-271, between the intersection of Brainard Road/I-271 southbound exit ramp and the intersection of Cedar Road/I-271 southbound entrance ramp, with a 'slip' entrance ramp from it to I-271 southbound. Perform capacity analysis for the resulting four-approach intersection of the marginal road with Cedar Road and I-271 southbound entrance ramp as part of the reexamination to determine whether such marginal road would be viable and feasible. Appended Exhibit-A shows the subject marginal road tentatively crossed-out to signify the need to address the presence of physical impediments, and the cost of any potential acquisition of right-of-way. The marginal road suggested may provide access to I-271 southbound via a slip entrance ramp from it to I-271 southbound and a direct access to Cedar Road westbound at or near its intersection with the I-271 southbound entrance ramp as shown in schematic Diagram 3-1

Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

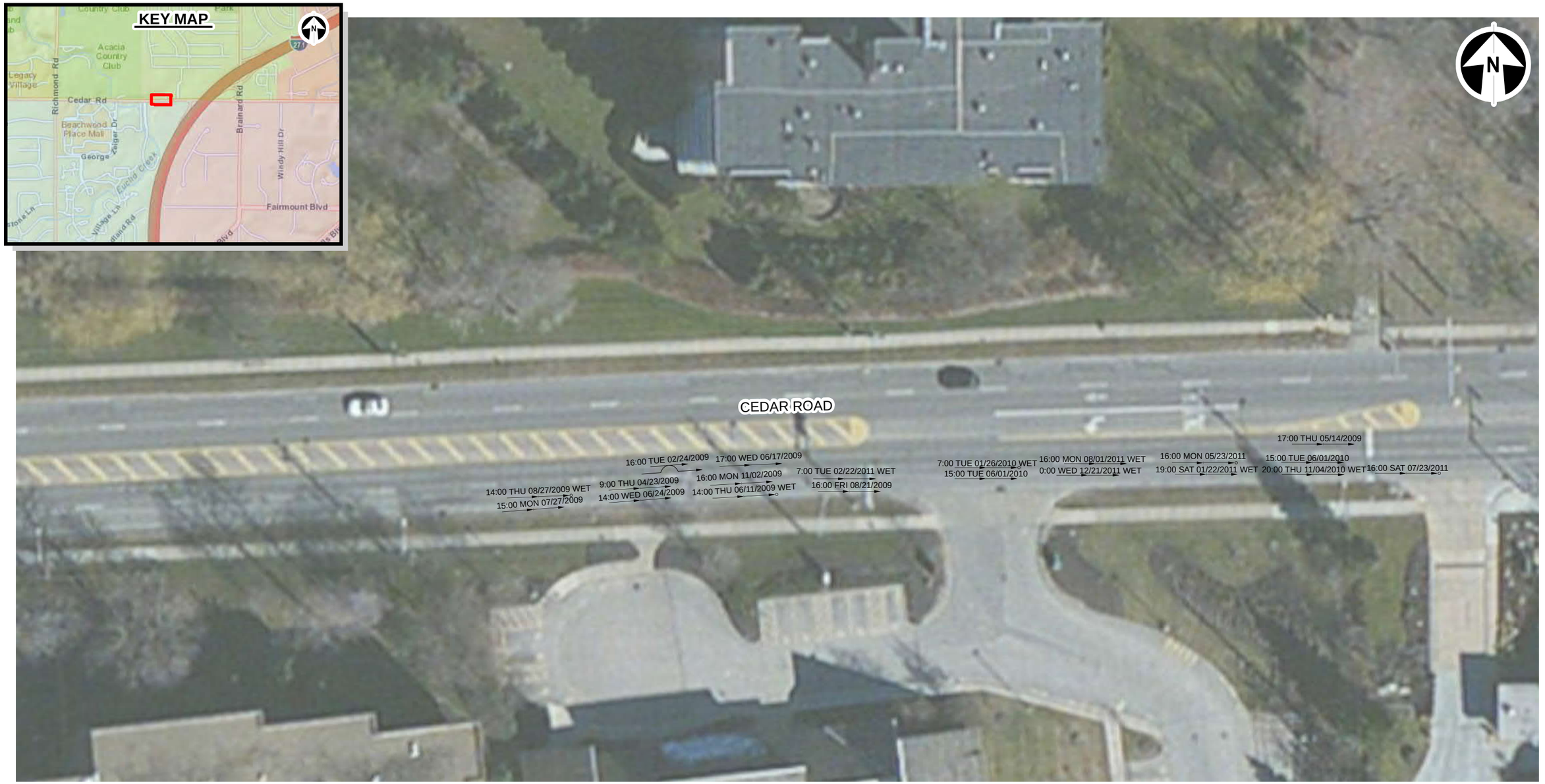
Appended Exhibit-A: Alternative #10 presented in the *'I-271--Cedar/Brainard Access Point Modification Study'* prepared by Burgess & Niple in 2002 for ODOT District-12 under PID #21029



Source: Road Safety Audit for the Intersection of Cedar & Brainard Roads and I-271 Interchange with Brainard & Cedar Roads, Prepared by the Northeast Ohio Areawide Coordinating Agency (NOACA), February 2013.

Appendix B

Collision Diagrams



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

15	PROPERTY DAMAGE ONLY
5	INJURY OR FATAL
20	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

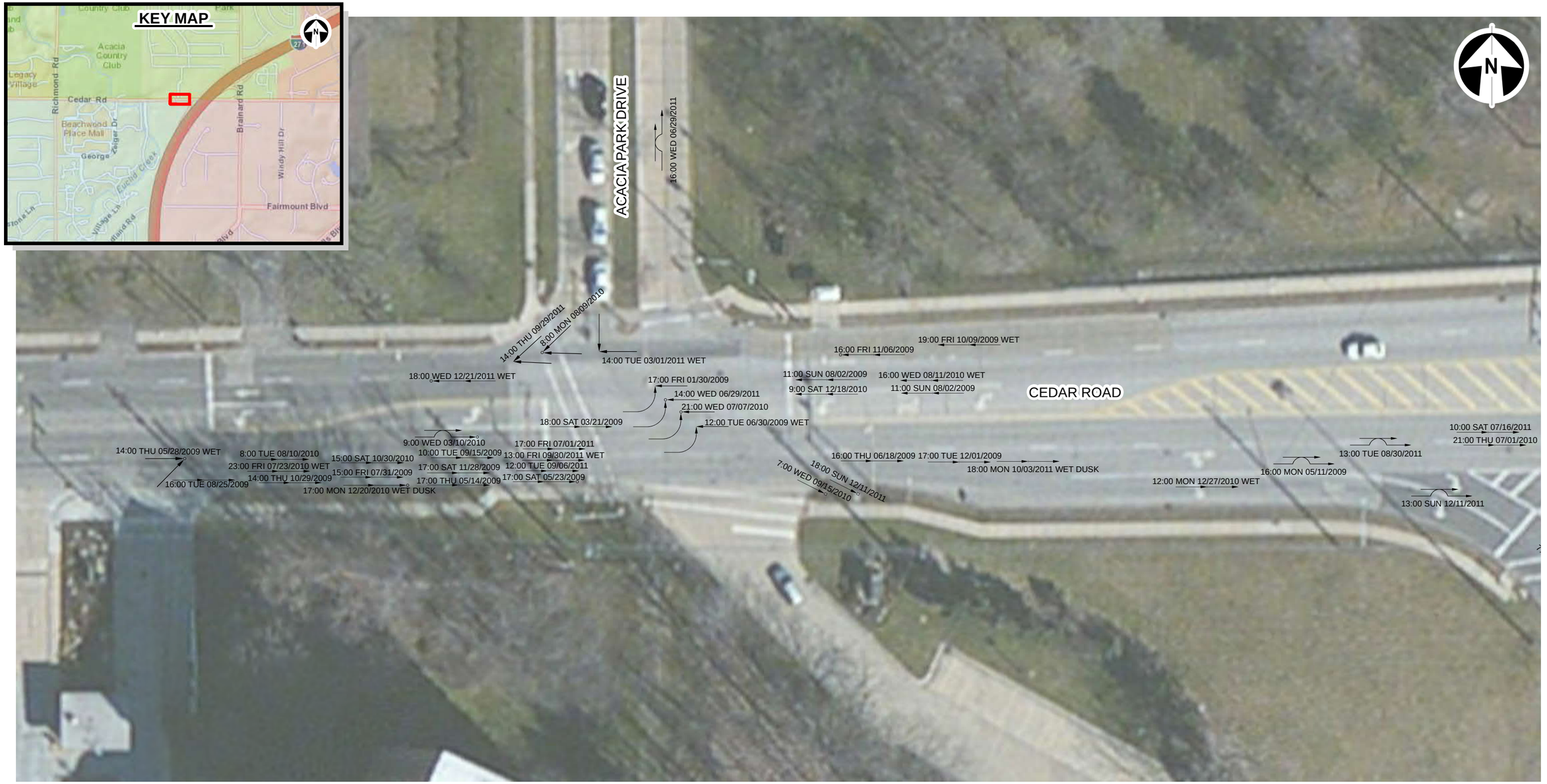
COLLISION DIAGRAM

LOG POINT No. 8.633 TO 8.750

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Lyndhurst, Ohio ROUTE NUMBER Cedar Road (CR-23)

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

33	PROPERTY DAMAGE ONLY
10	INJURY OR FATAL
43	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 8.750 TO 8.859

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Lyndhurst, Ohio ROUTE NUMBER Cedar Road (CR-23)

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

29	PROPERTY DAMAGE ONLY
9	INJURY OR FATAL
38	TOTAL CRASHES

SYMBOLS	
	MOVING VEHICLE
	BACKING VEHICLE
	NON-INVOLVED VEH.
	PEDESTRIAN
	PARKED VEHICLE
□	FIXED OBJECT
●	FATAL CRASH
○	INJURY CRASH

TYPES OF COLLISIONS
REAR END
RIGHT ANGLE
SIDE SWIPE
OUT OF CONTROL
LEFT TURN
HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 8.859 TO 8.975

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Lyndhurst, Ohio ROUTE NUMBER Cedar Road (CR-23)

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

5	PROPERTY DAMAGE ONLY
3	INJURY OR FATAL
8	TOTAL CRASHES

SYMBOLS	
	MOVING VEHICLE
	BACKING VEHICLE
	NON-INVOLVED VEH.
	PEDESTRIAN
	PARKED VEHICLE
	FIXED OBJECT
	FATAL CRASH
	INJURY CRASH

TYPES OF COLLISIONS
REAR END
RIGHT ANGLE
SIDE SWIPE
OUT OF CONTROL
LEFT TURN
HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

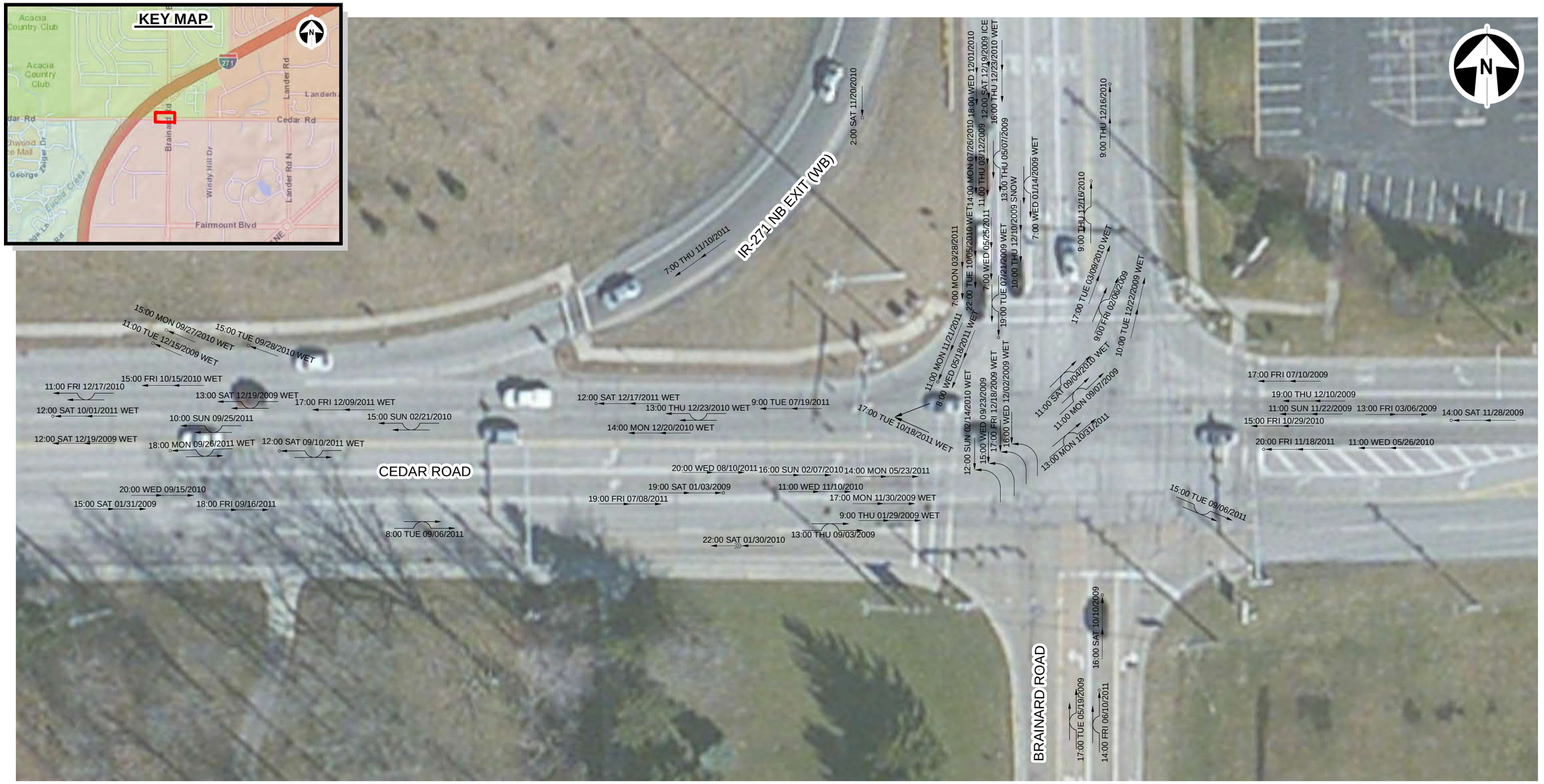
COLLISION DIAGRAM

LOG POINT No. 8.966 TO 9.081

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike & Lyndhurst, Ohio ROUTE NUMBER Cedar Road (CR-23)

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

59	PROPERTY DAMAGE ONLY
13	INJURY OR FATAL
72	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

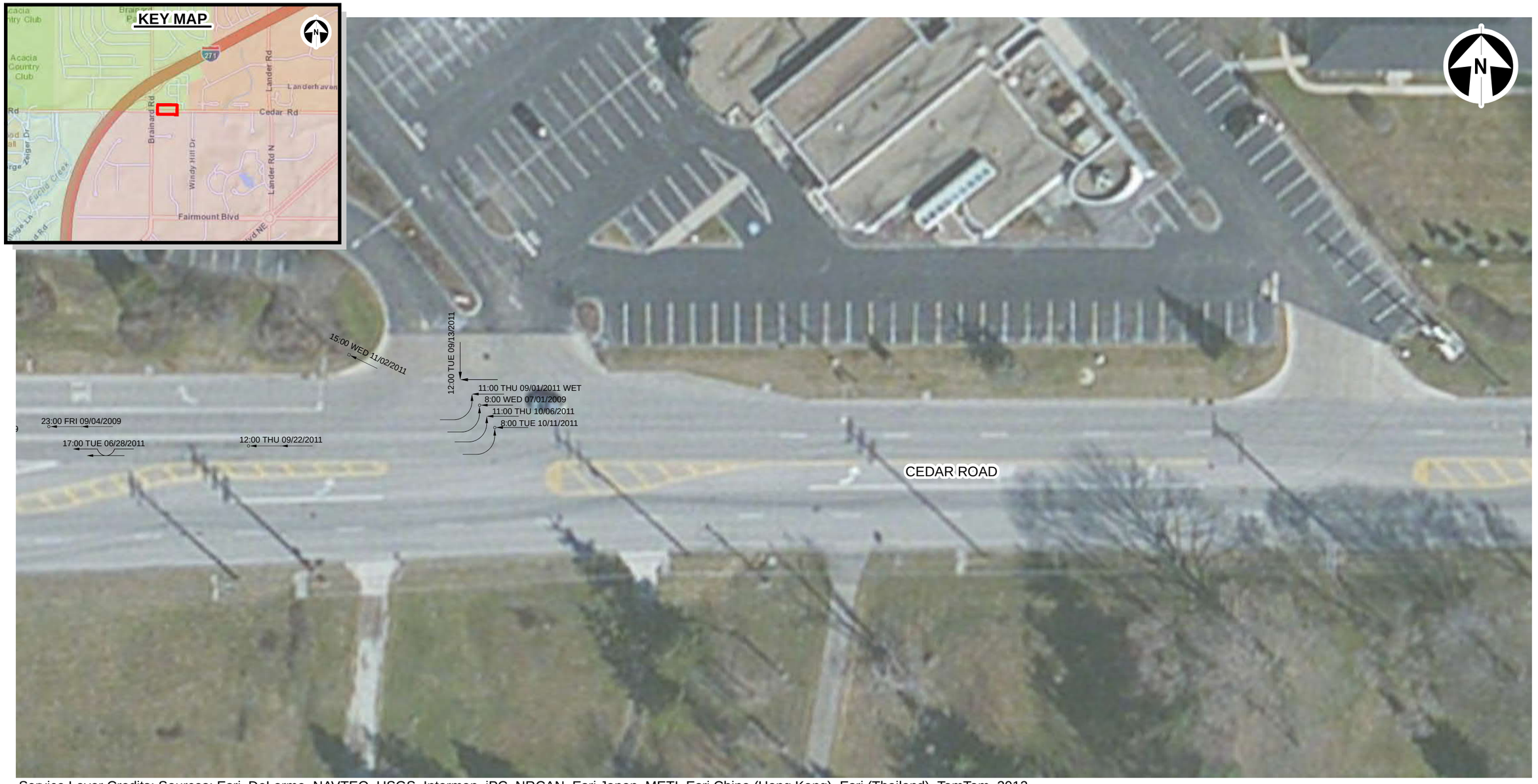
COLLISION DIAGRAM

LOG POINT No. 9.081 TO 9.195

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike & Lyndhurst, Ohio ROUTE NUMBER Cedar Rd. (CR-23)

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

5	PROPERTY DAMAGE ONLY
4	INJURY OR FATAL
9	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

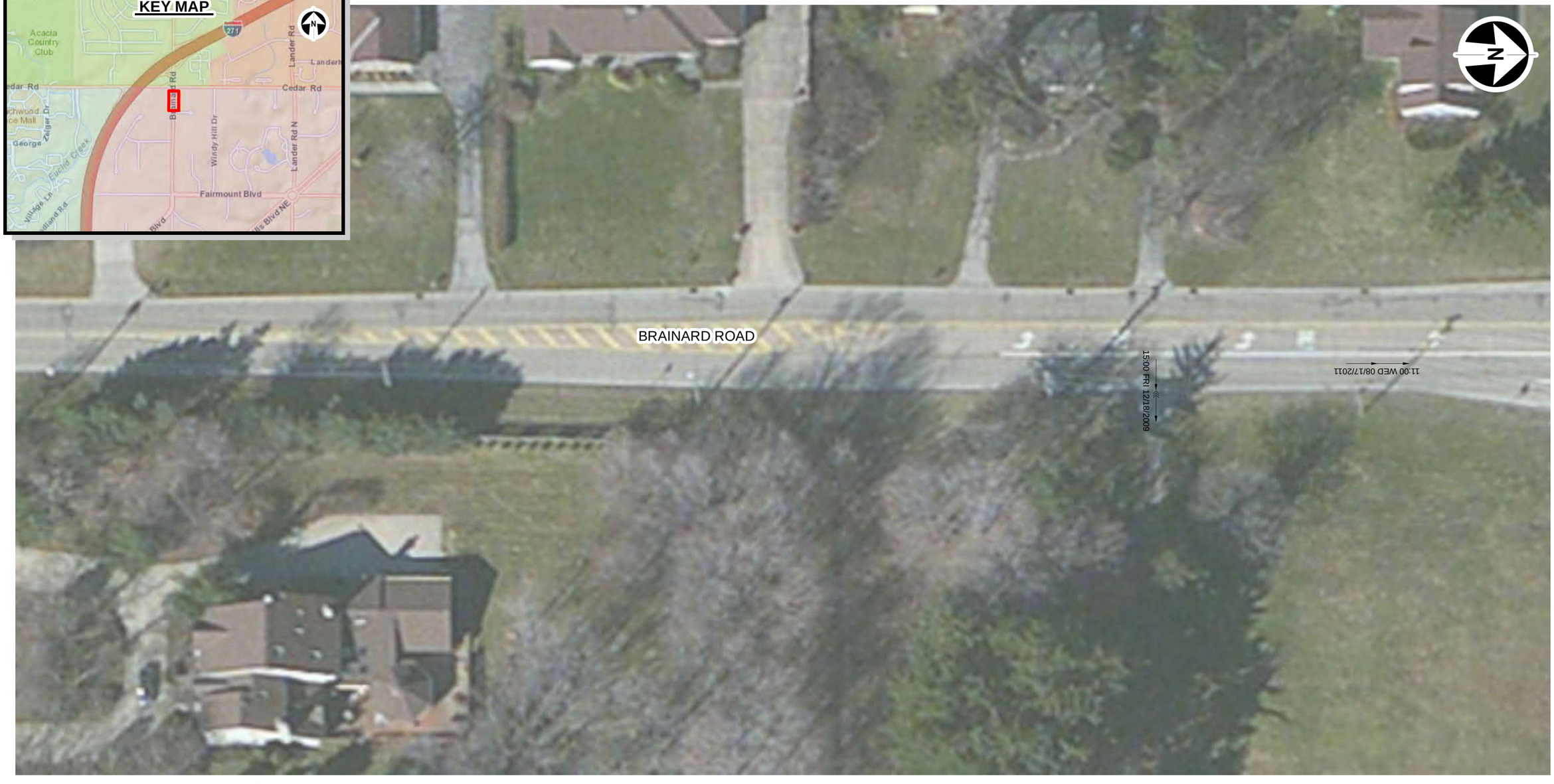
COLLISION DIAGRAM

LOG POINT No. 9.195 TO 9.309

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike & Lyndhurst, Ohio ROUTE NUMBER Cedar Road (CR-23)

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

2	PROPERTY DAMAGE ONLY
0	INJURY OR FATAL
2	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

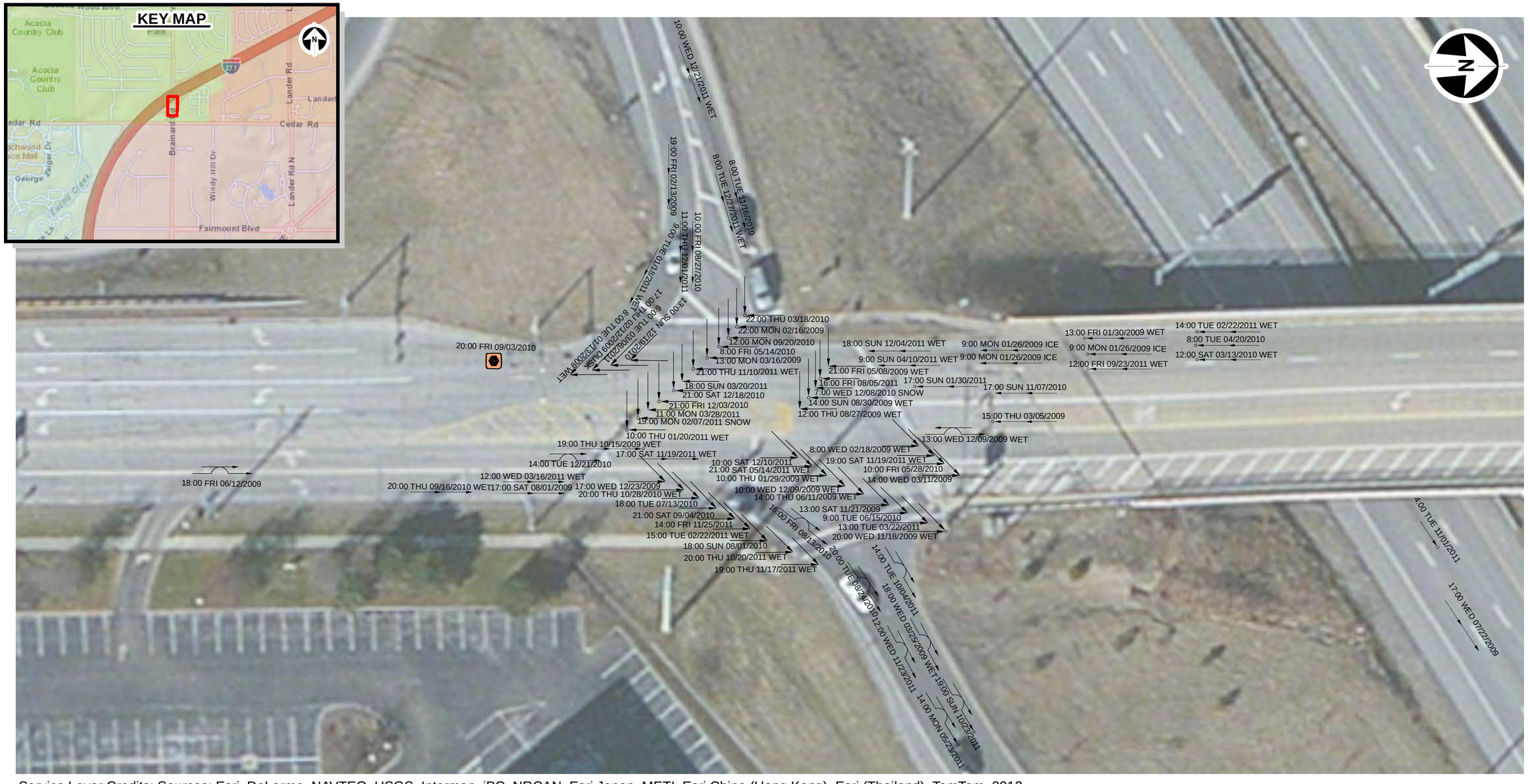
COLLISION DIAGRAM

LOG POINT No. 6.633 TO 6.516

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike, Ohio ROUTE NUMBER Brainard Road (CR-28)

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

52	PROPERTY DAMAGE ONLY
27	INJURY OR FATAL
79	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 6.818 TO 6.962

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike & Lyndhurst, Ohio ROUTE NUMBER Brainard Road (CR-28)

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

2	PROPERTY DAMAGE ONLY
2	INJURY OR FATAL
4	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

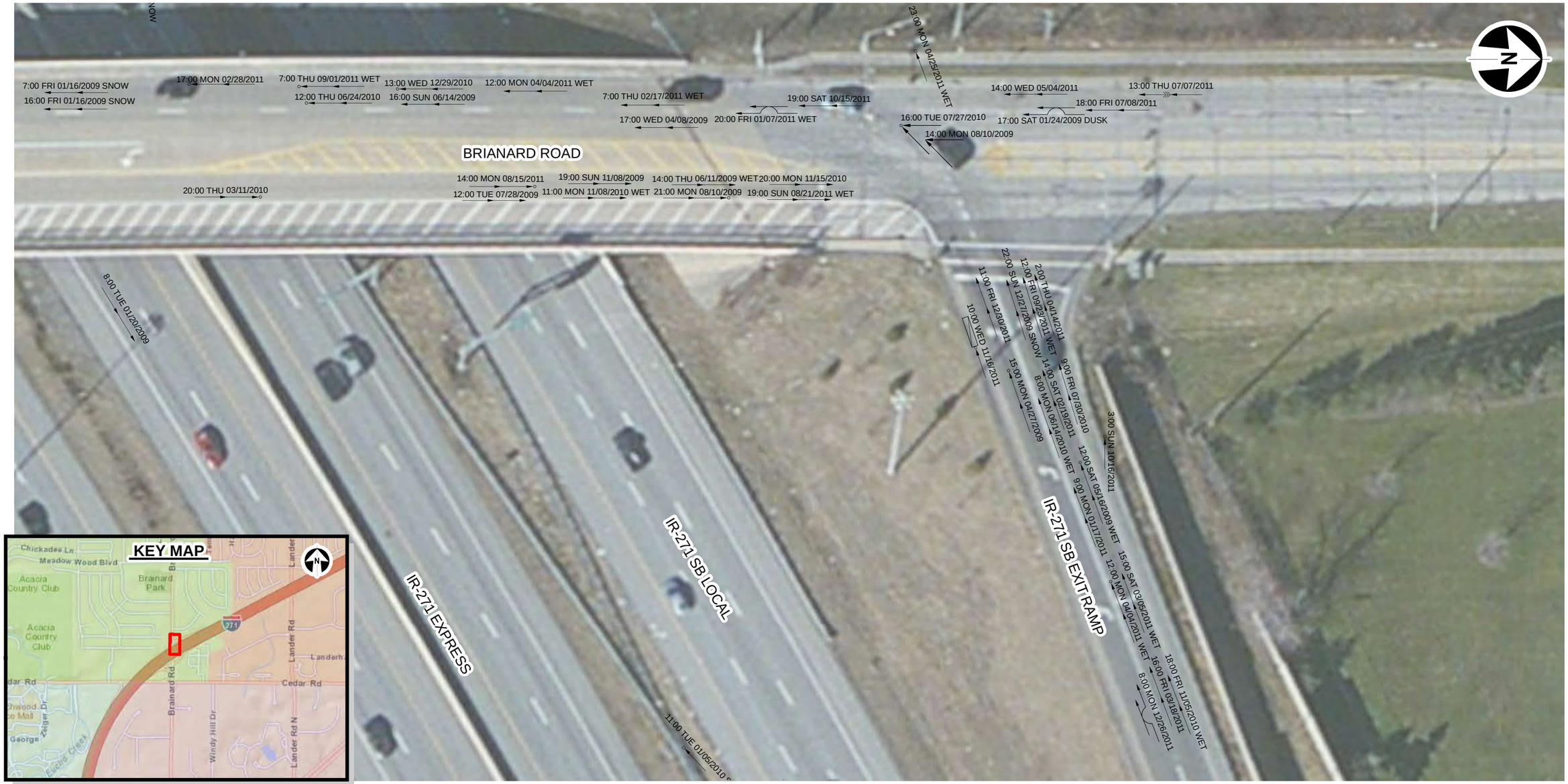
COLLISION DIAGRAM

LOG POINT No. 0.047 TO 0.112

PERIOD 3 years FROM 2009 TO 2011

CITY Lyndhurst, Ohio ROUTE NUMBER I-275 EB Exit at Brainard Road

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

33	PROPERTY DAMAGE ONLY
12	INJURY OR FATAL
45	TOTAL CRASHES

SYMBOLS	
	MOVING VEHICLE
	BACKING VEHICLE
	NON-INVOLVED VEH.
	PEDESTRIAN
	PARKED VEHICLE
	FIXED OBJECT
	FATAL CRASH
	INJURY CRASH

TYPES OF COLLISIONS
REAR END
RIGHT ANGLE
SIDE SWIPE
OUT OF CONTROL
LEFT TURN
HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

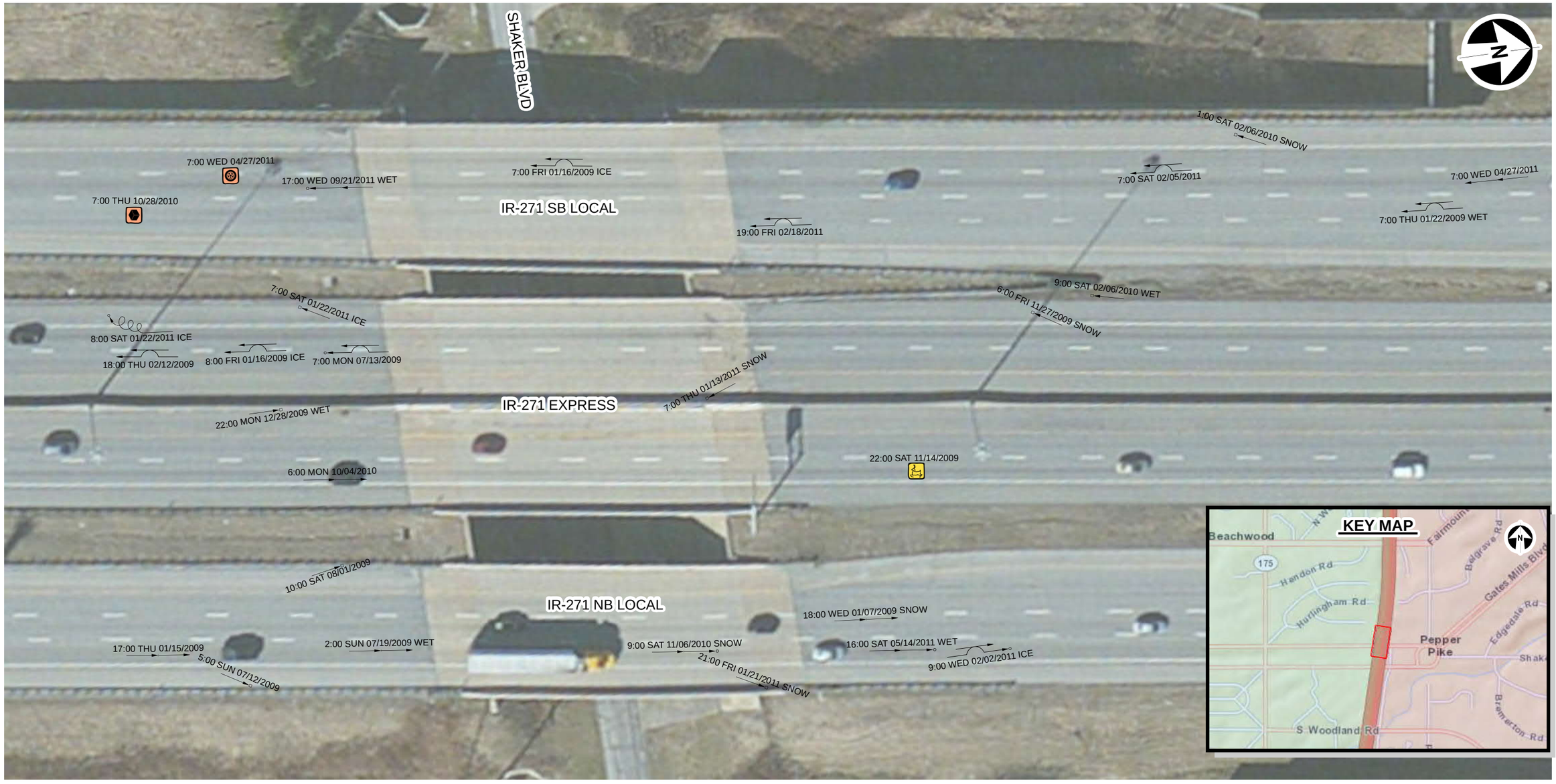
COLLISION DIAGRAM

LOG POINT No. 6.821 TO 6.934

PERIOD 3 years FROM 2009 TO 2011

CITY Lyndhurst, Ohio ROUTE NUMBER Brainard Road (CR-28)

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

20	PROPERTY DAMAGE ONLY
9	INJURY OR FATAL
29	TOTAL CRASHES

SYMBOLS	TYPES OF COLLISIONS	SHOW FOR EACH CRASH
MOVING VEHICLE	REAR END	1. TIME, DAY, DATE
BACKING VEHICLE	RIGHT ANGLE	2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
NON-INVOLVED VEH.	SIDE SWIPE	3. NITE - IF BETWEEN DUSK AND DAWN
PEDESTRIAN	OUT OF CONTROL	
PARKED VEHICLE	LEFT TURN	
FIXED OBJECT	HEAD ON	
FATAL CRASH		
INJURY CRASH		

COLLISION DIAGRAM

LOG POINT No. 9.197 TO 9.341

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

10	PROPERTY DAMAGE ONLY
3	INJURY OR FATAL
13	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 9.349 TO 9.496

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

2	PROPERTY DAMAGE ONLY
2	INJURY OR FATAL
4	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

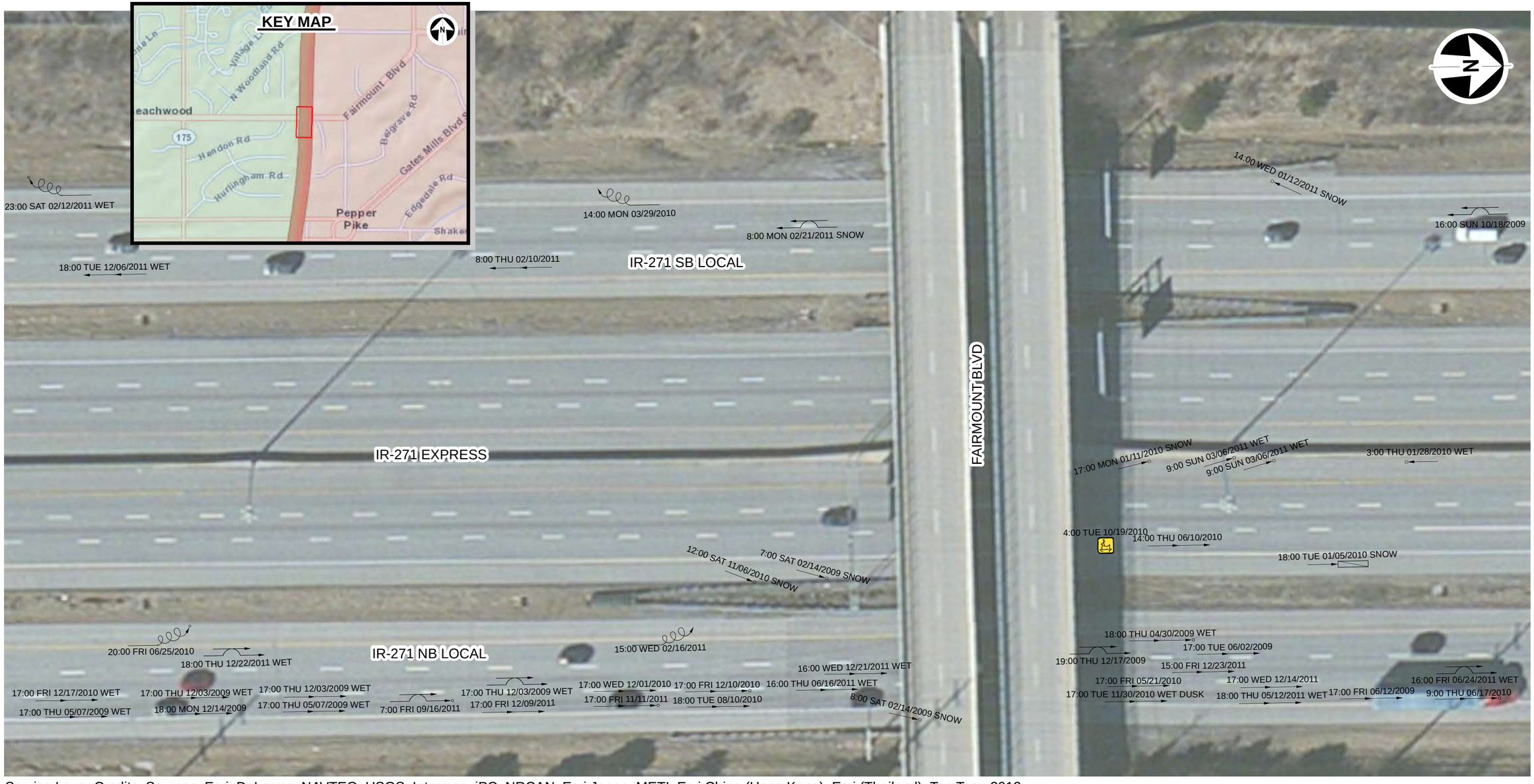
COLLISION DIAGRAM

LOG POINT No. 9.493 TO 9.639

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike & Lyndhurst, Ohio ROUTE NUMBER I-275

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

35	PROPERTY DAMAGE ONLY
11	INJURY OR FATAL
46	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

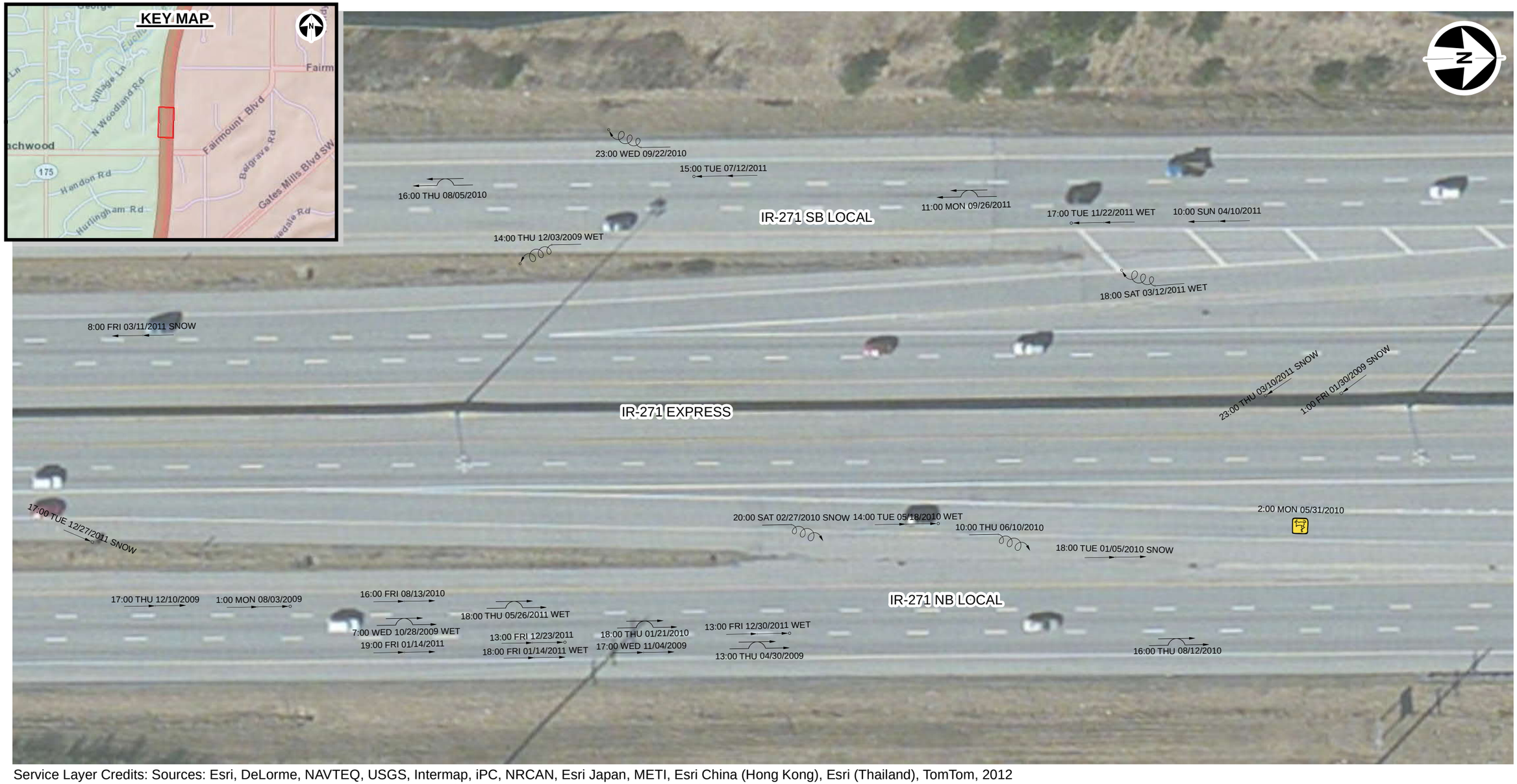
COLLISION DIAGRAM

LOG POINT No. 9.640 TO 9.786

PERIOD 3 years FROM 2009 TO 2011

CITY Pepper Pike & Lyndhurst, Ohio ROUTE NUMBER I-275

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

20	PROPERTY DAMAGE ONLY
10	INJURY OR FATAL
30	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 9.807 TO 9.953

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

20	PROPERTY DAMAGE ONLY
8	INJURY OR FATAL
28	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

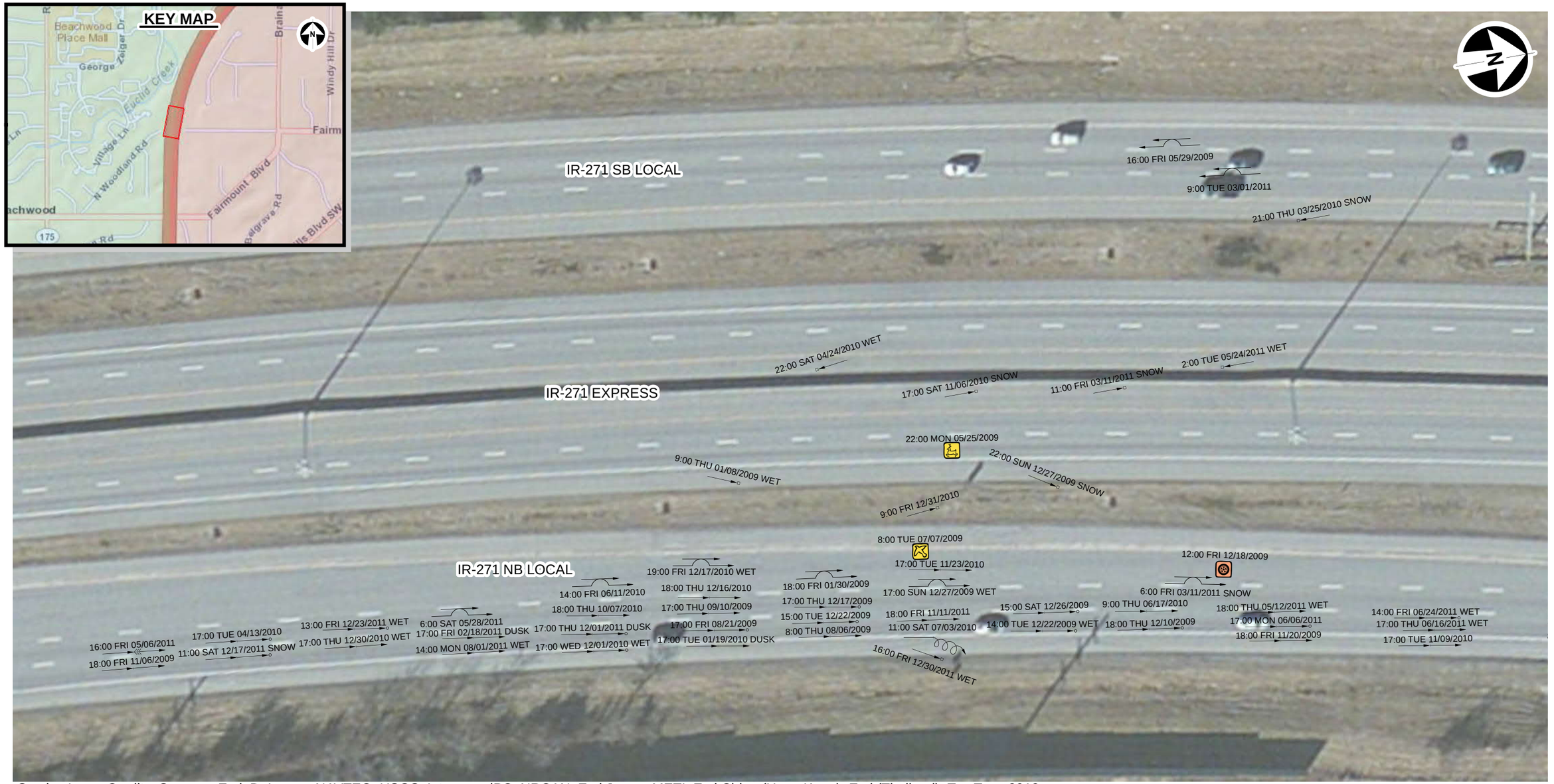
COLLISION DIAGRAM

LOG POINT No. 9.968 TO 10.115

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

36	PROPERTY DAMAGE ONLY
15	INJURY OR FATAL
51	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

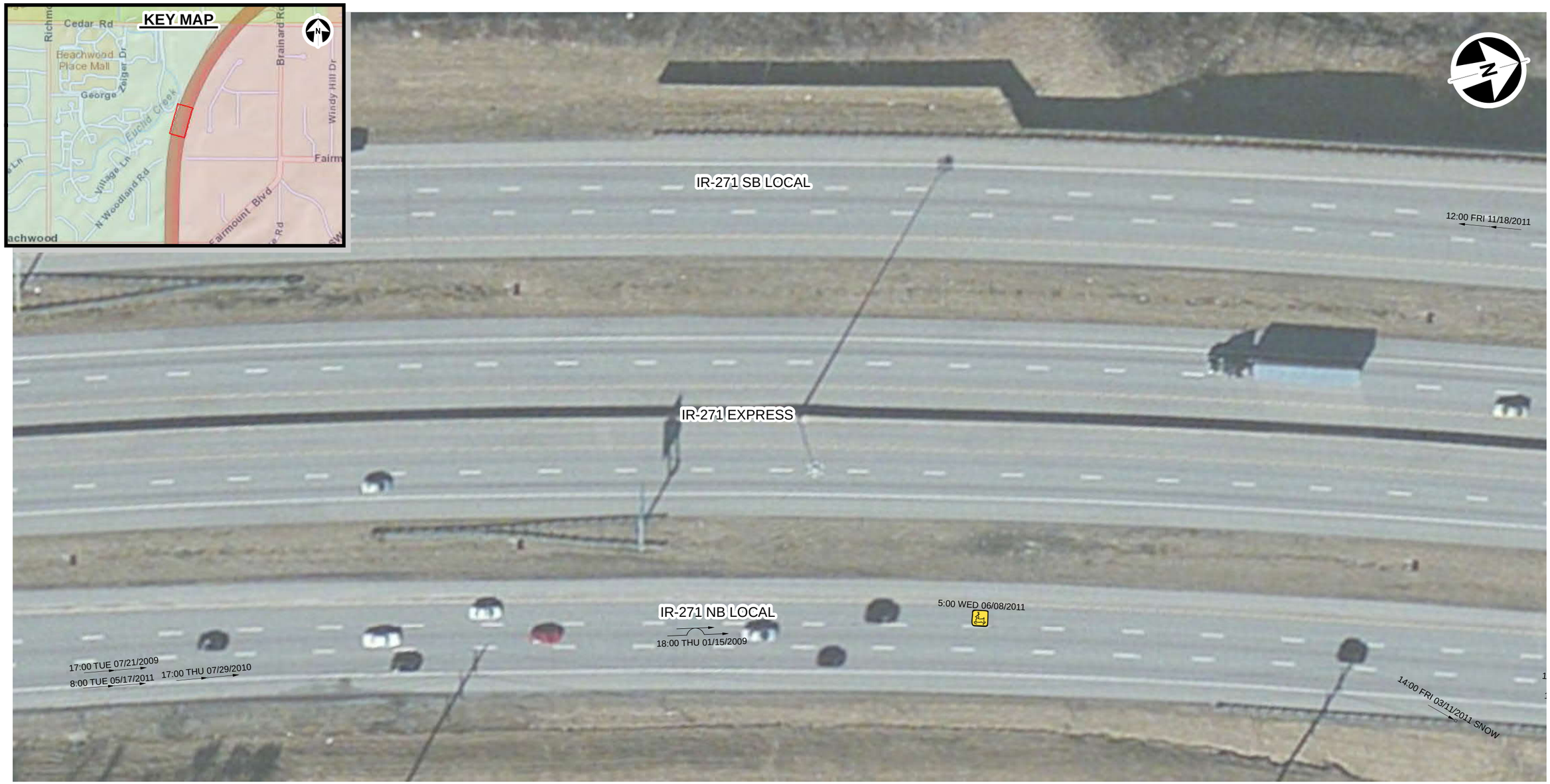
COLLISION DIAGRAM

LOG POINT No. 10.111 TO 10.257

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

7	PROPERTY DAMAGE ONLY
0	INJURY OR FATAL
7	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 10.254 TO 10.400

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

16	PROPERTY DAMAGE ONLY
8	INJURY OR FATAL
24	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

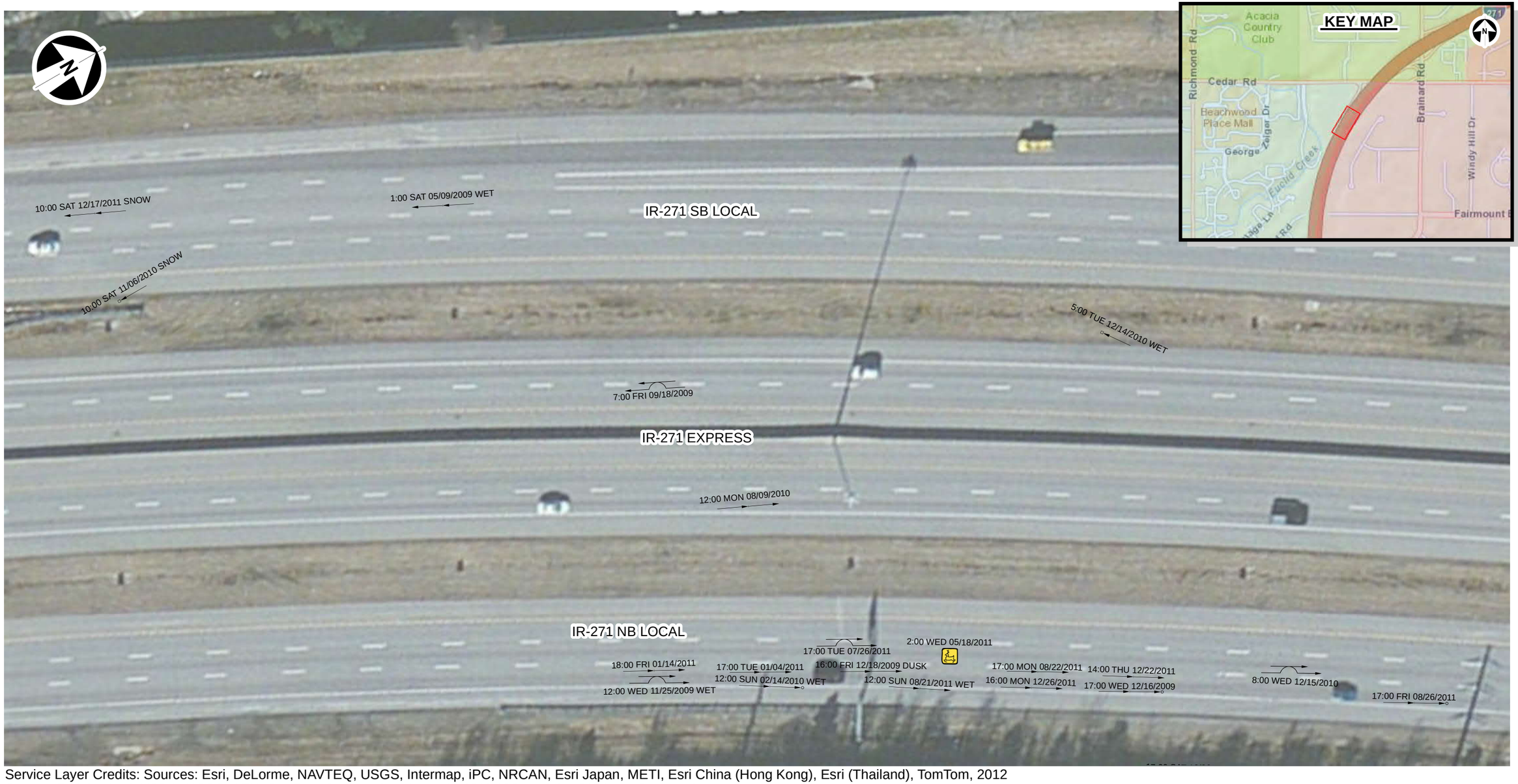
COLLISION DIAGRAM

LOG POINT No. 10.400 TO 10.547

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

17	PROPERTY DAMAGE ONLY
4	INJURY OR FATAL
21	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 10.538 TO 10.684

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

11	PROPERTY DAMAGE ONLY
5	INJURY OR FATAL
16	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 10.672 TO 10.819

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

10	PROPERTY DAMAGE ONLY
10	INJURY OR FATAL
20	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 10.822 TO 10.967

PERIOD 3 years FROM 2009 TO 2011

CITY Beachwood, Lyndhurst & Pepper Pike, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

6	PROPERTY DAMAGE ONLY
1	INJURY OR FATAL
7	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

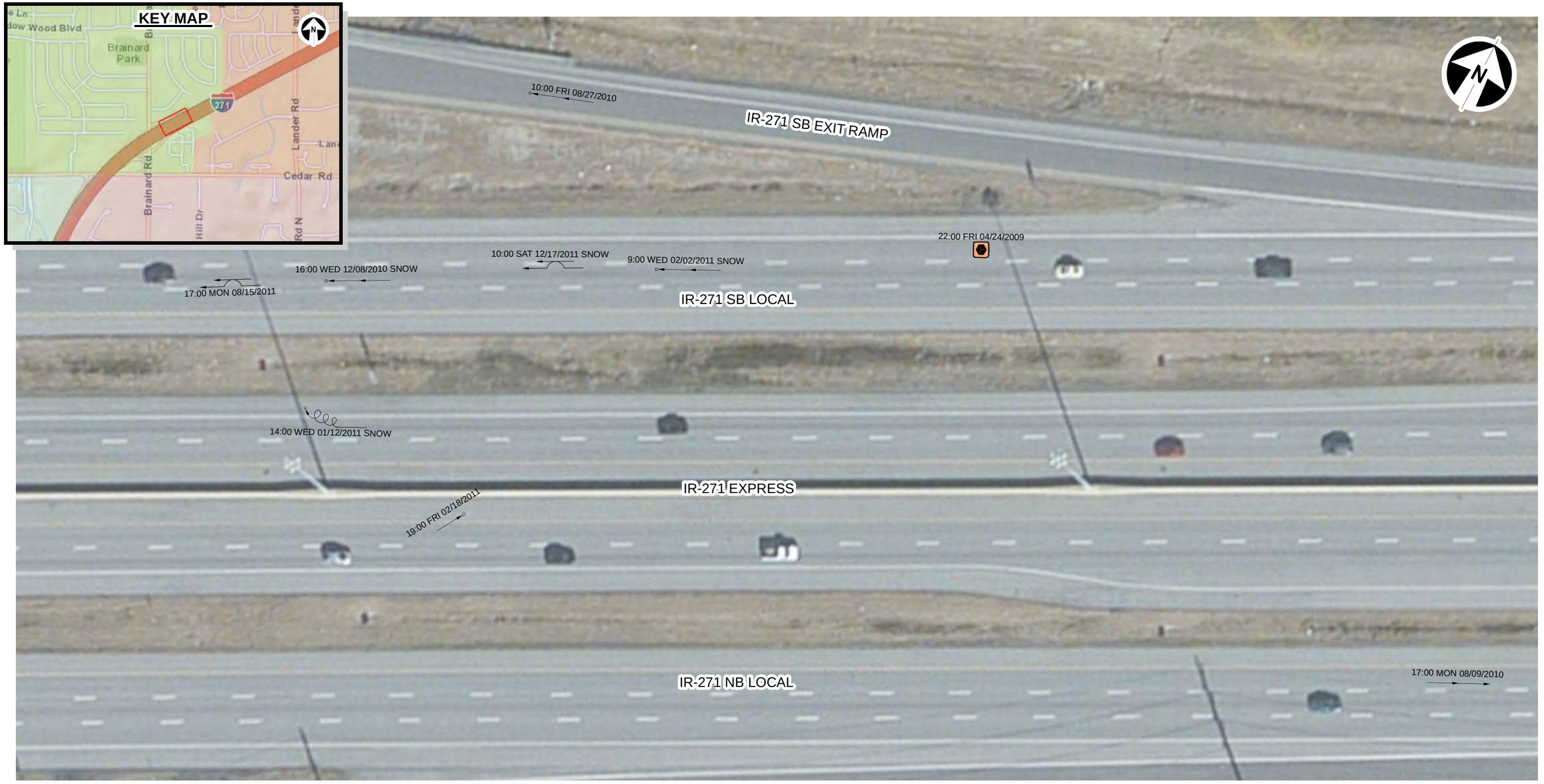
SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 11.067 TO 11.209
PERIOD 3 years FROM 2009 TO 2011
CITY Lyndhurst, Ohio ROUTE NUMBER I-275

DATE: 5/20/13



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

5	PROPERTY DAMAGE ONLY
4	INJURY OR FATAL
9	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 11.207 TO 11.349

PERIOD 3 years FROM 2009 TO 2011

CITY Cleveland ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

7	PROPERTY DAMAGE ONLY
3	INJURY OR FATAL
10	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 11.346 TO 11.452

PERIOD 3 years FROM 2009 TO 2011

CITY Lyndhurst, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

NUMBER OF CRASHES

1	PROPERTY DAMAGE ONLY
0	INJURY OR FATAL
1	TOTAL CRASHES

SYMBOLS

- MOVING VEHICLE
- BACKING VEHICLE
- NON-INVOLVED VEH.
- PEDESTRIAN
- PARKED VEHICLE
- FIXED OBJECT
- FATAL CRASH
- INJURY CRASH

TYPES OF COLLISIONS

- REAR END
- RIGHT ANGLE
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- HEAD ON

SHOW FOR EACH CRASH

1. TIME, DAY, DATE
2. WEATHER AND ROAD SURFACE IF UNUSUAL CONDITION EXISTED
3. NITE - IF BETWEEN DUSK AND DAWN

COLLISION DIAGRAM

LOG POINT No. 11.668 TO 11.773

PERIOD 3 years FROM 2009 TO 2011

CITY Mayfield Heights, Ohio ROUTE NUMBER I-275

DATE: 5/20/13

Appendix C

Certified Traffic

INTER-OFFICE COMMUNICATION

TO: **Brian Blayney, P.E., Traffic Planning Engineer, District 12**

FROM: Joshua Kieselbach, P.E., Transportation Engineer, Division of Statewide Planning & Research, Modeling & Forecasting Section

SUBJECT: **CUY-271-8.14, PID 97676**

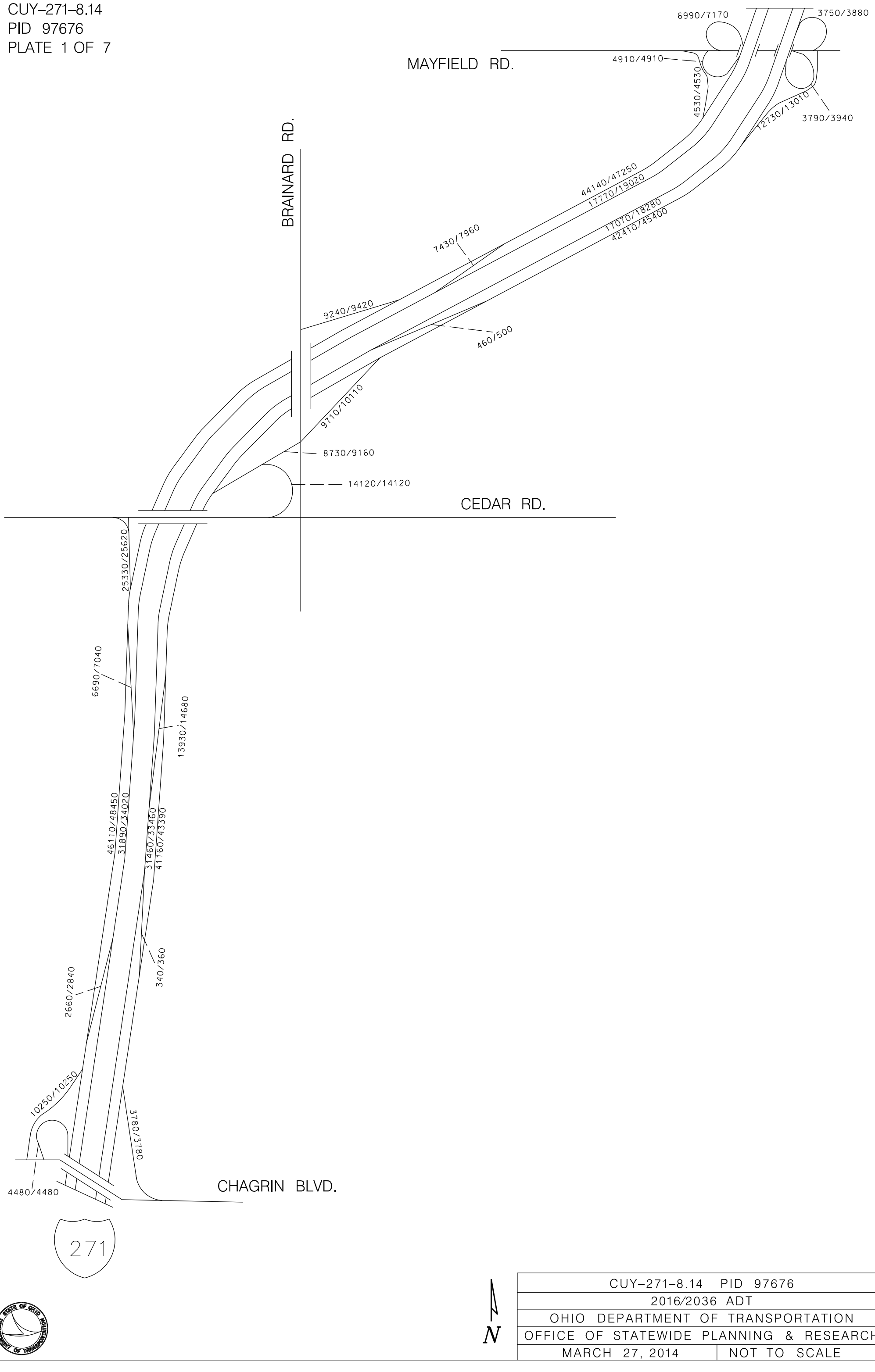
DATE: March 27, 2014

In reply to a request dated March 25, 2014, the request to update subject project has been completed. Based on our conversation the truck factors for the loop ramp from I-271 northbound to westbound Cedar Road have been reduced. In addition the two loop ramps for westbound Mayfield Road have been added to the traffic plates. The updated plates have been attached to this memo. All plates have been updated to include the PID for this project since it was not available prior to completion of the memo dated March 14, 2014.

If you have any questions, please contact me at Joshua.Kieselbach@dot.state.oh.us or (614) 752-5747.

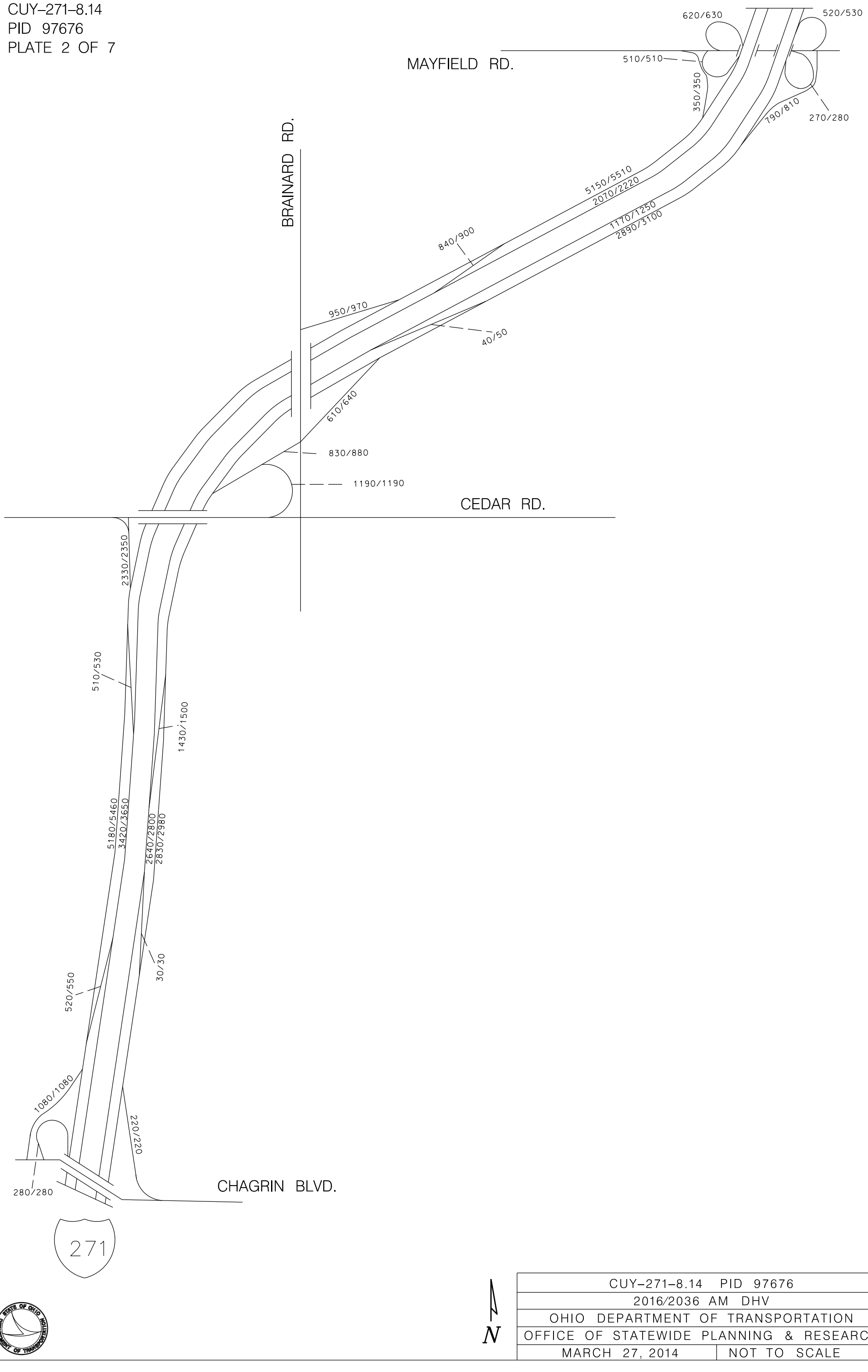
c: M. Byram, OSPR – G. Giaimo, OSPR – File

CUY–271–8.14
PID 97676
PLATE 1 OF 7



CUY–271–8.14 PID 97676	
2016/2036 ADT	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

CUY–271–8.14
PID 97676
PLATE 2 OF 7



CUY–271–8.14 PID 97676	
2016/2036 AM DHV	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

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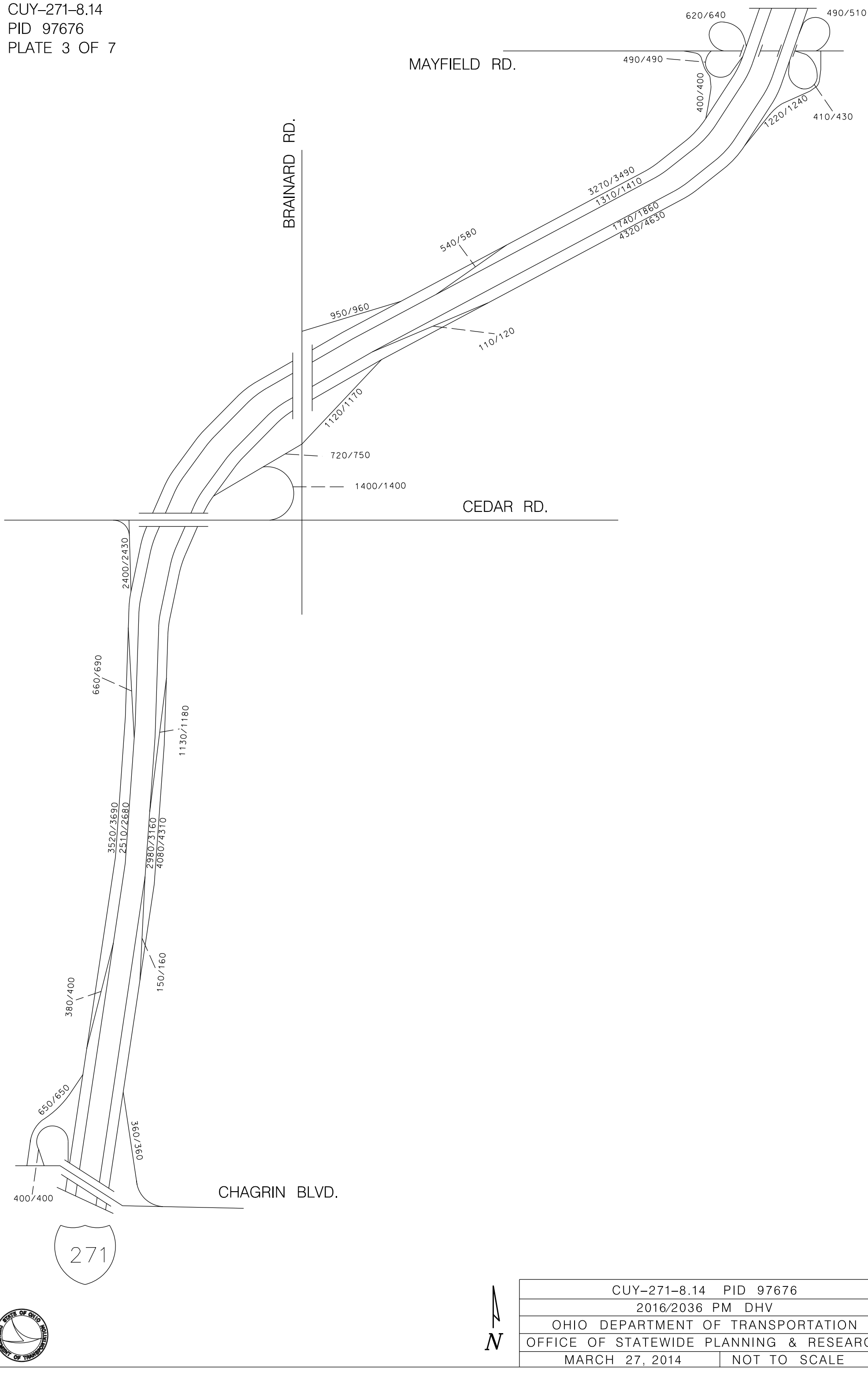
CUY–271–8.14
PID 97676
PLATE 3 OF 7



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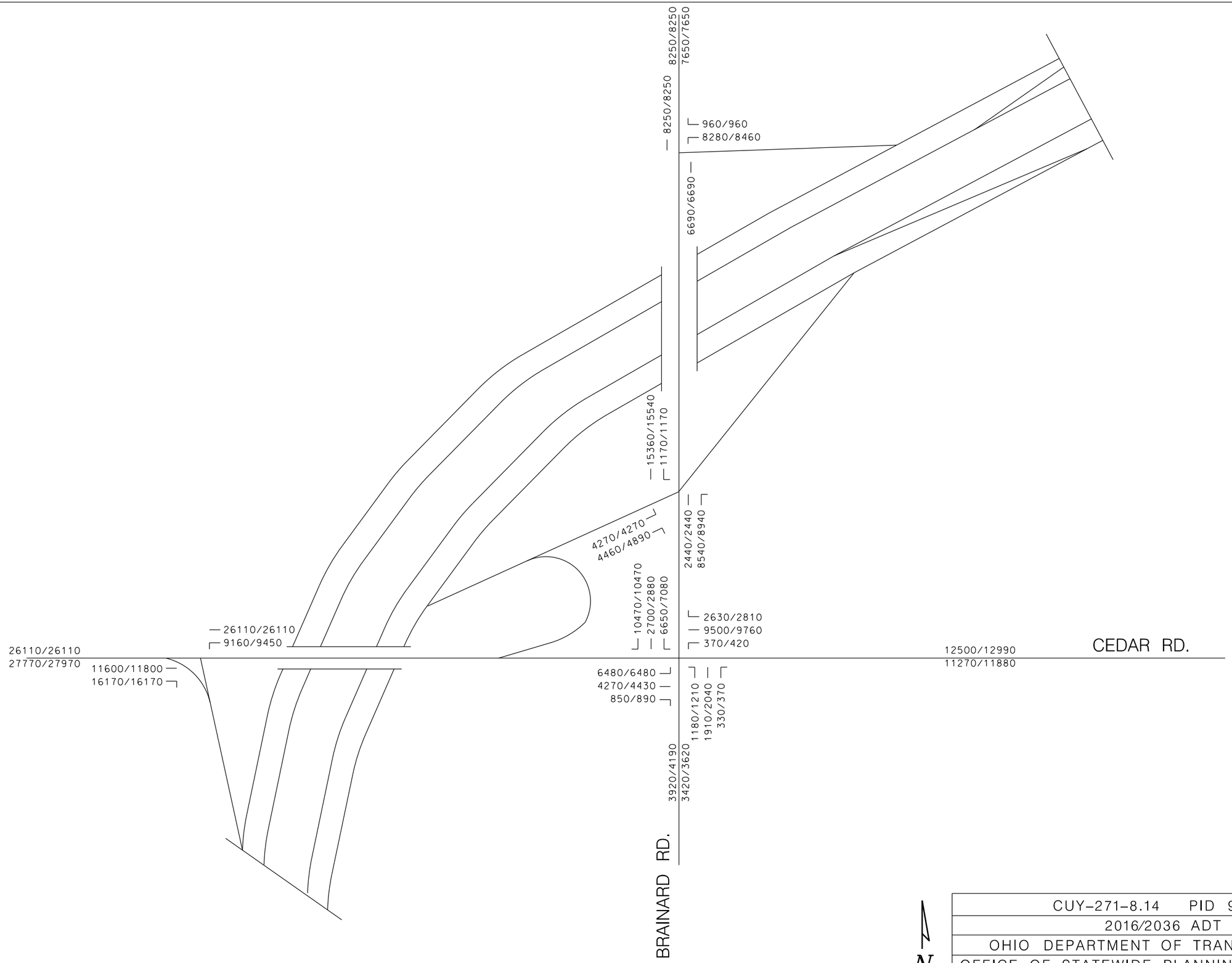
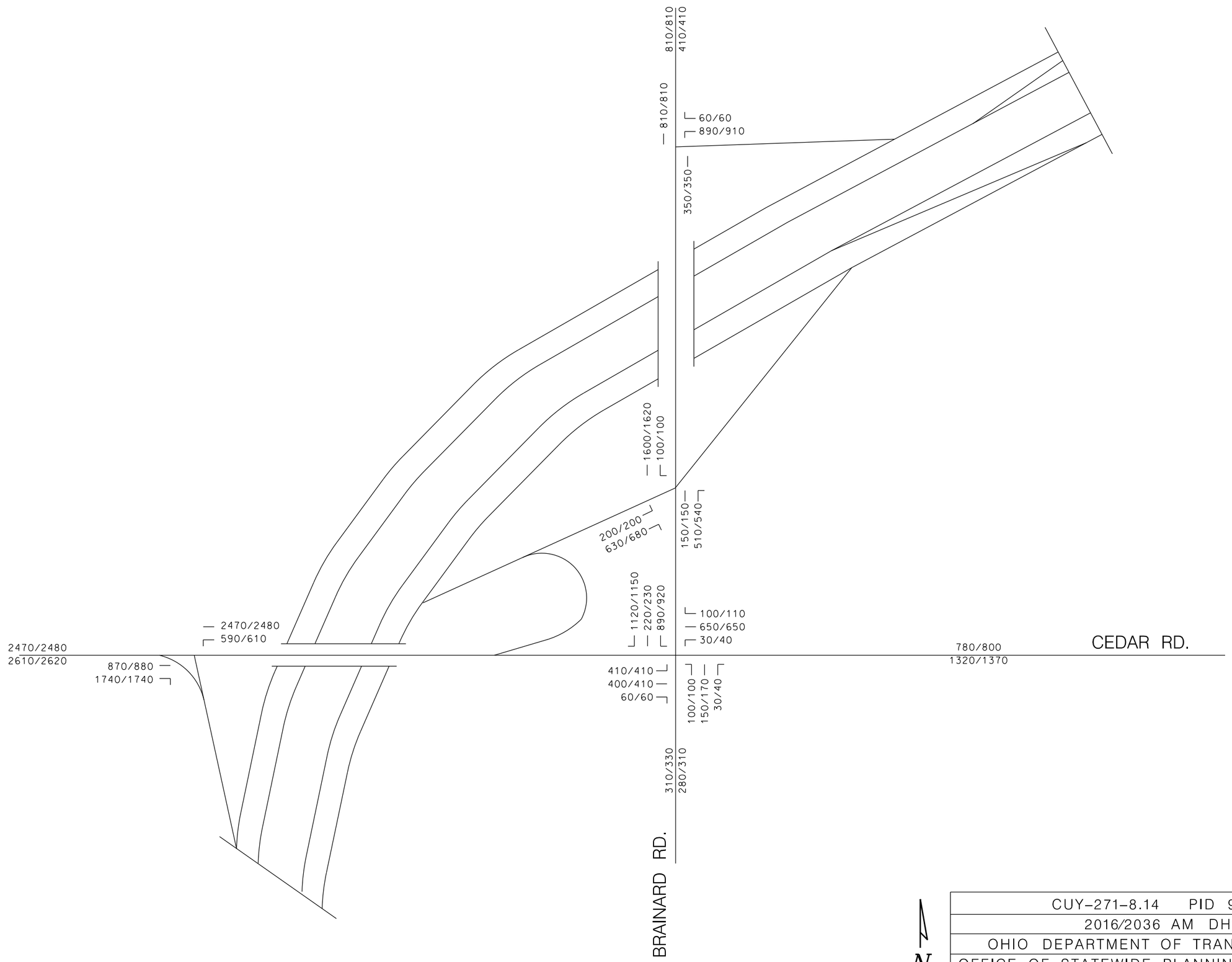
2016/2036 PM DHV	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

CUY–271–8.14
PID 97676
PLATE 4 OF 7



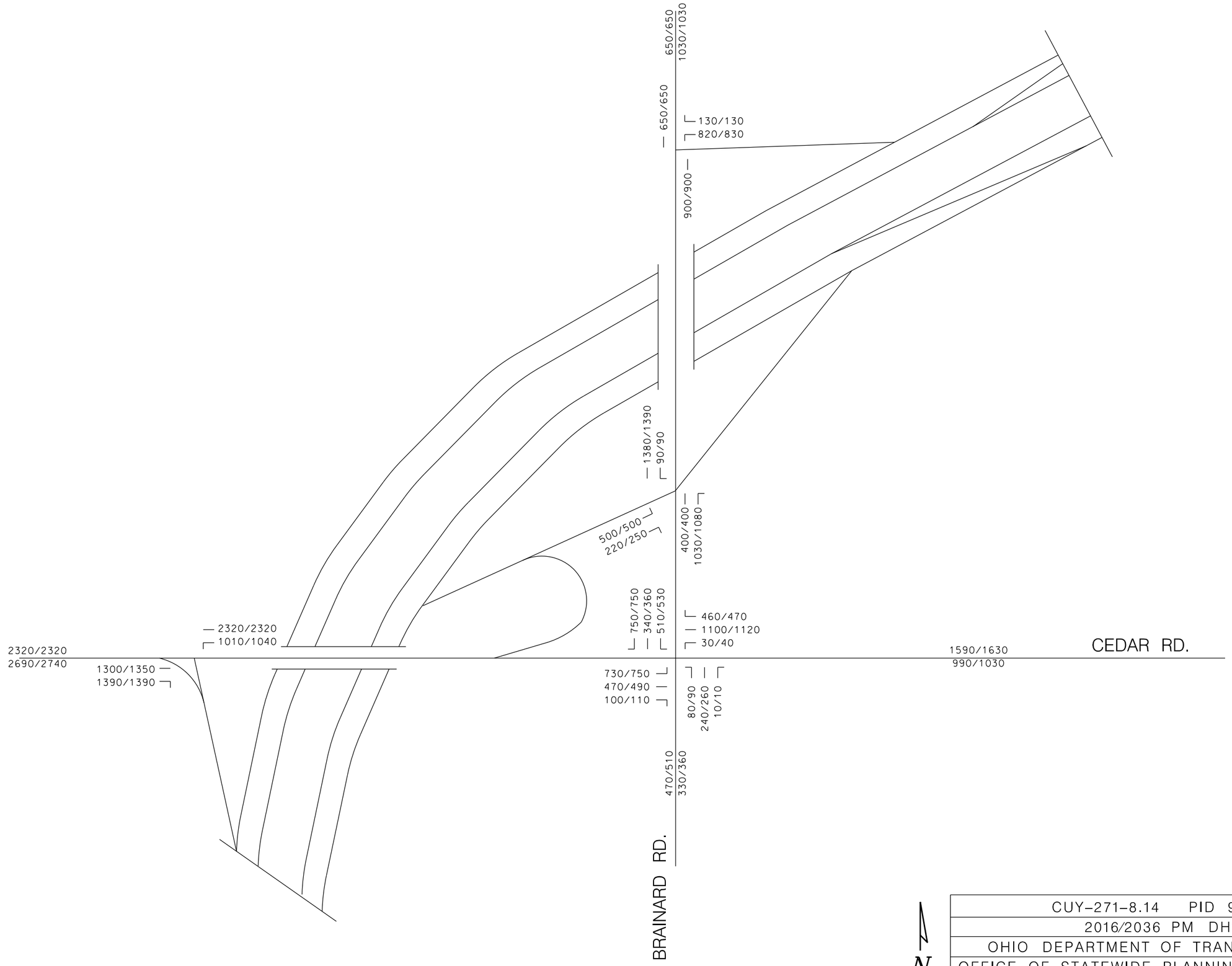
CUY–271–8.14 PID 97676	
2016/2036 ADT	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

CUY–271–8.14
PID 97676
PLATE 5 OF 7



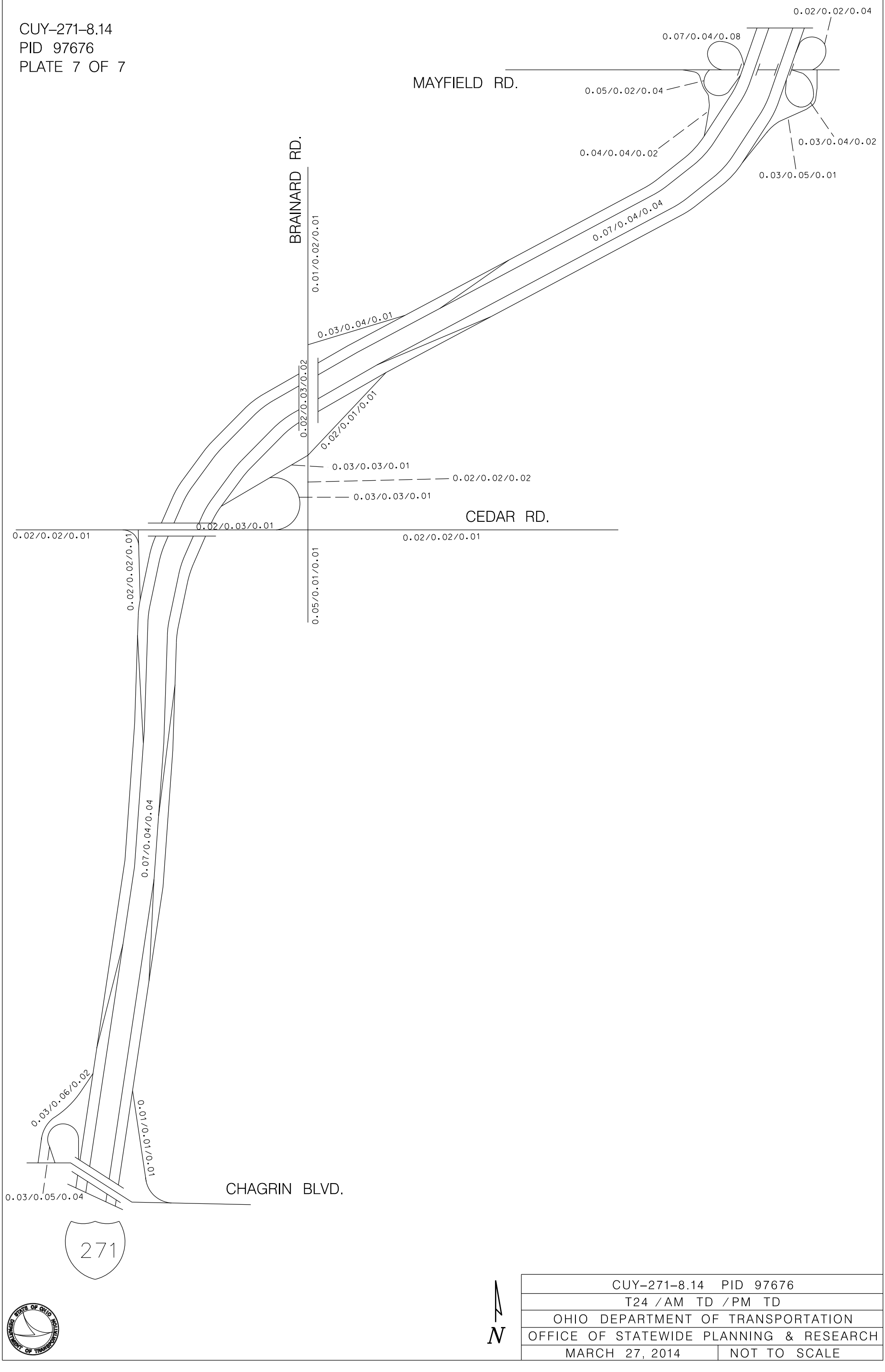
CUY–271–8.14 PID 97676	
2016/2036 AM DHV	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

CUY–271–8.14
PID 97676
PLATE 6 OF 7



CUY–271–8.14 PID 97676	
2016/2036 PM DHV	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

CUY–271–8.14
PID 97676
PLATE 7 OF 7



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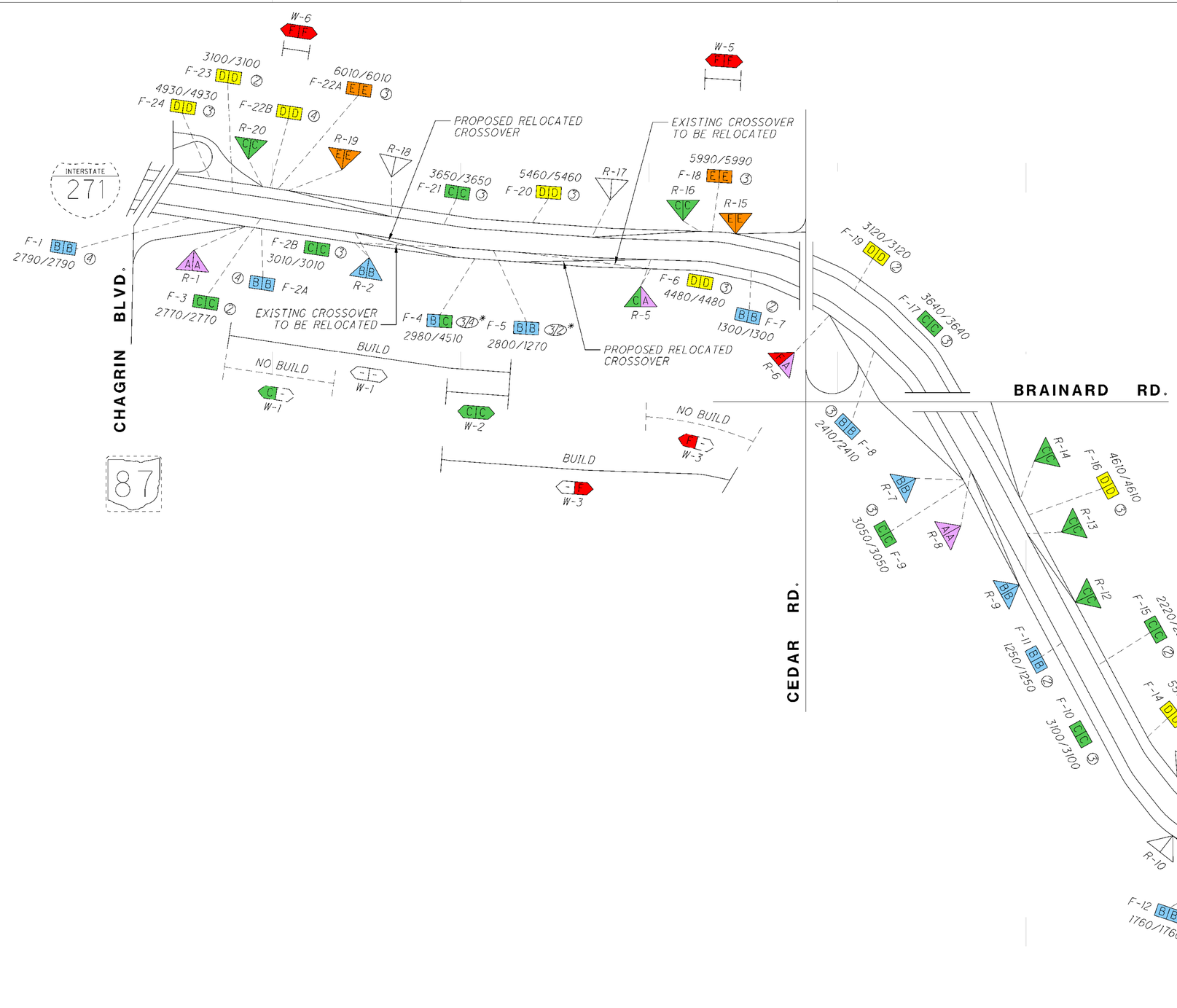
CUY–271–8.14 PID 97676	
T24 /AM TD /PM TD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
MARCH 27, 2014	NOT TO SCALE

Appendix D

HCS Results



NOTES:

1. FREEWAY SEGMENT F-4 IS THREE LANES IN THE NO BUILD CONDITION AND FOUR LANES IN THE BUILD CONDITION. FREEWAY SEGMENT F-5 IS THREE LANES IN THE NO BUILD CONDITION AND TWO LANES IN THE BUILD CONDITION.

LOS GUIDE	LOCATION TYPE	CROSS REFERENCE
A B C D E F	FREEWAY SEGMENT	FREEWAY SEGMENT = F-#
NO-BUILD/BUILD, TRAFFIC VOLUMES	WEAVE SEGMENT	WEAVE SEGMENT = W-#
Ⓧ = # OF LANES	RAMP JUNCTION	RAMP JUNCTION = R-#
* SEE NOTE 1	INTERSECTION	INTERSECTION = I-#

N

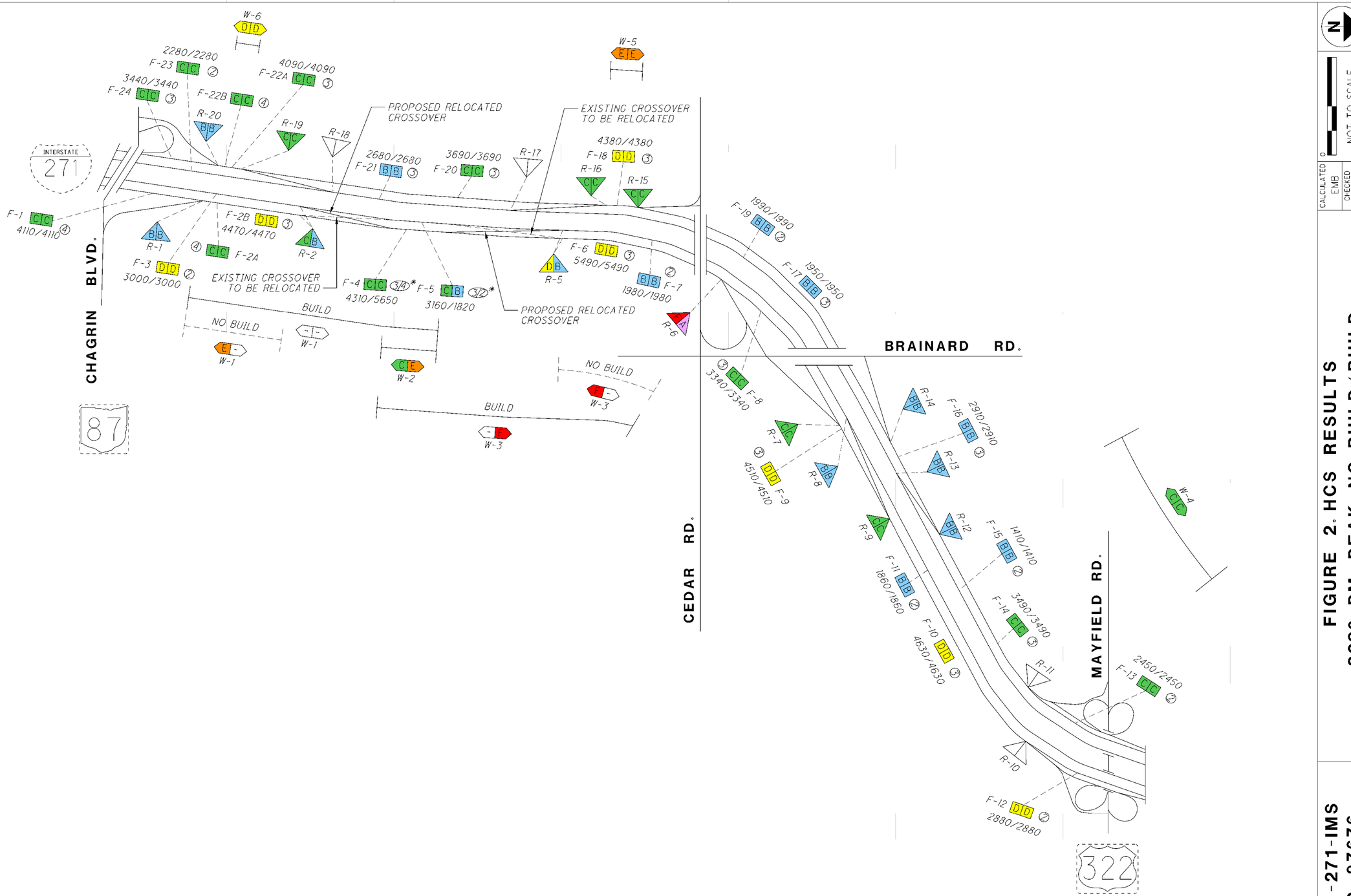
NOT TO SCALE

CALCULATED EMB
CHECKED JRL

FIGURE 1. HCS RESULTS
2036 AM PEAK NO-BUILD/BUILD

CUY-271-IMS
PID 97676

1/4



NOTES:

1. FREEWAY SEGMENT F-4 IS THREE LANES IN THE NO BUILD CONDITION AND FOUR LANES IN THE BUILD CONDITION. FREEWAY SEGMENT F-5 IS THREE LANES IN THE NO BUILD CONDITION AND TWO LANES IN THE BUILD CONDITION.

LOS GUIDE	LOCATION TYPE	CROSS REFERENCE
A B C D E F	FREEWAY SEGMENT	FREEWAY SEGMENT = F-#
NO-BUILD/BUILD, TRAFFIC VOLUMES	WEAVE SEGMENT	WEAVE SEGMENT = W-#
Ⓧ = # OF LANES	RAMP JUNCTION	RAMP JUNCTION = R-#
* SEE NOTE 1	INTERSECTION	INTERSECTION = I-#

FIGURE 2. HCS RESULTS
2036 PM PEAK NO-BUILD/BUILD

CUY-271-IMS
PID 97676

LOS GUIDE

A B C D E F

NO-BUILD/BUILD, TRAFFIC VOLUMES

Ⓧ = # OF LANES

LOCATION TYPE

FREEWAY SEGMENT

WEAVE SEGMENT

RAMP JUNCTION

INTERSECTION

CROSS REFERENCE

FREEWAY SEGMENT = F-#

WEAVE SEGMENT = W-#

RAMP JUNCTION = R-#

INTERSECTION = I-#

N

0 NOT TO SCALE

CALCULATED EMB

CHECKED JRL

FIGURE 3. HCS RESULTS

2036 AM PEAK NO-BUILD/BUILD

CUY-271-IMS

PID 97676

3/4

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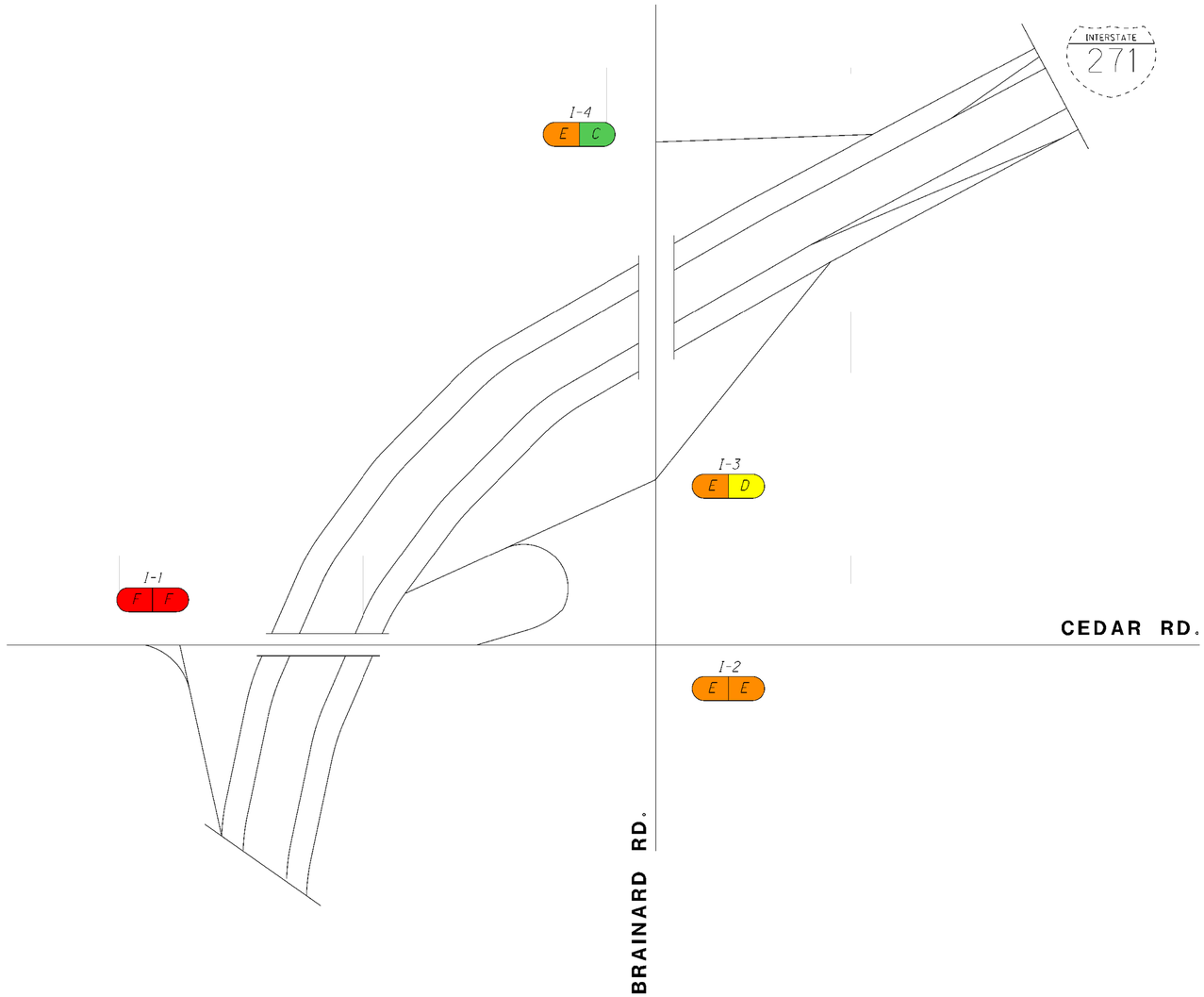

LOS GUIDE

A B C D E F

NO-BUILD/BUILD, TRAFFIC VOLUMES

Ⓧ = # OF LANES

LOCATION TYPE

FREEWAY SEGMENT

WEAVE SEGMENT

RAMP JUNCTION

INTERSECTION

CROSS REFERENCE

FREEWAY SEGMENT = F-#

WEAVE SEGMENT = W-#

RAMP JUNCTION = R-#

INTERSECTION = I-#

N

0 NOT TO SCALE

CALCULATED EMB

CHECKED JRL

FIGURE 4. HCS RESULTS

2036 PM PEAK NO-BUILD/BUILD

CUY-271-IMS

PID 97676

4/4

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HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	Chagrin Blvd to R-1 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-1

Flow Inputs and Adjustments

Volume, V	2790	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	742	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	757	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	757	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	12.6	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-3 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-2a

Flow Inputs and Adjustments

Volume, V	3010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	801	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	817	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	817	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	13.6	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-3 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-2b

Flow Inputs and Adjustments

Volume, V	3010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	801	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1089	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1089	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.1	pc/mi/ln
Level of service, LOS	C	

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	Chagrin Blvd to R-2 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-3

Flow Inputs and Adjustments

Volume, V	2770	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	737	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1503	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1503	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	25.0	pc/mi/ln
Level of service, LOS	C	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-3 Merge to R-4 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-4

Flow Inputs and Adjustments

Volume, V	4510	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1199	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1223	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1223	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	20.4	pc/mi/ln
Level of service, LOS	C	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-2 Diverge to R-5 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-5

Flow Inputs and Adjustments

Volume, V	1270	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	338	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	689	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	689	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	11.5	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-4 Diverge to R-6 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-6

Flow Inputs and Adjustments

Volume, V	4480	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1191	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1620	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1620	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.0	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-5 Merge to R-8 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-7

Flow Inputs and Adjustments

Volume, V	1300	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	346	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	705	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	705	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	11.8	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-6 Diverge to R-7 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-8

Flow Inputs and Adjustments

Volume, V	2410	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	641	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	872	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	872	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	14.5	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-7 Merge to R-9 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-9

Flow Inputs and Adjustments

Volume, V	3050	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	811	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1103	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1103	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.4	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-9 Merge to R-10 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-10

Flow Inputs and Adjustments

Volume, V	3100	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	824	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1121	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1121	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.7	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-8 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-11

Flow Inputs and Adjustments

Volume, V	1250	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	332	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	678	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	678	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	11.3	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-10 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-12

Flow Inputs and Adjustments

Volume, V	1760	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	468	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	955	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	955	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	15.9	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	Mayfield Rd to R-11 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-13

Flow Inputs and Adjustments

Volume, V	4530	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1205	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2458	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	2458	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	46.6	mi/h
Number of lanes, N	2	
Density, D	52.7	pc/mi/ln
Level of service, LOS	F	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-11 Merge to R-12 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-14

Flow Inputs and Adjustments

Volume, V	5510	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1465	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1993	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1993	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	57.2	mi/h
Number of lanes, N	3	
Density, D	34.8	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	Mayfield Rd to R-13 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-15

Flow Inputs and Adjustments

Volume, V	2220	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	590	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1204	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1204	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-12 Diverge to R-14 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-16

Flow Inputs and Adjustments

Volume, V	4610	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1226	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1667	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1667	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	3	
Density, D	27.8	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	Brainard Rd to Cedar Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-17

Flow Inputs and Adjustments

Volume, V	3640	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	968	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1317	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1317	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	22.0	pc/mi/ln
Level of service, LOS	C	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-15 Merge to R-16 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-18

Flow Inputs and Adjustments

Volume, V	5990	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1593	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2167	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	2167	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	54.2	mi/h
Number of lanes, N	3	
Density, D	40.0	pc/mi/ln
Level of service, LOS	E	

HCS 2010: Basic Freeway Segments Release 6.60

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-13 Merge to R-17 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-19

Flow Inputs and Adjustments

Volume, V	3120	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	830	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1693	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1693	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.8	mi/h
Number of lanes, N	2	
Density, D	28.3	pc/mi/ln
Level of service, LOS	D	

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-16 Diverge to R-19 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-20

Flow Inputs and Adjustments

Volume, V	5460	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1452	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1975	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1975	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	57.4	mi/h
Number of lanes, N	3	
Density, D	34.4	pc/mi/ln
Level of service, LOS	D	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-17 Merge to R-18 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-21

Flow Inputs and Adjustments

Volume, V	3650	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	971	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1320	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1320	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	22.0	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-22a

Flow Inputs and Adjustments

Volume, V	6010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1598	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2174	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	2174	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	54.0	mi/h
Number of lanes, N	3	
Density, D	40.2	pc/mi/ln
Level of service, LOS	E	

HCS 2010: Basic Freeway Segments Release 6.60

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-22b

Flow Inputs and Adjustments

Volume, V	6010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1598	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1630	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1630	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	27.2	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-18 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-23

Flow Inputs and Adjustments

Volume, V	3100	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	824	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1682	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1682	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	2	
Density, D	28.1	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-20 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-24

Flow Inputs and Adjustments

Volume, V	4930	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1311	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1783	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1783	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.4	mi/h
Number of lanes, N	3	
Density, D	30.0	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/14/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2790	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	220	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	30	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	4700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2790	220	30	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	775	61	8	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3162	246	33	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.187 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 591 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3408	9200	No
v_3 or v_{av34}	1285 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1264 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1510	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 7.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, M_S = 0.234

Space mean speed in ramp influence area, S_R = 55.8 mph

Space mean speed in outer lanes, S_0 = 58.4 mph

Space mean speed for all vehicles, S = 57.2 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/18/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB (Express Lanes)
Junction:	I-271 NB (Local Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-2

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2770	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	1500	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1500	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3600	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2770	1500	1500	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	769	417	417	v
Trucks and buses	4	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3139	1667	1667	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.605 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2557 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3139	6900	No
$v_{FO} = v - v_R$	1472	6900	No
v_R	1667	2200	No
v_3 or v_{av34}	582 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2557 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2557	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 13.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.253	
Space mean speed in ramp influence area,	S_R = 55.4	mph
Space mean speed in outer lanes,	S_0 = 65.8	mph
Space mean speed for all vehicles,	S = 56.7	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	12/11/14
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB (Express Lanes)
Junction:	I-271 NB (Local Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-5

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1270	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	30	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1500	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3000	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1270	30	1500	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	353	8	417	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1439	34	1667	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1439 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1473	4600	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1439 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	1645	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 7.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, M_S = 0.236

Space mean speed in ramp influence area, S_R = 55.7 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 55.7 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
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Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-6

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4480	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2070	vph
Length of first accel/decel lane	1400	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	640	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4480		2070		640		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1244		575		178		v
Trucks and buses	4		3		1		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.985	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5077	2335	715	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3569 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5077	6900	No
$v_{FO} = v - v_R$	2742	6900	No
v_R	2335	4000	No
v_3 or v_{av34}	1508 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3569 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3569	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 5.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.638

Space mean speed in ramp influence area, S_R = 48.5 mph

Space mean speed in outer lanes, S_0 = 63.8 mph

Space mean speed for all vehicles, S = 52.2 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-7

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2410	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	640	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	50	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2410	640	50	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	669	178	14	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2731	715	56	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 1692 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3446	6900	No
v_3 or v_{av34}	1039 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 1692 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2407	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 14.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.259

Space mean speed in ramp influence area, S_R = 55.3 mph

Space mean speed in outer lanes, S_0 = 58.1 mph

Space mean speed for all vehicles, S = 56.1 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB (Express Lanes)
Junction:	Expressway (Local Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-8

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1300	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1500	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	8000	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1300	50	1500	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	361	14	417	v
Trucks and buses	4	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1473	56	1667	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 1473 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1473	4600	No
$v_{FO} = v - v_F - v_R$	1417	4600	No
v_R	56	2200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 1473 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1473	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 3.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.108	
Space mean speed in ramp influence area,	S_R = 58.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.1	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-9

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3050	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	640	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3050	50	640	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	847	14	178	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3457	56	715	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2142 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3513	6900	No
v_3 or v_{av34}	1315 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2142 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2455	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 15.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.186

Space mean speed in ramp influence area, S_R = 56.6 mph

Space mean speed in outer lanes, S_0 = 58.0 mph

Space mean speed for all vehicles, S = 57.0 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-12

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5510	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	900	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	970	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5510	900	970	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1531	250	269	v
Trucks and buses	4	0	4	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.980	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6245	1000	1099	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 1893.28 (Equation 13-12 or 13-13)

P_{FD} = 0.565 Using Equation 7

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3964 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6245	6900	No
$v_{FO} = v - v_R$	5245	6900	No
v_R	1000	2200	No
v_3 or v_{av34}	2281 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3964 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3964	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 26.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.193

Space mean speed in ramp influence area, S_R = 56.5 mph

Space mean speed in outer lanes, S_0 = 61.6 mph

Space mean speed for all vehicles, S = 58.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB (Express Lanes)
Junction:	I-271 SB (Local Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-13

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2220	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	900	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2220	900		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	617	250		v
Trucks and buses	4	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	
Driver population factor, fP	1.00	1.00	
Flow rate, vp	2516	1000	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM}) =$ 2516 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3516	4600	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2516 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3516	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 23.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.272	
Space mean speed in ramp influence area,	S_R = 55.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 55.1	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-14

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4610	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	970	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	900	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4610		970		900		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1281		269		250		v
Trucks and buses	4		4		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.980	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5225	1099	1000	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.579 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3487 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5225	6900	No
$v_{FO} = v - v_R$	4126	6900	No
v_R	1099	2000	No
v_3 or v_{av34}	1738 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3487 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3487	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 20.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.527

Space mean speed in ramp influence area, S_R = 50.5 mph

Space mean speed in outer lanes, S_0 = 62.9 mph

Space mean speed for all vehicles, S = 54.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Cedar Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-15

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3640	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2350	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	530	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3640	2350	530	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1011	653	147	v
Trucks and buses	4	2	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.990	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4125	2637	589	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2180.67 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2555 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6762	6900	No
v_3 or v_{av34}	1570 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2555 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5192	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 35.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, M_S = 0.917

Space mean speed in ramp influence area, S_R = 43.5 mph

Space mean speed in outer lanes, S_0 = 56.1 mph

Space mean speed for all vehicles, S = 45.9 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-16

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5990	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	530	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	2350	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	5990		530		2350		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1664		147		653		v
Trucks and buses	4		0		2		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	0.990	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6789	589	2637	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 14458.58 Equation 13-12 or 13-13)

P_{FD} = 0.563 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 4081 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6789	6900	No
$v_{FO} = v - v_F - v_R$	6200	6900	No
v_R	589	2200	No
v_3 or v_{av34}	2708 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	Yes	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 4089 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4089	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 27.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.156	
Space mean speed in ramp influence area,	S_R = 57.2	mph
Space mean speed in outer lanes,	S_0 = 60.0	mph
Space mean speed for all vehicles,	S = 58.2	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-19

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5460	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	550	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1080	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5460	550	1080	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1517	153	300	v
Trucks and buses	4	0	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6188	611	1236	pcph

Estimation of V12 Merge Areas

L_{EQ} = 4576.08 (Equation 13-6 or 13-7)

P_{FM} = 0.724 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 4482 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6799	6900	No
v_3 or v_{av34}	1706 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 4482 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5630	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 39.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, M_S = 1.228

Space mean speed in ramp influence area, S_R = 37.9 mph

Space mean speed in outer lanes, S_0 = 57.6 mph

Space mean speed for all vehicles, S = 40.3 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-20

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	6010	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1080	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	550	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	6010		1080		550		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1669		300		153		v
Trucks and buses	4		6		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.971	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6811	1236	611	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 4569.35 (Equation 13-12 or 13-13)

P_{FD} = 0.533 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 4207 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6811	6900	No
$v_{FO} = v - v_R$	5575	6900	No
v_R	1236	2000	No
v_3 or v_{av34}	2604 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4207 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4207	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 26.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.539

Space mean speed in ramp influence area, S_R = 50.3 mph

Space mean speed in outer lanes, S_0 = 59.6 mph

Space mean speed for all vehicles, S = 53.5 mph

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	12/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-1 Merge to R-4 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-1

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	7300	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4290	190	0	30	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1192	53	0	8	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4767	211	0	33	pc/h
Volume ratio, VR		0.007			

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	4	lc/pc
Minimum weaving lane changes, LCMIN	132	lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW	mi/h
Average non-weaving speed, SNW	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	mi/h
Weaving segment density, D	pc/mi/ln
Level of service, LOS	
Weaving segment v/c ratio	
Weaving segment flow rate, v	veh/h
Weaving segment capacity, cW	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5788	7300	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300		c
		Maximum	Analyzed	
v/c ratio		1.00		d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

Undefined LOS in HCS, calculated as LOS D at 5787 ft. Location cannot be analyzed as a weave. See note b.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	12/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 NB (Local Lanes)
Weaving Location:	R-3 Merge to R-4 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-2

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	1400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2980	1500	30	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	828	417	8	0	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3311	1667	33	0	pc/h

Volume ratio, VR	0.339	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	1700	lc/h
Weaving lane changes, LCW	2001	lc/h
Non-weaving vehicle index, INW	278	
Non-weaving lane change, LCNW	670	lc/h
Total lane changes, LCALL	2671	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.376	

Average weaving speed, SW	55.9	mi/h
Average non-weaving speed, SNW	41.7	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	45.7	mi/h
Weaving segment density, D	27.4	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.708	
Weaving segment flow rate, v	5012	veh/h
Weaving segment capacity, cW	7074	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6009	1400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1947	c
		Maximum	Analyzed	
v/c ratio		1.00	0.708	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	12/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-3 Merge to R-6 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-3

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4350	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2440	0	570	1500	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	678	0	158	417	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2711	0	633	1667	pc/h

Volume ratio, VR	0.333	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW	5326	lc/h
Non-weaving vehicle index, INW	873	
Non-weaving lane change, LCNW	2469	lc/h
Total lane changes, LCALL	7795	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.358	

Average weaving speed, SW	56.0	mi/h
Average non-weaving speed, SNW	16.0	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	21.0	mi/h
Weaving segment density, D	79.7	pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	0.861	
Weaving segment flow rate, v	5012	veh/h
Weaving segment capacity, cW	5817	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	9069	4350	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1939	c
		Maximum	Analyzed	
v/c ratio		1.00	0.861	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-11 Merge to R-12 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-4

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4100	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4530	80	0	900	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1258	22	0	250	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5033	89	0	1000	pc/h

Volume ratio, VR	0.163	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	2	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW	2315	lc/h
Non-weaving vehicle index, INW	1260	
Non-weaving lane change, LCNW	2700	lc/h
Total lane changes, LCALL	5015	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.265

Average weaving speed, SW	56.9	mi/h
Average non-weaving speed, SNW	35.8	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	38.1	mi/h
Weaving segment density, D	53.5	pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	0.993	
Weaving segment flow rate, v	6123	veh/h
Weaving segment capacity, cW	6165	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7297	4100	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2055	c
		Maximum	Analyzed	
v/c ratio		1.00	0.993	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-15 Merge to R-16 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-5

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	2400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3640	1820	0	530	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1011	506	0	147	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4044	2022	0	589	pc/h

Volume ratio, VR 0.089

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW		mi/h
Average non-weaving speed, SNW		mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S		mi/h
Weaving segment density, D		pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	1.119	
Weaving segment flow rate, v	6656	veh/h
Weaving segment capacity, cW	5946	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6560	2400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1982	c
		Maximum	Analyzed	
v/c ratio		1.00	1.119	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-19 Merge to R-20 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-6

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	1900	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4930	0	530	550	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1369	0	147	153	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5478	0	589	611	pc/h

Volume ratio, VR 0.091

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW		mi/h
Average non-weaving speed, SNW		mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S		mi/h
Weaving segment density, D		pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	1.147	
Weaving segment flow rate, v	6678	veh/h
Weaving segment capacity, cW	5823	veh/h

Limitations on Weaving Segments

If limit reached, see note.

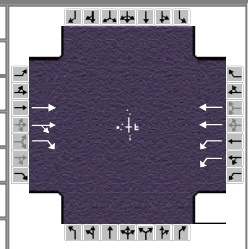
	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6589	1900	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1941	c
		Maximum	Analyzed	
v/c ratio		1.00	1.147	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

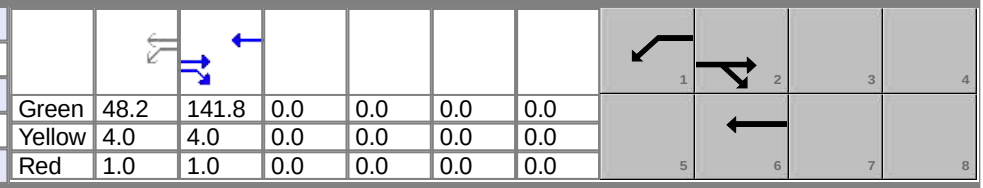
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 25, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak	PHF	0.92
Intersection	I-271 SB On Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name					
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h		880	1740	610	2480							

Signal Information			
Cycle, s	200.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	48.2	141.8	0.0	0.0	0.0	0.0		
Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
Red	1.0	1.0	0.0	0.0	0.0	0.0		

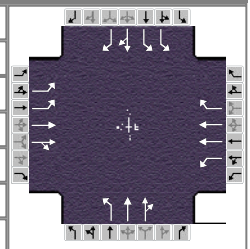
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				
Case Number		7.3	2.0	4.0				
Phase Duration, s		146.8	53.2	200.0				
Change Period, ($Y+R_c$), s		5.0	5.0	5.0				
Max Allow Headway (*MAH*), s		0.0	3.1	0.0				
Queue Clearance Time (g_s), s			50.2					
Green Extension Time (g_e), s		0.0	0.0	0.0				
Phase Call Probability			1.00					
Max Out Probability			1.00					

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6							
Adjusted Flow Rate (*v*), veh/h		957	1891	663	2696							
Adjusted Saturation Flow Rate (*s*), veh/h/ln		950	1579	887	950							
Queue Service Time (g_s), s		59.0	141.8	48.2	195.0							
Cycle Queue Clearance Time (g_c), s		59.0	141.8	48.2	195.0							
Green Ratio (*g/C*)		0.71	0.71	0.24	0.98							
Capacity (*c*), veh/h		1347	1119	428	1853							
Volume-to-Capacity Ratio (*X*)		0.710	1.690	1.551	1.455							
Available Capacity (c_a), veh/h		1347	1119	428	1853							
Back of Queue (*Q*), veh/ln (50th percentile)		13.2	147.9	26.4	53.5							
Queue Storage Ratio (*RQ*) (50th percentile)		0.00	18.79	1.03	0.00							
Uniform Delay (d_1), s/veh		17.1	29.1	75.9	2.5							
Incremental Delay (d_2), s/veh		3.2	314.3	259.2	207.9							
Initial Queue Delay (d_3), s/veh		0.0	0.0	0.0	0.0							
Control Delay (*d*), s/veh		20.2	343.4	335.1	210.4							
Level of Service (LOS)		C	F	F	F							
Approach Delay, s/veh / LOS	234.9	F		235.0	F		0.0			0.0		
Intersection Delay, s/veh / LOS	234.9						F					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	0.5	A	3.0	C	2.9	C
Bicycle LOS Score / LOS	2.8	C	3.3	C				

HCS 2010 Signalized Intersection Results Summary

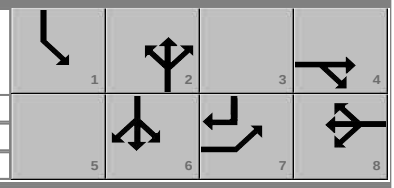
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak Build	PHF	0.92
Intersection	Cedar Rd	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 AM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	410	410	60	40	650	110	100	170	40	920	230	1150

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	32.5	21.5	17.0	29.0	0.0	0.0
Yellow	3.6	3.6	3.6	3.6	0.0	0.0
Red	1.4	1.4	1.4	1.4	0.0	0.0



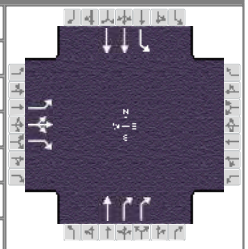
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4		8		2	1	6
Case Number	2.0	4.0		5.3		6.3	1.0	3.0
Phase Duration, s	22.0	56.0		34.0		26.5	37.5	64.0
Change Period, ($Y+R_c$), s	5.0	5.0		5.0		5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.1	3.1		3.1		0.0	3.1	0.0
Queue Clearance Time (g_s), s	17.0	13.3		24.6			21.8	
Green Extension Time (g_e), s	0.0	3.3		1.7		0.0	1.8	0.0
Phase Call Probability	1.00	1.00		1.00			1.00	
Max Out Probability	1.00	0.00		0.73			0.03	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	446	260	251	43	707	120	109	116	113	831	291	956
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757	1863	1779	903	1773	1610	1193	1881	1759	1757	1791	1610
Queue Service Time (g_s), s	15.0	11.2	11.3	4.6	22.6	7.3	9.9	6.5	6.7	19.8	11.4	59.0
Cycle Queue Clearance Time (g_c), s	15.0	11.2	11.3	4.6	22.6	7.3	9.9	6.5	6.7	19.8	11.4	59.0
Green Ratio (*g/C*)	0.14	0.42	0.42	0.24	0.24	0.24	0.18	0.18	0.18	0.47	0.49	0.63
Capacity (*c*), veh/h	498	792	756	278	857	389	274	337	315	1360	880	1020
Volume-to-Capacity Ratio (*X*)	0.895	0.328	0.332	0.156	0.824	0.307	0.397	0.343	0.357	0.611	0.330	0.937
Available Capacity (c_a), veh/h	498	792	756	278	857	389	274	337	315	1360	880	1020
Back of Queue (*Q*), veh/ln (95th percentile)	12.3	8.5	8.3	1.8	15.8	5.2	5.8	5.8	5.7	9.8	6.1	7.4
Queue Storage Ratio (*RQ*) (95th percentile)	0.53	0.00	0.00	0.37	0.00	0.35	0.42	0.00	0.00	0.85	0.00	0.64
Uniform Delay (d_1), s/veh	50.6	23.1	23.1	36.2	43.1	37.3	44.5	43.1	43.2	22.5	17.6	13.1
Incremental Delay (d_2), s/veh	18.0	0.1	0.1	0.1	6.2	0.2	4.3	2.8	3.1	0.1	0.2	4.3
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	68.7	23.1	23.2	36.3	49.3	37.4	48.7	45.8	46.3	22.6	17.8	17.4
Level of Service (LOS)	E	C	C	D	D	D	D	D	D	C	B	B
Approach Delay, s/veh / LOS	44.4	D		47.0	D		46.9	D		19.5	B	
Intersection Delay, s/veh / LOS	32.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	3.0	C	3.0	C	2.9	C
Bicycle LOS Score / LOS	1.3	A	1.2	A	0.8	A	4.6	E

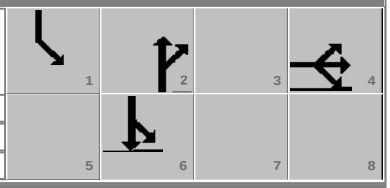
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak Build	PHF	0.92
Intersection	I-271 NB On/Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2 I-3 I-4 CUY-271-8.14 AM Peak_Revised.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	200	1	680					150	540	100	1620	

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	6.0	57.0	42.0	0.0	0.0	0.0
Yellow	3.6	3.6	3.6	0.0	0.0	0.0
Red	1.4	1.4	1.4	0.0	0.0	0.0

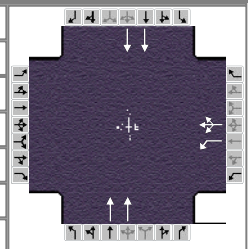
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		9.0				7.3	1.0	4.0
Phase Duration, s		47.0				62.0	11.0	73.0
Change Period, ($Y+R_c$), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.2				0.0	3.1	0.0
Queue Clearance Time (g_s), s		26.2					5.1	
Green Extension Time (g_e), s		1.9				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		0.01					1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	217	371	370					163	587	94	1531	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757	1564	1563					1863	1411	1792	1756	
Queue Service Time (g_s), s	11.0	24.2	24.1					9.6	21.6	3.1	44.4	
Cycle Queue Clearance Time (g_c), s	11.0	24.2	24.1					9.6	21.6	3.1	44.4	
Green Ratio (*g/C*)	0.35	0.35	0.35					0.48	0.48	0.54	0.57	
Capacity (*c*), veh/h	615	547	547					885	1340	636	1990	
Volume-to-Capacity Ratio (*X*)	0.354	0.677	0.675					0.184	0.438	0.149	0.769	
Available Capacity (c_a), veh/h	615	547	547					885	1340	636	1990	
Back of Queue (*Q*), veh/ln (95th percentile)	8.1	14.5	14.4					7.8	12.7	2.2	22.8	
Queue Storage Ratio (*RQ*) (95th percentile)	0.00	0.00	0.00					0.00	0.00	0.17	0.00	
Uniform Delay (d_1), s/veh	28.9	33.2	33.2					32.5	33.1	14.4	27.2	
Incremental Delay (d_2), s/veh	0.1	2.7	2.7					0.3	0.7	0.0	0.8	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0					0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	29.1	36.0	35.9					32.8	33.9	14.4	28.0	
Level of Service (LOS)	C	D	D					C	C	B	C	
Approach Delay, s/veh / LOS	34.4	C		0.0			33.6	C		27.2	C	
Intersection Delay, s/veh / LOS	30.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.5	B	2.4	B	1.9	A
Bicycle LOS Score / LOS	2.1	B			1.7	A	2.0	B

HCS 2010 Signalized Intersection Results Summary

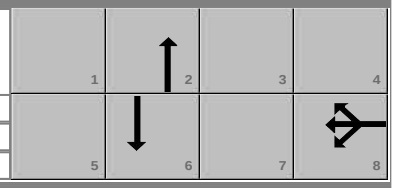
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak Build	PHF	0.92
Intersection	I-271 SB Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 AM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				910	1	60		350			810	

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	61.6	49.4	0.0	0.0	0.0	0.0	
Yellow	3.6	4.0	0.0	0.0	0.0	0.0	
Red	1.4	0.0	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2		6
Case Number				10.0		8.0		8.0
Phase Duration, s				53.4		66.6		66.6
Change Period, ($Y+R_c$), s				4.0		5.0		5.0
Max Allow Headway (*MAH*), s				3.2		0.0		0.0
Queue Clearance Time (g_s), s				31.6				
Green Extension Time (g_e), s				2.4		0.0		0.0
Phase Call Probability				1.00				
Max Out Probability				0.01				

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3	8	18		2			6	
Adjusted Flow Rate (*v*), veh/h				534	521			380			880	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810	1785			1809			1809	
Queue Service Time (g_s), s				29.6	29.1			11.7			18.8	
Cycle Queue Clearance Time (g_c), s				29.6	29.1			11.7			18.8	
Green Ratio (*g/C*)				0.41	0.41			0.51			0.51	
Capacity (*c*), veh/h				745	735			1857			1857	
Volume-to-Capacity Ratio (*X*)				0.717	0.710			0.205			0.474	
Available Capacity (c_a), veh/h				745	735			1857			1857	
Back of Queue (*Q*), veh/ln (95th percentile)				19.1	18.6			9.8			12.4	
Queue Storage Ratio (*RQ*) (95th percentile)				0.00	0.00			0.00			0.00	
Uniform Delay (d_1), s/veh				29.5	29.3			32.0			18.8	
Incremental Delay (d_2), s/veh				2.9	2.7			0.2			0.9	
Initial Queue Delay (d_3), s/veh				0.0	0.0			0.0			0.0	
Control Delay (*d*), s/veh				32.3	32.1			32.2			19.7	
Level of Service (LOS)				C	C			C			B	
Approach Delay, s/veh / LOS	0.0			32.2		C	32.2		C	19.7		B
Intersection Delay, s/veh / LOS	27.4						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.8	C	2.8	C	1.7	A	1.9	A
Bicycle LOS Score / LOS			2.2	B	0.8	A	1.2	A

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	Chagrin Blvd to R-1 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-1

Flow Inputs and Adjustments

Volume, V	2790	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	742	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	757	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	757	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	12.6	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-2 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-2a

Flow Inputs and Adjustments

Volume, V	3010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	801	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	817	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	817	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	13.6	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-2 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-2b

Flow Inputs and Adjustments

Volume, V	3010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	801	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1089	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1089	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.1	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	Chagrin Blvd to R-3 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-3

Flow Inputs and Adjustments

Volume, V	2770	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	737	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1503	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1503	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	25.0	pc/mi/ln
Level of service, LOS	C	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-2 Diverge to R-5 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-4

Flow Inputs and Adjustments

Volume, V	2980	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	793	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1078	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1078	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.0-	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-3 Merge to R4 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-5

Flow Inputs and Adjustments

Volume, V	2800	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	745	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1013	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1013	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	16.9	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-5 Merge to R-6 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-6

Flow Inputs and Adjustments

Volume, V	4480	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1191	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1620	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1620	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.0	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-4 Diverge R-8 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-7

Flow Inputs and Adjustments

Volume, V	1300	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	346	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	705	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	705	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	11.8	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-6 Diverge to R-7 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-8

Flow Inputs and Adjustments

Volume, V	2410	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	641	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	872	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	872	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	14.5	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-7 Merge to R-9 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-9

Flow Inputs and Adjustments

Volume, V	3050	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	811	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1103	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1103	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.4	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-9 Merge to R-10 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-10

Flow Inputs and Adjustments

Volume, V	3100	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	824	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1121	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1121	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	18.7	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-8 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-11

Flow Inputs and Adjustments

Volume, V	1250	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	332	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	678	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	678	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	11.3	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 NB
From/To:	R-10 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-12

Flow Inputs and Adjustments

Volume, V	1760	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	468	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	955	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	955	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	15.9	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	Mayfield Rd to R-11 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-13

Flow Inputs and Adjustments

Volume, V	4530	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1205	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2458	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	2458	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	46.6	mi/h
Number of lanes, N	2	
Density, D	52.7	pc/mi/ln
Level of service, LOS	F	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-11 Merge to R-12 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-14

Flow Inputs and Adjustments

Volume, V	5510	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1465	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1993	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1993	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	57.2	mi/h
Number of lanes, N	3	
Density, D	34.8	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	Mayfield Rd to R-13 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-15

Flow Inputs and Adjustments

Volume, V	2220	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	590	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1204	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1204	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-12 Diverge to R-14 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-16

Flow Inputs and Adjustments

Volume, V	4610	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1226	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1667	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1667	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	3	
Density, D	27.8	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	Brainard Rd to Cedar Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-17

Flow Inputs and Adjustments

Volume, V	3640	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	968	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1317	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1317	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	22.0	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-15 Merge to R-16 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-18

Flow Inputs and Adjustments

Volume, V	5990	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1593	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2167	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	2167	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	54.2	mi/h
Number of lanes, N	3	
Density, D	40.0	pc/mi/ln
Level of service, LOS	E	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-13 Merge to R-17 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-19

Flow Inputs and Adjustments

Volume, V	3120	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	830	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1693	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1693	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.8	mi/h
Number of lanes, N	2	
Density, D	28.3	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-16 Diverge to R-19 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-20

Flow Inputs and Adjustments

Volume, V	5460	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1452	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1975	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1975	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	57.4	mi/h
Number of lanes, N	3	
Density, D	34.4	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-17 Merge to R-18 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-21

Flow Inputs and Adjustments

Volume, V	3650	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	971	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1320	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1320	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	22.0	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-22a

Flow Inputs and Adjustments

Volume, V	6010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1598	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	2174	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	2174	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	54.0	mi/h
Number of lanes, N	3	
Density, D	40.2	pc/mi/ln
Level of service, LOS	E	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-22b

Flow Inputs and Adjustments

Volume, V	6010	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1598	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1630	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1630	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	27.2	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-18 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-23

Flow Inputs and Adjustments

Volume, V	3100	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	824	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1682	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1682	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	2	
Density, D	28.1	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	AM Peak
Freeway/Direction:	I-271 SB
From/To:	R-20 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-24

Flow Inputs and Adjustments

Volume, V	4930	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1311	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1783	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1783	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.4	mi/h
Number of lanes, N	3	
Density, D	30.0	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/14/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2790	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	220	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	30	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	4700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2790	220	30	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	775	61	8	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3162	246	33	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.187 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 591 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3408	9200	No
v_3 or v_{av34}	1285 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1264 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1510	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 7.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, M_S = 0.234

Space mean speed in ramp influence area, S_R = 55.8 mph

Space mean speed in outer lanes, S_0 = 58.4 mph

Space mean speed for all vehicles, S = 57.2 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/18/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-2

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3010	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	30	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1500	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3600	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	3010		30		1500		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	836		8		417		v
Trucks and buses	4		0		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3411	33	1667	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.673 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2307 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3411	6900	No
$v_{FO} = v - v_R$	3378	6900	No
v_R	33	2200	No
v_3 or v_{av34}	1104 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2307 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2307	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 18.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.106

Space mean speed in ramp influence area, S_R = 58.1 mph

Space mean speed in outer lanes, S_0 = 65.8 mph

Space mean speed for all vehicles, S = 60.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/18/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-5

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2980	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	1500	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	30	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3600	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2980	1500	30	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	828	417	8	v
Trucks and buses	4	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3377	1667	33	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2481.62 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2092 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5044	6900	No
v_3 or v_{av34}	1285 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2092 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4010	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 26.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.356

Space mean speed in ramp influence area, S_R = 53.6 mph

Space mean speed in outer lanes, S_0 = 58.1 mph

Space mean speed for all vehicles, S = 54.5 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-6

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4480	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2070	vph
Length of first accel/decel lane	1400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	640	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4480		2070		640		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1244		575		178		v
Trucks and buses	4		3		1		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.985	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5077	2335	715	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.526 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3776 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5077	6900	No
$v_{FO} = v - v_F - v_R$	2742	6900	No
v_R	2335	2000	Yes
v_3 or v_{av34}	1301 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3776 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3776	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 24.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.638	
Space mean speed in ramp influence area,	S_R = 48.5	mph
Space mean speed in outer lanes,	S_0 = 64.6	mph
Space mean speed for all vehicles,	S = 51.8	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-7

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2410	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	640	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	50	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2410	640	50	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	669	178	14	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2731	715	56	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 1692 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3446	6900	No
v_3 or v_{av34}	1039 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 1692 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2407	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 14.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.259

Space mean speed in ramp influence area, S_R = 55.3 mph

Space mean speed in outer lanes, S_0 = 58.1 mph

Space mean speed for all vehicles, S = 56.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-8

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1300	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1500	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	8000	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	1300		50		1500		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	361		14		417		v
Trucks and buses	4		0		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1473	56	1667	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD} = 1473$ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1473	4600	No
$v_{FO} = v - v_F - v_R$	1417	4600	No
v_R	56	2200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1473 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1473	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 3.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.108

Space mean speed in ramp influence area, S_R = 58.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 58.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-9

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3050	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	640	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3050	50	640	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	847	14	178	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3457	56	715	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2142 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3513	6900	No
v_3 or v_{av34}	1315 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2142 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2455	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 15.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.186

Space mean speed in ramp influence area, S_R = 56.6 mph

Space mean speed in outer lanes, S_0 = 58.0 mph

Space mean speed for all vehicles, S = 57.0 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-12

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5510	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	900	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	970	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	5510		900		970		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1531		250		269		v
Trucks and buses	4		0		4		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	0.980	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6245	1000	1099	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 1893.28 (Equation 13-12 or 13-13)

P_{FD} = 0.565 Using Equation 7

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3964 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6245	6900	No
$v_{FO} = v - v_R$	5245	6900	No
v_R	1000	2200	No
v_3 or v_{av34}	2281 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3964 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3964	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 26.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.193

Space mean speed in ramp influence area, S_R = 56.5 mph

Space mean speed in outer lanes, S_0 = 61.6 mph

Space mean speed for all vehicles, S = 58.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-13

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2220	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	900	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2220	900		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	617	250		v
Trucks and buses	4	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		

Heavy vehicle adjustment, fHV 0.980 1.000
Driver population factor, fP 1.00 1.00
Flow rate, vp 2516 1000 pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 1.000 Using Equation 0
v_{12} = v_F (P_{FM}) = 2516 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3516	4600	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2516 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3516	4600	No

Level of Service Determination (if not F)

Density, $D = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 23.0 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.272
Space mean speed in ramp influence area, S_R = 55.1 mph
Space mean speed in outer lanes, S_0 = N/A mph
Space mean speed for all vehicles, S = 55.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-14

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4610	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	970	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	900	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4610		970		900		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1281		269		250		v
Trucks and buses	4		4		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.980	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5225	1099	1000	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.579 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3487 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5225	6900	No
$v_{FO} = v - v_R$	4126	6900	No
v_R	1099	2000	No
v_3 or v_{av34}	1738 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3487 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3487	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 20.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.527

Space mean speed in ramp influence area, S_R = 50.5 mph

Space mean speed in outer lanes, S_0 = 62.9 mph

Space mean speed for all vehicles, S = 54.1 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Cedar Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-15

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3640	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2350	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	530	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3640	2350	530	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1011	653	147	v
Trucks and buses	4	2	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.990	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4125	2637	589	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2180.67 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2555 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6762	6900	No
v_3 or v_{av34}	1570 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2555 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5192	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 35.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, M_S = 0.917

Space mean speed in ramp influence area, S_R = 43.5 mph

Space mean speed in outer lanes, S_0 = 56.1 mph

Space mean speed for all vehicles, S = 45.9 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-16

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5990	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	530	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	2350	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	5990		530		2350		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1664		147		653		v
Trucks and buses	4		0		2		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	0.990	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6789	589	2637	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 14458.58 Equation 13-12 or 13-13)

P_{FD} = 0.563 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 4081 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6789	6900	No
$v_{FO} = v - v_F - v_R$	6200	6900	No
v_R	589	2200	No
v_3 or v_{av34}	2708 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	Yes	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 4089 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4089	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 27.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.156	
Space mean speed in ramp influence area,	S_R = 57.2	mph
Space mean speed in outer lanes,	S_0 = 60.0	mph
Space mean speed for all vehicles,	S = 58.2	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-19

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5460	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	550	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1080	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5460	550	1080	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1517	153	300	v
Trucks and buses	4	0	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6188	611	1236	pcph

Estimation of V12 Merge Areas

L_{EQ} = 4576.08 (Equation 13-6 or 13-7)

P_{FM} = 0.724 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 4482 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6799	6900	No
v_3 or v_{av34}	1706 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 4482 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5630	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 39.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable, M_S = 1.228

Space mean speed in ramp influence area, S_R = 37.9 mph

Space mean speed in outer lanes, S_0 = 57.6 mph

Space mean speed for all vehicles, S = 40.3 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-20

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	6010	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1080	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	550	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	6010	1080	550	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1669	300	153	v
Trucks and buses	4	6	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.971	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6811	1236	611	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 4569.35 (Equation 13-12 or 13-13)

P_{FD} = 0.533 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 4207 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6811	6900	No
$v_{FO} = v - v_R$	5575	6900	No
v_R	1236	2000	No
v_3 or v_{av34}	2604 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4207 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4207	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 26.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.539

Space mean speed in ramp influence area, S_R = 50.3 mph

Space mean speed in outer lanes, S_0 = 59.6 mph

Space mean speed for all vehicles, S = 53.5 mph

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-1 Merge to R-2 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-1

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4000	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2790	190	0	30	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	775	53	0	8	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3100	211	0	33	pc/h

Volume ratio, VR	0.010	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	4	lc/pc
Minimum weaving lane changes, LCMIN	132	lc/h
Weaving lane changes, LCW	443	lc/h
Non-weaving vehicle index, INW	795	
Non-weaving lane change, LCNW	2272	lc/h
Total lane changes, LCALL	2715	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.166	

Average weaving speed, SW	57.9	mi/h
Average non-weaving speed, SNW	53.7	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	53.7	mi/h
Weaving segment density, D	20.7	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.516	
Weaving segment flow rate, v	3345	veh/h
Weaving segment capacity, cW	6483	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5819	4000	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2161	c
		Maximum	Analyzed	
v/c ratio		1.00	0.516	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 NB (Expressway)
Weaving Location:	R-3 Merge to R-4 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-2

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	1400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1270	30	1500	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	353	8	417	0	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1411	33	1667	0	pc/h

Volume ratio, VR	0.546	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	1700	lc/h
Weaving lane changes, LCW	1870	lc/h
Non-weaving vehicle index, INW	119	
Non-weaving lane change, LCNW	472	lc/h
Total lane changes, LCALL	2342	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.339	

Average weaving speed, SW	56.2	mi/h
Average non-weaving speed, SNW	42.8	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	49.2	mi/h
Weaving segment density, D	21.1	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.708	
Weaving segment flow rate, v	3112	veh/h
Weaving segment capacity, cW	4392	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	8374	1400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1766	c
		Maximum	Analyzed	
v/c ratio		1.00	0.708	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/25/2014
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-5 Merge to R-6 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-3

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	3300	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2410	0	570	1500	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	669	0	158	417	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2678	0	633	1667	pc/h

Volume ratio, VR	0.335	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW	5281	lc/h
Non-weaving vehicle index, INW	656	
Non-weaving lane change, LCNW	1893	lc/h
Total lane changes, LCALL	7174	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.417	

Average weaving speed, SW	55.6	mi/h
Average non-weaving speed, SNW	16.0	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	21.0	mi/h
Weaving segment density, D	78.9	pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	0.894	
Weaving segment flow rate, v	4978	veh/h
Weaving segment capacity, cW	5571	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	9093	3300	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1857	c
		Maximum	Analyzed	
v/c ratio		1.00	0.894	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-11 Merge to R-12 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-4

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4100	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4530	80	0	900	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1258	22	0	250	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5033	89	0	1000	pc/h

Volume ratio, VR	0.163	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	2	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW	2315	lc/h
Non-weaving vehicle index, INW	1260	
Non-weaving lane change, LCNW	2700	lc/h
Total lane changes, LCALL	5015	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.265	

Average weaving speed, SW	56.9	mi/h
Average non-weaving speed, SNW	35.8	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	38.1	mi/h
Weaving segment density, D	53.5	pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	0.993	
Weaving segment flow rate, v	6123	veh/h
Weaving segment capacity, cW	6165	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7297	4100	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2055	c
		Maximum	Analyzed	
v/c ratio		1.00	0.993	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-15 Merge to R-16 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-5

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	2400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3640	1820	0	530	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1011	506	0	147	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4044	2022	0	589	pc/h

Volume ratio, VR 0.089

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW		mi/h
Average non-weaving speed, SNW		mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S		mi/h
Weaving segment density, D		pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	1.119	
Weaving segment flow rate, v	6656	veh/h
Weaving segment capacity, cW	5946	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6560	2400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1982	c
		Maximum	Analyzed	
v/c ratio		1.00	1.119	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	AM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-19 Merge to R-20 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-6

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	1900	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4930	0	530	550	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1369	0	147	153	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5478	0	589	611	pc/h

Volume ratio, VR 0.091

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW		mi/h
Average non-weaving speed, SNW		mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S		mi/h
Weaving segment density, D		pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	1.147	
Weaving segment flow rate, v	6678	veh/h
Weaving segment capacity, cW	5823	veh/h

Limitations on Weaving Segments

If limit reached, see note.

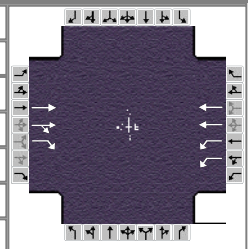
	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6589	1900	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1941	c
		Maximum	Analyzed	
v/c ratio		1.00	1.147	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

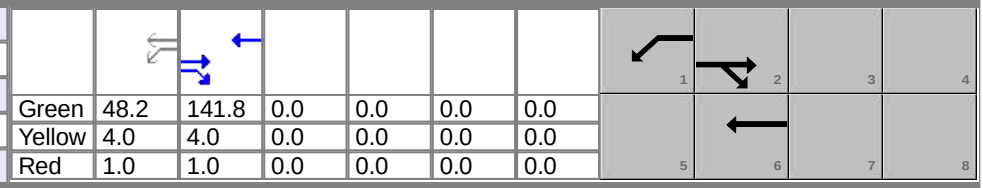
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 25, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak No Build	PHF	0.92
Intersection	I-271 SB On Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name					
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h		880	1740	610	2480							

Signal Information			
Cycle, s	200.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	48.2	141.8	0.0	0.0	0.0	0.0		
Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
Red	1.0	1.0	0.0	0.0	0.0	0.0		

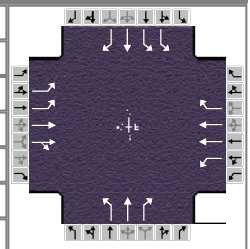
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				
Case Number		7.3	2.0	4.0				
Phase Duration, s		146.8	53.2	200.0				
Change Period, ($Y+R_c$), s		5.0	5.0	5.0				
Max Allow Headway (*MAH*), s		0.0	3.1	0.0				
Queue Clearance Time (g_s), s			50.2					
Green Extension Time (g_e), s		0.0	0.0	0.0				
Phase Call Probability			1.00					
Max Out Probability			1.00					

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6							
Adjusted Flow Rate (*v*), veh/h		957	1891	663	2696							
Adjusted Saturation Flow Rate (*s*), veh/h/ln		950	1579	887	950							
Queue Service Time (g_s), s		59.0	141.8	48.2	195.0							
Cycle Queue Clearance Time (g_c), s		59.0	141.8	48.2	195.0							
Green Ratio (*g/C*)		0.71	0.71	0.24	0.98							
Capacity (*c*), veh/h		1347	1119	428	1853							
Volume-to-Capacity Ratio (*X*)		0.710	1.690	1.551	1.455							
Available Capacity (c_a), veh/h		1347	1119	428	1853							
Back of Queue (*Q*), veh/ln (95th percentile)		19.1	234.6	42.3	86.9							
Queue Storage Ratio (*RQ*) (95th percentile)		0.00	29.80	1.65	0.00							
Uniform Delay (d_1), s/veh		17.1	29.1	75.9	2.5							
Incremental Delay (d_2), s/veh		3.2	314.3	259.2	207.9							
Initial Queue Delay (d_3), s/veh		0.0	0.0	0.0	0.0							
Control Delay (*d*), s/veh		20.2	343.4	335.1	210.4							
Level of Service (LOS)		C	F	F	F							
Approach Delay, s/veh / LOS	234.9	F		235.0	F		0.0			0.0		
Intersection Delay, s/veh / LOS	234.9						F					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	0.5	A	3.0	C	2.9	C
Bicycle LOS Score / LOS	2.8	C	3.3	C				

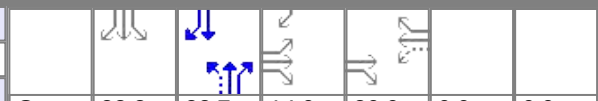
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak No Build	PHF	0.92
Intersection	Cedar Rd	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 AM Peak.xus				
Project Description					

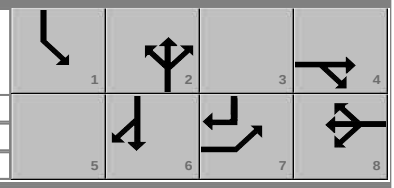


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	410	410	60	40	650	110	100	170	40	920	230	1150

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	33.3	22.7	14.0	30.0	0.0	0.0
Yellow	3.6	3.6	3.6	3.6	0.0	0.0
Red	1.4	1.4	1.4	1.4	0.0	0.0



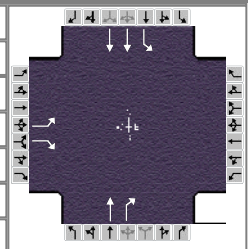
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4		8		2	1	6
Case Number	2.0	4.0		5.3		5.3	2.0	3.0
Phase Duration, s	19.0	54.0		35.0		27.7	38.3	66.0
Change Period, ($Y+R_c$), s	5.0	5.0		5.0		5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.1	3.1		3.1		0.0	3.1	0.0
Queue Clearance Time (g_s), s	16.0	13.7		24.4			33.8	
Green Extension Time (g_e), s	0.0	3.3		2.0		0.0	0.0	0.0
Phase Call Probability	1.00	1.00		1.00			1.00	
Max Out Probability	1.00	0.00		0.53			1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	446	260	251	43	707	120	109	185	43	939	235	1174
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757	1863	1779	903	1773	1610	1164	1881	1610	1757	1863	1610
Queue Service Time (g_s), s	14.0	11.5	11.7	4.6	22.4	7.2	10.0	10.6	2.7	31.8	8.6	61.0
Cycle Queue Clearance Time (g_c), s	14.0	11.5	11.7	4.6	22.4	7.2	10.0	10.6	2.7	31.8	8.6	61.0
Green Ratio (*g/C*)	0.12	0.41	0.41	0.25	0.25	0.25	0.19	0.19	0.19	0.28	0.51	0.63
Capacity (*c*), veh/h	410	761	727	286	887	403	280	356	305	975	947	1006
Volume-to-Capacity Ratio (*X*)	1.087	0.342	0.345	0.152	0.797	0.297	0.388	0.519	0.143	0.963	0.248	1.166
Available Capacity (c_a), veh/h	410	761	727	286	887	403	280	356	305	975	947	1006
Back of Queue (*Q*), veh/ln (50th percentile)	10.1	5.0	4.9	1.0	10.2	2.8	3.2	5.4	1.2	14.6	3.6	44.2
Queue Storage Ratio (*RQ*) (50th percentile)	0.43	0.00	0.00	0.20	0.00	0.19	0.23	0.00	0.29	1.26	0.00	3.81
Uniform Delay (d_1), s/veh	53.0	24.4	24.5	35.5	42.1	36.5	43.5	43.7	40.5	46.8	16.9	21.5
Incremental Delay (d_2), s/veh	69.9	0.1	0.1	0.1	4.7	0.2	4.0	5.3	1.0	3.3	0.1	75.9
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	122.9	24.5	24.6	35.5	46.9	36.6	47.5	49.1	41.5	50.1	16.9	97.4
Level of Service (LOS)	F	C	C	D	D	D	D	D	D	D	B	F
Approach Delay, s/veh / LOS	70.4	E		44.9	D		47.6	D		70.5	E	
Intersection Delay, s/veh / LOS	63.8						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	3.0	C	3.0	C	2.9	C
Bicycle LOS Score / LOS	1.3	A	1.2	A	1.0	A	4.6	E

HCS 2010 Signalized Intersection Results Summary

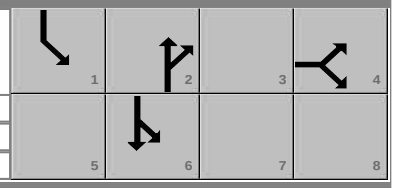
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak No Build	PHF	0.92
Intersection	I-271 NB On/Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 AM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	200		680					150	540	100	1620	

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	6.0	45.3	53.7	0.0	0.0	0.0	
Yellow	3.6	3.6	3.6	0.0	0.0	0.0	
Red	1.4	1.4	1.4	0.0	0.0	0.0	



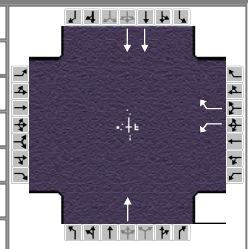
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		9.0				7.3	1.0	4.0
Phase Duration, s		58.7				50.3	11.0	61.3
Change Period, ($Y+R_c$), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.3				0.0	3.1	0.0
Queue Clearance Time (g_s), s		55.7					6.3	
Green Extension Time (g_e), s		0.0				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		1.00					1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	217		739					155	559	109	1761	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757		1563					1863	1594	1792	1756	
Queue Service Time (g_s), s	9.4		53.7					9.3	41.3	4.3	56.3	
Cycle Queue Clearance Time (g_c), s	9.4		53.7					9.3	41.3	4.3	56.3	
Green Ratio (*g/C*)	0.45		0.45					0.38	0.38	0.44	0.47	
Capacity (*c*), veh/h	786		700					703	602	522	1648	
Volume-to-Capacity Ratio (*X*)	0.277		1.057					0.221	0.929	0.208	1.069	
Available Capacity (c_a), veh/h	786		700					703	602	522	1648	
Back of Queue (*Q*), veh/ln (50th percentile)	3.8		29.1					4.6	21.9	1.8	32.0	
Queue Storage Ratio (*RQ*) (50th percentile)	0.00		0.00					0.00	0.00	0.14	0.00	
Uniform Delay (d_1), s/veh	20.9		33.2					38.1	45.3	20.7	34.9	
Incremental Delay (d_2), s/veh	0.1		49.9					0.3	12.9	0.0	37.2	
Initial Queue Delay (d_3), s/veh	0.0		0.0					0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	21.0		83.1					38.4	58.2	20.7	72.1	
Level of Service (LOS)	C		F					D	E	C	F	
Approach Delay, s/veh / LOS	69.0		E	0.0			53.9		D	69.1		E
Intersection Delay, s/veh / LOS	66.0						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.8	C	2.5	B	1.9	A	1.7	A
Bicycle LOS Score / LOS		F			1.7	A	2.0	B

HCS 2010 Signalized Intersection Results Summary

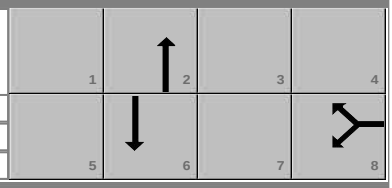
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	AM Peak No Build	PHF	0.92
Intersection	I-271 SB Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 AM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				910		60		350			810	

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	44.7	66.3	0.0	0.0	0.0	0.0	
Yellow	3.6	4.0	0.0	0.0	0.0	0.0	
Red	1.4	0.0	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2		6
Case Number				9.0		8.0		8.0
Phase Duration, s				70.3		49.7		49.7
Change Period, ($Y+R_c$), s				4.0		5.0		5.0
Max Allow Headway (*MAH*), s				3.1		0.0		0.0
Queue Clearance Time (g_s), s				66.7				
Green Extension Time (g_e), s				0.0		0.0		0.0
Phase Call Probability				1.00				
Max Out Probability				1.00				

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2			6	
Adjusted Flow Rate (*v*), veh/h				989		65		373			880	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1900			1809	
Queue Service Time (g_s), s				64.7		2.3		23.0			24.2	
Cycle Queue Clearance Time (g_c), s				64.7		2.3		23.0			24.2	
Green Ratio (*g/C*)				0.55		0.55		0.37			0.37	
Capacity (*c*), veh/h				1000		890		708			1348	
Volume-to-Capacity Ratio (*X*)				0.989		0.073		0.527			0.653	
Available Capacity (c_a), veh/h				1000		890		708			1348	
Back of Queue (*Q*), veh/ln (50th percentile)				32.9		0.8		12.5			10.8	
Queue Storage Ratio (*RQ*) (50th percentile)				0.00		0.06		0.00			0.00	
Uniform Delay (d_1), s/veh				26.5		12.5		46.8			31.2	
Incremental Delay (d_2), s/veh				25.7		0.0		2.7			2.5	
Initial Queue Delay (d_3), s/veh				0.0		0.0		0.0			0.0	
Control Delay (*d*), s/veh				52.2		12.5		49.5			33.7	
Level of Service (LOS)				D		B		D			C	
Approach Delay, s/veh / LOS	0.0			49.8		D	49.5		D	33.7		C
Intersection Delay, s/veh / LOS	43.6						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.6	B	2.3	B	1.7	A	0.7	A
Bicycle LOS Score / LOS				F	1.1	A	1.2	A

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	Chagrin Blvd to R-1 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-1

Flow Inputs and Adjustments

Volume, V	4110	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1093	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1115	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1115	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	18.6	pc/mi/ln
Level of service, LOS	C	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-3 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-2a

Flow Inputs and Adjustments

Volume, V	4470	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1189	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1213	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1213	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	20.2	pc/mi/ln
Level of service, LOS	C	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-3 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-2b

Flow Inputs and Adjustments

Volume, V	4470	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1189	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1617	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1617	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.0	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	Chagrin Blvd to R-2 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-3

Flow Inputs and Adjustments

Volume, V	3000	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	798	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1628	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1628	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	27.1	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	12/19/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-3 Merge to R-4 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-4

Flow Inputs and Adjustments

Volume, V	5650	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1503	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1533	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1533	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	25.5	pc/mi/ln
Level of service, LOS	C	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-2 Diverge to R-5 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-5

Flow Inputs and Adjustments

Volume, V	1820	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	484	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	987	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	987	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	16.5	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-4 Diverge to R-6 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-6

Flow Inputs and Adjustments

Volume, V	5490	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1460	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1986	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1986	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	57.3	mi/h
Number of lanes, N	3	
Density, D	34.7	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-5 Merge to R-8 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-7

Flow Inputs and Adjustments

Volume, V	1980	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	527	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1074	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1074	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	17.9	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-6 Diverge to R-7 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-8

Flow Inputs and Adjustments

Volume, V	3340	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	888	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-7 Merge to R-9 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-9

Flow Inputs and Adjustments

Volume, V	4510	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1199	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1631	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1631	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.2	pc/mi/ln
Level of service, LOS	D	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-9 Merge to R-10 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-10

Flow Inputs and Adjustments

Volume, V	4630	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1231	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1675	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1675	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	3	
Density, D	28.0	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-8 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-11

Flow Inputs and Adjustments

Volume, V	1860	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	495	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1009	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1009	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	16.8	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-10 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-12

Flow Inputs and Adjustments

Volume, V	2880	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	766	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1563	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1563	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	26.0+	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	Mayfield Rd to R-11 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-13

Flow Inputs and Adjustments

Volume, V	2450	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	652	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1329	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1329	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	22.1	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-11 Merge to R-12 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-14

Flow Inputs and Adjustments

Volume, V	3490	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	928	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1262	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1262	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	21.0	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	Mayfield Rd to R-13 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-15

Flow Inputs and Adjustments

Volume, V	1410	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	375	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	765	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	765	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	12.8	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-12 Diverge to R-14 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-16

Flow Inputs and Adjustments

Volume, V	2910	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	774	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1053	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1053	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	17.5	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	Brainard Rd to Cedar Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-17

Flow Inputs and Adjustments

Volume, V	1950	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	519	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	705	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	705	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	11.8	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-15 Merge to R-16 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-18

Flow Inputs and Adjustments

Volume, V	4380	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1165	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1584	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1584	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	26.4	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-13 Merge to R-17 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-19

Flow Inputs and Adjustments

Volume, V	1990	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	529	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1080	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1080	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	18.0	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-16 Diverge to R-19 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-20

Flow Inputs and Adjustments

Volume, V	3690	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	981	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1335	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1335	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	22.3	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-17 Merge to R-18 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-21

Flow Inputs and Adjustments

Volume, V	2680	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	713	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	969	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	969	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	16.1	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-22a

Flow Inputs and Adjustments

Volume, V	4090	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1088	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1479	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1479	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	24.6	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-22b

Flow Inputs and Adjustments

Volume, V	4090	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1088	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1110	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1110	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	18.5	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-18 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-23

Flow Inputs and Adjustments

Volume, V	2280	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	606	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1237	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1237	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	20.6	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-20 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build F-24

Flow Inputs and Adjustments

Volume, V	3440	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	915	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1244	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1244	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	20.7	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/14/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4110	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	360	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	160	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	4700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4110	360	160	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1142	100	44	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4658	402	178	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.168 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 780 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5060	9200	No
v_3 or v_{av34}	1939 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 1863 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2265	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 13.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.254	
Space mean speed in ramp influence area,	S_R = 55.4	mph
Space mean speed in outer lanes,	S_0 = 56.8	mph
Space mean speed for all vehicles,	S = 56.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/18/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB (Express Lanes)
Junction:	I-271 NB (Local Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-2

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3000	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	1180	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1180	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3600	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3000	1180	1180	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	833	328	328	v
Trucks and buses	4	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3400	1311	1311	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.615 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2595 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3400	6900	No
$v_{FO} = v - v_F - v_R$	2089	6900	No
v_R	1311	2200	No
v_3 or v_{av34}	805 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2595 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2595	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 13.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.221	
Space mean speed in ramp influence area,	S_R = 56.0	mph
Space mean speed in outer lanes,	S_0 = 65.8	mph
Space mean speed for all vehicles,	S = 58.1	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	12/11/14
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB (Local Lanes)
Junction:	I-271 NB (Express Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-3

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4470	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1500	vph
Length of first accel/decel lane	1180	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	160	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4470	1500	160	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1242	417	44	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5066	1675	178	pcph

Estimation of V12 Merge Areas

L_{EQ} = 754.68 (Equation 13-6 or 13-7)

P_{FM} = 0.611 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 3093 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6741	6900	No
v_3 or v_{av34}	1973 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 3093 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5139	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 37.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable,	M_S = 0.904	
Space mean speed in ramp influence area,	S_R = 43.7	mph
Space mean speed in outer lanes,	S_0 = 56.0	mph
Space mean speed for all vehicles,	S = 46.1	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	12/11/14
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB (Local Lanes)
Junction:	I-271 NB (Express Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-4

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5650	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	160	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1180	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5650	160	1180	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1569	44	328	v
Trucks and buses	4	3	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.985	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6403	180	1318	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 6442.18 (Equation 13-12 or 13-13)

P_{FD} = 0.592 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3862 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6403	6900	No
$v_{FO} = v - v_R$	6223	6900	No
v_R	180	2000	No
v_3 or v_{av34}	2541 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3862 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3862	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 25.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.444	
Space mean speed in ramp influence area,	S_R = 52.0	mph
Space mean speed in outer lanes,	S_0 = 60.6	mph
Space mean speed for all vehicles,	S = 54.8	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	12/11/14
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB (Express Lanes)
Junction:	I-271 NB (Local Lanes)
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-5

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1820	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	160	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1180	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3000	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1820	160	1180	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	506	44	328	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2063	179	1311	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM}) =$ 2063 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2242	4600	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2063 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2489	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 13.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.263

Space mean speed in ramp influence area, S_R = 55.3 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 55.3 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-6

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5490	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2150	vph
Length of first accel/decel lane	1400	ft
Length of second accel/decel lane	500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1170	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5490	2150	1170	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1525	597	325	v
Trucks and buses	4	1	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6222	2401	1307	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 4120 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6222	6900	No
$v_{FO} = v - v_F - v_R$	3821	6900	No
v_R	2401	4000	No
v_3 or v_{av34}	2102 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4120 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4120	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 10.0- pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.644

Space mean speed in ramp influence area, S_R = 48.4 mph

Space mean speed in outer lanes, S_0 = 61.5 mph

Space mean speed for all vehicles, S = 52.2 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-7

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3340	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1170	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	120	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3340	1170	120	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	928	325	33	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3785	1307	133	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2345 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5092	6900	No
v_3 or v_{av34}	1440 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2345 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3652	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 24.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.366	
Space mean speed in ramp influence area,	S_R = 53.4	mph
Space mean speed in outer lanes,	S_0 = 56.6	mph
Space mean speed for all vehicles,	S = 54.3	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-8

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1980	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1180	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	8000	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	1980		120		1180		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	550		33		328		v
Trucks and buses	4		0		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2244	133	1311	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2244 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2244	4600	No
$v_{FO} = v - v_F - v_R$	2111	4600	No
v_R	133	2200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2244 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2244	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 10.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.115

Space mean speed in ramp influence area, S_R = 57.9 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 57.9 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-9

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4510	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1170	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4510	120	1170	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1253	33	325	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5111	133	1307	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 3166 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5244	6900	No
v_3 or v_{av34}	1945 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 3166 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3678	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 24.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.295	
Space mean speed in ramp influence area,	S_R = 54.7	mph
Space mean speed in outer lanes,	S_0 = 56.2	mph
Space mean speed for all vehicles,	S = 55.1	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-12

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3490	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	580	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	960	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3490	580	960	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	969	161	267	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3955	644	1072	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 1364.96 (Equation 13-12 or 13-13)

P_{FD} = 0.632 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2735 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3955	6900	No
$v_{FO} = v - v_R$	3311	6900	No
v_R	644	2200	No
v_3 or v_{av34}	1220 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2735 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2735	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 15.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.161

Space mean speed in ramp influence area, S_R = 57.1 mph

Space mean speed in outer lanes, S_0 = 65.5 mph

Space mean speed for all vehicles, S = 59.2 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-13

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1410	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	580	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1410	580		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	392	161		v
Trucks and buses	4	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		

Heavy vehicle adjustment, fHV 0.980 1.000
Driver population factor, fP 1.00 1.00
Flow rate, vp 1598 644 pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1598 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2242	4600	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1598 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2242	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 13.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.178

Space mean speed in ramp influence area, S_R = 56.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 56.8 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-14

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2910	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	960	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	580	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	2910		960		580		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	808		267		161		v
Trucks and buses	4		1		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3298	1072	644	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.628 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2470 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3298	6900	No
$v_{FO} = v - v_R$	2226	6900	No
v_R	1072	2000	No
v_3 or v_{av34}	828 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2470 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2470	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 12.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.524

Space mean speed in ramp influence area, S_R = 50.6 mph

Space mean speed in outer lanes, S_0 = 65.8 mph

Space mean speed for all vehicles, S = 53.7 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Cedar Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-15

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1950	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2430	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	690	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1950	2430	690	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	542	675	192	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2210	2714	767	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2839.69 (Equation 13-6 or 13-7)

P_{FM} = 0.640 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1415 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4924	6900	No
v_3 or v_{av34}	795 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1415 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4129	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 27.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.458

Space mean speed in ramp influence area, S_R = 51.8 mph

Space mean speed in outer lanes, S_0 = 58.9 mph

Space mean speed for all vehicles, S = 52.8 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-16

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4380	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	690	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	2430	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4380		690		2430		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1217		192		675		v
Trucks and buses	4		0		1		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4964	767	2714	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 21390.29 Equation 13-12 or 13-13)

P_{FD} = 0.601 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4964	6900	No
$v_{FO} = v - v_R$	4197	6900	No
v_R	767	2200	No
v_3 or v_{av34}	1676 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3288 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3288	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 20.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.172	
Space mean speed in ramp influence area,	S_R = 56.9	mph
Space mean speed in outer lanes,	S_0 = 63.8	mph
Space mean speed for all vehicles,	S = 58.8	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-19

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3690	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	400	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	650	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3690	400	650	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1025	111	181	v
Trucks and buses	4	0	2	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.990	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4182	444	729	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2699.00 (Equation 13-6 or 13-7)

P_{FM} = 0.652 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2728 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4626	6900	No
v_3 or v_{av34}	1454 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2728 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3499	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 23.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.270

Space mean speed in ramp influence area, S_R = 55.1 mph

Space mean speed in outer lanes, S_0 = 57.7 mph

Space mean speed for all vehicles, S = 55.8 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - Build R-20

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4090	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	650	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	400	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4090	650	400	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1136	181	111	v
Trucks and buses	4	2	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.990	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4635	729	444	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 3633.36 (Equation 13-12 or 13-13)

P_{FD} = 0.611 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3114 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4635	6900	No
$v_{FO} = v - v_R$	3906	6900	No
v_R	729	2000	No
v_3 or v_{av34}	1521 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3114 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3114	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 17.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.494	
Space mean speed in ramp influence area,	S_R = 51.1	mph
Space mean speed in outer lanes,	S_0 = 63.8	mph
Space mean speed for all vehicles,	S = 54.7	mph

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	12/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-1 Merge to R-4 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-1

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	7300	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	5290	200	0	160	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1469	56	0	44	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5878	222	0	178	pc/h
Volume ratio, VR		0.028			

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	4	lc/pc
Minimum weaving lane changes, LCMIN	712	lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW	mi/h
Average non-weaving speed, SNW	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	mi/h
Weaving segment density, D	pc/mi/ln
Level of service, LOS	
Weaving segment v/c ratio	
Weaving segment flow rate, v	veh/h
Weaving segment capacity, cW	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5990	7300	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300		c
		Maximum	Analyzed	
v/c ratio		1.00		d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

Undefined LOS in HCS, calculated as LOS F at 5989 ft. Location cannot be analyzed as a weave. See note b.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	12/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 NB (Local Lanes)
Weaving Location:	R-3 Merge to R-4 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-2

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	1400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4310	1180	160	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1197	328	44	0	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4789	1311	178	0	pc/h

Volume ratio, VR	0.237	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	1489	lc/h
Weaving lane changes, LCW	1790	lc/h
Non-weaving vehicle index, INW	402	
Non-weaving lane change, LCNW	975	lc/h
Total lane changes, LCALL	2765	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.387	

Average weaving speed, SW	55.8	mi/h
Average non-weaving speed, SNW	41.7	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	44.4	mi/h
Weaving segment density, D	35.3	pc/mi/ln
Level of service, LOS	E	
Weaving segment v/c ratio	0.773	
Weaving segment flow rate, v	6278	veh/h
Weaving segment capacity, cW	8124	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	4920	1400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2031	c
		Maximum	Analyzed	
v/c ratio		1.00	0.773	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	12/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-3 Merge to R-6 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-3

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4350	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3340	0	970	1180	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	928	0	269	328	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3711	0	1078	1311	pc/h

Volume ratio, VR	0.215	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW	4258	lc/h
Non-weaving vehicle index, INW	1250	
Non-weaving lane change, LCNW	2766	lc/h
Total lane changes, LCALL	7024	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.330	

Average weaving speed, SW	56.3	mi/h
Average non-weaving speed, SNW	21.9	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	25.2	mi/h
Weaving segment density, D	80.6	pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	1.000	
Weaving segment flow rate, v	6100	veh/h
Weaving segment capacity, cW	6102	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7821	4350	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2034	c
		Maximum	Analyzed	
v/c ratio		1.00	1.000	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-11 Merge to R-12 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-4

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4100	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2450	460	0	580	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	681	128	0	161	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2722	511	0	644	pc/h

Volume ratio, VR 0.166

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	2	lc/pc
Minimum weaving lane changes, LCMIN	1288	lc/h
Weaving lane changes, LCW	1603	lc/h
Non-weaving vehicle index, INW	795	
Non-weaving lane change, LCNW	2310	lc/h
Total lane changes, LCALL	3913	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.218

Average weaving speed, SW	57.3	mi/h
Average non-weaving speed, SNW	44.5	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	46.2	mi/h
Weaving segment density, D	27.9	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.630	
Weaving segment flow rate, v	3878	veh/h
Weaving segment capacity, cW	6159	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7325	4100	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2053	c
		Maximum	Analyzed	
v/c ratio		1.00	0.630	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-15 Merge to R-16 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-5

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	2400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1950	1740	0	690	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	542	483	0	192	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2167	1933	0	767	pc/h

Volume ratio, VR	0.158

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN	2301	lc/h
Weaving lane changes, LCW	2535	lc/h
Non-weaving vehicle index, INW	590	
Non-weaving lane change, LCNW	1568	lc/h
Total lane changes, LCALL	4103	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.345

Average weaving speed, SW	56.2	mi/h
Average non-weaving speed, SNW	35.6	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	37.8	mi/h
Weaving segment density, D	42.9	pc/mi/ln
Level of service, LOS	E	
Weaving segment v/c ratio	0.841	
Weaving segment flow rate, v	4867	veh/h
Weaving segment capacity, cW	5790	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7239	2400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1930	c
		Maximum	Analyzed	
v/c ratio		1.00	0.841	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-19 Merge to R-20 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - Build W-6

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	1900	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3440	0	250	400	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	956	0	69	111	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3822	0	278	444	pc/h

Volume ratio, VR	0.098	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN	1332	lc/h
Weaving lane changes, LCW	1536	lc/h
Non-weaving vehicle index, INW	467	
Non-weaving lane change, LCNW	1297	lc/h
Total lane changes, LCALL	2833	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.310	

Average weaving speed, SW	56.5	mi/h
Average non-weaving speed, SNW	43.1	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	44.2	mi/h
Weaving segment density, D	34.3	pc/mi/ln
Level of service, LOS	D	
Weaving segment v/c ratio	0.782	
Weaving segment flow rate, v	4545	veh/h
Weaving segment capacity, cW	5811	veh/h

Limitations on Weaving Segments

If limit reached, see note.

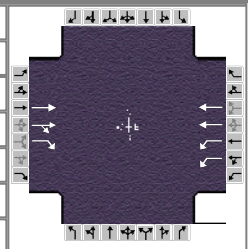
	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6649	1900	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1937	c
		Maximum	Analyzed	
v/c ratio		1.00	0.782	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

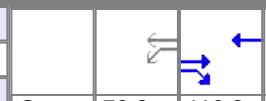
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 25, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak Build	PHF	0.92
Intersection	I-271 SB On Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name					
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h		1350	1390	1040	2320							

Signal Information			
Cycle, s	200.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



							1	2	3	4
Green	70.8	119.2	0.0	0.0	0.0	0.0	5	6	7	8
Yellow	4.0	4.0	0.0	0.0	0.0	0.0				
Red	1.0	1.0	0.0	0.0	0.0	0.0				

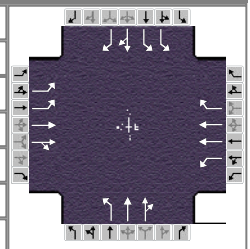
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				
Case Number		7.3	2.0	4.0				
Phase Duration, s		124.2	75.8	200.0				
Change Period, ($Y+R_c$), s		5.0	5.0	5.0				
Max Allow Headway (*MAH*), s		0.0	3.1	0.0				
Queue Clearance Time (g_s), s			72.8					
Green Extension Time (g_e), s		0.0	0.0	0.0				
Phase Call Probability			1.00					
Max Out Probability			1.00					

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6							
Adjusted Flow Rate (*v*), veh/h		1467	1511	1130	2522							
Adjusted Saturation Flow Rate (*s*), veh/h/ln		950	1579	887	950							
Queue Service Time (g_s), s		119.2	119.2	70.8	195.0							
Cycle Queue Clearance Time (g_c), s		119.2	119.2	70.8	195.0							
Green Ratio (*g/C*)		0.60	0.60	0.35	0.98							
Capacity (*c*), veh/h		1132	941	628	1853							
Volume-to-Capacity Ratio (*X*)		1.296	1.606	1.800	1.361							
Available Capacity (c_a), veh/h		1132	941	628	1853							
Back of Queue (*Q*), veh/ln (95th percentile)		73.0	182.4	77.6	68.2							
Queue Storage Ratio (*RQ*) (95th percentile)		0.00	23.16	3.03	0.00							
Uniform Delay (d_1), s/veh		40.4	40.4	64.6	2.5							
Incremental Delay (d_2), s/veh		139.8	277.6	366.3	166.2							
Initial Queue Delay (d_3), s/veh		0.0	0.0	0.0	0.0							
Control Delay (*d*), s/veh		180.2	318.0	430.9	168.7							
Level of Service (LOS)		F	F	F	F							
Approach Delay, s/veh / LOS	250.1	F		249.8	F		0.0			0.0		
Intersection Delay, s/veh / LOS	250.0						F					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	0.5	A	3.0	C	2.9	C
Bicycle LOS Score / LOS	2.9	C	3.5	D				

HCS 2010 Signalized Intersection Results Summary

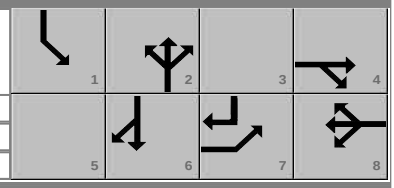
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak Build	PHF	0.92
Intersection	Cedar Rd	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 PM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	750	490	110	40	1120	470	90	260	10	530	360	750

Signal Information			
Cycle, s	135.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	25.0	15.0	30.0	45.0	0.0	0.0
Yellow	3.6	3.6	3.6	3.6	0.0	0.0
Red	1.4	1.4	1.4	1.4	0.0	0.0



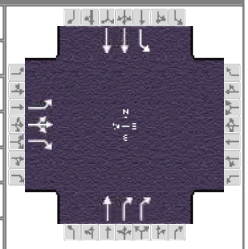
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4		8		2	1	6
Case Number	2.0	4.0		5.3		6.3	2.0	3.0
Phase Duration, s	35.0	85.0		50.0		20.0	30.0	50.0
Change Period, ($Y+R_c$), s	5.0	5.0		5.0		5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.1	3.2		3.2		0.0	3.1	0.0
Queue Clearance Time (g_s), s	32.0	14.2		47.0			19.3	
Green Extension Time (g_e), s	0.0	8.0		0.0		0.0	0.7	0.0
Phase Call Probability	1.00	1.00		1.00			1.00	
Max Out Probability	1.00	0.00		1.00			0.19	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	815	336	316	43	1217	511	98	147	146	520	353	736
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757	1863	1744	792	1773	1610	1044	1881	1856	1757	1863	1610
Queue Service Time (g_s), s	30.0	12.1	12.2	5.2	45.0	41.8	12.4	10.2	10.3	17.3	17.8	45.0
Cycle Queue Clearance Time (g_c), s	30.0	12.1	12.2	5.2	45.0	41.8	12.4	10.2	10.3	17.3	17.8	45.0
Green Ratio (*g/C*)	0.22	0.59	0.59	0.33	0.33	0.33	0.11	0.11	0.11	0.19	0.33	0.56
Capacity (*c*), veh/h	781	1104	1034	317	1182	537	169	209	206	651	621	895
Volume-to-Capacity Ratio (*X*)	1.044	0.304	0.306	0.137	1.030	0.952	0.578	0.704	0.709	0.799	0.569	0.822
Available Capacity (c_a), veh/h	781	1104	1034	317	1182	537	169	209	206	651	621	895
Back of Queue (*Q*), veh/ln (95th percentile)	25.4	8.7	8.3	1.8	33.9	27.8	7.0	9.9	9.8	9.4	11.1	10.6
Queue Storage Ratio (*RQ*) (95th percentile)	1.10	0.00	0.00	0.36	0.00	1.88	0.51	0.00	0.00	0.81	0.00	0.92
Uniform Delay (d_1), s/veh	52.5	13.7	13.7	31.7	45.0	43.9	58.8	57.9	57.9	36.3	26.8	17.0
Incremental Delay (d_2), s/veh	44.2	0.1	0.1	0.1	34.1	26.9	13.6	18.1	18.6	4.7	2.7	6.2
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	96.7	13.7	13.7	31.8	79.1	70.9	72.4	75.9	76.5	41.0	29.4	23.2
Level of Service (LOS)	F	B	B	C	F	E	E	E	E	D	C	C
Approach Delay, s/veh / LOS	59.9	E		75.6	E		75.3	E		30.3	C	
Intersection Delay, s/veh / LOS	57.2						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	3.0	C	3.0	C	3.0	C
Bicycle LOS Score / LOS	1.7	A	1.9	A	0.8	A	3.4	C

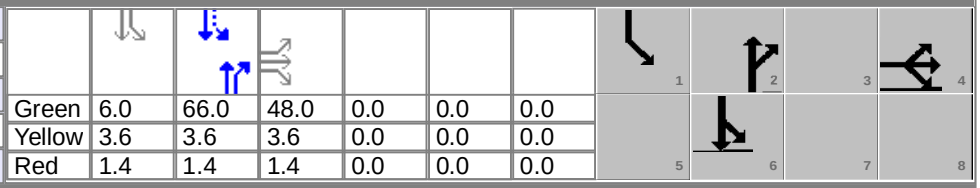
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak Build	PHF	0.92
Intersection	I-271 NB On/Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2 I-3 I-4 CUY-271-8.14 PM Peak_Revised.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	500	1	250					400	1080	90	1390	

Signal Information			
Cycle, s	135.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	6.0	66.0	48.0	0.0	0.0	0.0
Yellow	3.6	3.6	3.6	0.0	0.0	0.0
Red	1.4	1.4	1.4	0.0	0.0	0.0

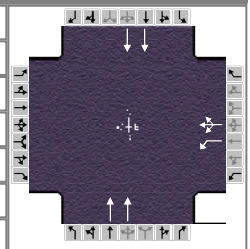
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		9.0				7.3	1.0	4.0
Phase Duration, s		53.0				71.0	11.0	82.0
Change Period, ($Y+R_c$), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.1				0.0	3.1	0.0
Queue Clearance Time (g_s), s		41.0					4.9	
Green Extension Time (g_e), s		1.2				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		0.21					1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	543	137	136					426	1149	82	1259	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757	1566	1563					1863	1411	1792	1756	
Queue Service Time (g_s), s	39.0	8.3	8.3					23.6	52.9	2.9	39.1	
Cycle Queue Clearance Time (g_c), s	39.0	8.3	8.3					23.6	52.9	2.9	39.1	
Green Ratio (*g/C*)	0.36	0.36	0.36					0.49	0.49	0.55	0.57	
Capacity (*c*), veh/h	625	557	556					911	1380	437	2003	
Volume-to-Capacity Ratio (*X*)	0.870	0.246	0.244					0.467	0.833	0.187	0.628	
Available Capacity (c_a), veh/h	625	557	556					911	1380	437	2003	
Back of Queue (*Q*), veh/ln (95th percentile)	25.8	5.7	5.7					13.5	0.4	2.1	20.6	
Queue Storage Ratio (*RQ*) (95th percentile)	0.00	0.00	0.00					0.00	0.00	0.16	0.00	
Uniform Delay (d_1), s/veh	40.6	30.7	30.7					29.4	49.5	17.6	29.6	
Incremental Delay (d_2), s/veh	12.2	0.1	0.1					0.3	1.2	0.0	0.3	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0					0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	52.7	30.8	30.8					29.8	50.7	17.7	29.9	
Level of Service (LOS)	D	C	C					C	D	B	C	
Approach Delay, s/veh / LOS	45.4	D		0.0			45.1	D		29.1	C	
Intersection Delay, s/veh / LOS	39.4						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.5	B	2.4	B	1.9	A
Bicycle LOS Score / LOS	1.8	A			3.1	C	1.8	A

HCS 2010 Signalized Intersection Results Summary

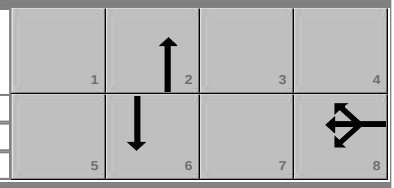
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak Build	PHF	0.92
Intersection	I-271 SB Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 PM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				830	1	130		900			650	

Signal Information			
Cycle, s	135.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	72.5	53.5	0.0	0.0	0.0	0.0	
Yellow	3.6	4.0	0.0	0.0	0.0	0.0	
Red	1.4	0.0	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2		6
Case Number				10.0		8.0		8.0
Phase Duration, s				57.5		77.5		77.5
Change Period, ($Y+R_c$), s				4.0		5.0		5.0
Max Allow Headway (*MAH*), s				3.2		0.0		0.0
Queue Clearance Time (g_s), s				36.0				
Green Extension Time (g_e), s				2.4		0.0		0.0
Phase Call Probability				1.00				
Max Out Probability				0.02				

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3	8	18		2			6	
Adjusted Flow Rate (*v*), veh/h				532	512			969			707	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810	1755			1809			1809	
Queue Service Time (g_s), s				34.0	33.6			32.1			15.2	
Cycle Queue Clearance Time (g_c), s				34.0	33.6			32.1			15.2	
Green Ratio (*g/C*)				0.40	0.40			0.54			0.54	
Capacity (*c*), veh/h				717	695			1943			1943	
Volume-to-Capacity Ratio (*X*)				0.742	0.737			0.499			0.364	
Available Capacity (c_a), veh/h				717	695			1943			1943	
Back of Queue (*Q*), veh/ln (95th percentile)				21.9	21.1			21.5			10.5	
Queue Storage Ratio (*RQ*) (95th percentile)				0.00	0.00			0.00			0.00	
Uniform Delay (d_1), s/veh				34.9	34.7			37.9			18.0	
Incremental Delay (d_2), s/veh				3.7	3.6			0.7			0.5	
Initial Queue Delay (d_3), s/veh				0.0	0.0			0.0			0.0	
Control Delay (*d*), s/veh				38.5	38.4			38.6			18.5	
Level of Service (LOS)				D	D			D			B	
Approach Delay, s/veh / LOS	0.0			38.5		D	38.6		D	18.5		B
Intersection Delay, s/veh / LOS	33.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.8	C	2.8	C	1.7	A	1.9	A
Bicycle LOS Score / LOS			2.2	B	1.3	A	1.1	A

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	Chagrin Blvd to R-1 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-1

Flow Inputs and Adjustments

Volume, V	4110	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1093	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1115	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1115	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	18.6	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-2 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-2a

Flow Inputs and Adjustments

Volume, V	4470	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1189	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1213	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1213	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	20.2	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-1 Merge to R-2 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-2b

Flow Inputs and Adjustments

Volume, V	4470	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1189	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1617	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1617	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.0	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	Chagrin Blvd to R-3 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-3

Flow Inputs and Adjustments

Volume, V	3000	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	798	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1628	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1628	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	27.1	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-2 Diverge to R-5 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-4

Flow Inputs and Adjustments

Volume, V	4310	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1146	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1559	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1559	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	26.0-	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-3 Merge to R4 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-5

Flow Inputs and Adjustments

Volume, V	3160	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	840	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1143	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1143	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	19.0	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-5 Merge to R-6 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-6

Flow Inputs and Adjustments

Volume, V	5490	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1460	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1986	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1986	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	57.3	mi/h
Number of lanes, N	3	
Density, D	34.7	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-4 Diverge R-8 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-7

Flow Inputs and Adjustments

Volume, V	1980	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	527	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1074	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1074	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	17.9	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-6 Diverge to R-7 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-8

Flow Inputs and Adjustments

Volume, V	3340	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	888	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1208	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1208	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	20.1	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-7 Merge to R-9 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-9

Flow Inputs and Adjustments

Volume, V	4510	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1199	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1631	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1631	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	27.2	pc/mi/ln
Level of service, LOS	D	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-9 Merge to R-10 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-10

Flow Inputs and Adjustments

Volume, V	4630	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1231	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1675	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1675	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	3	
Density, D	28.0	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB (Express Lanes)
From/To:	R-8 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-11

Flow Inputs and Adjustments

Volume, V	1860	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	495	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1009	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1009	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	16.8	pc/mi/ln
Level of service, LOS	B	

HCS 2010: Basic Freeway Segments Release 6.60

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 NB
From/To:	R-10 Diverge to Mayfield Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-12

Flow Inputs and Adjustments

Volume, V	2880	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	766	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1563	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1563	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	26.0+	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	Mayfield Rd to R-11 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-13

Flow Inputs and Adjustments

Volume, V	2450	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	652	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1329	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1329	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	22.1	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-11 Merge to R-12 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-14

Flow Inputs and Adjustments

Volume, V	3490	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	928	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1262	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1262	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	21.0	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	Mayfield Rd to R-13 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-15

Flow Inputs and Adjustments

Volume, V	1410	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	375	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	765	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	765	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	12.8	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-12 Diverge to R-14 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-16

Flow Inputs and Adjustments

Volume, V	2910	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	774	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1053	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1053	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	17.5	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	Brainard Rd to Cedar Rd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-17

Flow Inputs and Adjustments

Volume, V	1950	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	519	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	705	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	705	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	11.8	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-15 Merge to R-16 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-18

Flow Inputs and Adjustments

Volume, V	4380	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1165	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1584	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1584	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	26.4	pc/mi/ln
Level of service, LOS	D	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-13 Merge to R-17 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-19

Flow Inputs and Adjustments

Volume, V	1990	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	529	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1080	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1080	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	18.0	pc/mi/ln
Level of service, LOS	B	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-16 Diverge to R-19 Merge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-20

Flow Inputs and Adjustments

Volume, V	3690	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	981	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1335	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1335	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	22.3	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-17 Merge to R-18 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-21

Flow Inputs and Adjustments

Volume, V	2680	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	713	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	969	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	969	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	16.1	pc/mi/ln
Level of service, LOS	B	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-22a

Flow Inputs and Adjustments

Volume, V	4090	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1088	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1479	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1479	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	24.6	pc/mi/ln
Level of service, LOS	C	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-19 Merge to R-20 Diverge
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-22b

Flow Inputs and Adjustments

Volume, V	4090	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	1088	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1110	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	4	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1110	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	4	
Density, D	18.5	pc/mi/ln
Level of service, LOS	C	

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Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/21/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB (Express Lanes)
From/To:	R-18 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-23

Flow Inputs and Adjustments

Volume, V	2280	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	606	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1237	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1237	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	2	
Density, D	20.6	pc/mi/ln
Level of service, LOS	C	

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E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency or Company:	Parsons Brinckerhoff
Date Performed:	8/22/2014
Analysis Time Period:	PM Peak
Freeway/Direction:	I-271 SB
From/To:	R-20 Diverge to Chagrin Blvd
Jurisdiction:	ODOT District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build F-24

Flow Inputs and Adjustments

Volume, V	3440	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	915	v
Trucks and buses	4	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.980	
Driver population factor, fp	1.00	
Flow rate, vp	1244	pc/h/ln

Speed Inputs and Adjustments

Lane width	-	ft
Right-side lateral clearance	-	ft
Total ramp density, TRD	-	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Measured	
FFS or BFFS	60.0	mi/h
Lane width adjustment, fLW	-	mi/h
Lateral clearance adjustment, fLC	-	mi/h
TRD adjustment	-	mi/h
Free-flow speed, FFS	60.0	mi/h

LOS and Performance Measures

Flow rate, vp	1244	pc/h/ln
Free-flow speed, FFS	60.0	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	20.7	pc/mi/ln
Level of service, LOS	C	

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

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Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/14/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	4	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4110	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	360	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	160	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	4700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4110	360	160	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1142	100	44	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4658	402	178	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.168 Using Equation 4

$v_{12} = v_F (P_{FM})$ = 780 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5060	9200	No
v_3 or v_{av34}	1939 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 1863 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2265	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 13.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.254	
Space mean speed in ramp influence area,	S_R = 55.4	mph
Space mean speed in outer lanes,	S_0 = 56.8	mph
Space mean speed for all vehicles,	S = 56.2	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/18/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-2

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4470	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	160	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1180	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3600	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4470		160		1180		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1242		44		328		v
Trucks and buses	4		0		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5066	178	1311	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.625 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3234 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5066	6900	No
$v_{FO} = v - v_R$	4888	6900	No
v_R	178	2200	No
v_3 or v_{av34}	1832 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3234 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3234	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 26.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.119

Space mean speed in ramp influence area, S_R = 57.9 mph

Space mean speed in outer lanes, S_0 = 63.2 mph

Space mean speed for all vehicles, S = 59.5 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/18/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-5

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4310	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	1180	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	160	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3600	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4310	1180	160	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1197	328	44	v
Trucks and buses	4	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4885	1311	178	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2728.14 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 3026 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6196	6900	No
v_3 or v_{av34}	1859 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 3026 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4700	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 32.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, M_S = 0.570

Space mean speed in ramp influence area, S_R = 49.7 mph

Space mean speed in outer lanes, S_0 = 56.4 mph

Space mean speed for all vehicles, S = 51.2 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-6

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	5490	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2150	vph
Length of first accel/decel lane	1400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1170	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3500	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	5490		2150		1170		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1525		597		325		v
Trucks and buses	4		1		1		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.995	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6222	2401	1307	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.494 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 4289 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6222	6900	No
$v_{FO} = v - v_F - v_R$	3821	6900	No
v_R	2401	2000	Yes
v_3 or v_{av34}	1933 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4289 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4289	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 28.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.644	
Space mean speed in ramp influence area,	S_R = 48.4	mph
Space mean speed in outer lanes,	S_0 = 62.2	mph
Space mean speed for all vehicles,	S = 52.0	mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-7

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3340	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	1170	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	120	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3340	1170	120	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	928	325	33	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3785	1307	133	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2345 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5092	6900	No
v_3 or v_{av34}	1440 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2345 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3652	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 24.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.366	
Space mean speed in ramp influence area,	S_R = 53.4	mph
Space mean speed in outer lanes,	S_0 = 56.6	mph
Space mean speed for all vehicles,	S = 54.3	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-8

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1980	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1180	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	8000	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	1980		120		1180		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	550		33		328		v
Trucks and buses	4		0		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2244	133	1311	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2244 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2244	4600	No
$v_{FO} = v - v_F - v_R$	2111	4600	No
v_R	133	2200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2244 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2244	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 10.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.115

Space mean speed in ramp influence area, S_R = 57.9 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 57.9 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/19/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-9

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4307	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	967	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	1400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4307	120	967	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1196	33	269	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4881	133	1080	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 3024 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5014	6900	No
v_3 or v_{av34}	1857 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 3024 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3519	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 23.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.273

Space mean speed in ramp influence area, S_R = 55.1 mph

Space mean speed in outer lanes, S_0 = 56.4 mph

Space mean speed for all vehicles, S = 55.5 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-12

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3490	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	580	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	960	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3490	580	960	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	969	161	267	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3955	644	1072	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 1364.96 (Equation 13-12 or 13-13)

P_{FD} = 0.632 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2735 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3955	6900	No
$v_{FO} = v - v_R$	3311	6900	No
v_R	644	2200	No
v_3 or v_{av34}	1220 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2735 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2735	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 15.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.161	
Space mean speed in ramp influence area,	S_R = 57.1	mph
Space mean speed in outer lanes,	S_0 = 65.5	mph
Space mean speed for all vehicles,	S = 59.2	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-13

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1410	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	580	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	No	
Volume on adjacent Ramp		vph
Position of adjacent Ramp		
Type of adjacent Ramp		
Distance to adjacent Ramp		ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1410	580		vph
Peak-hour factor, PHF	0.90	0.90		
Peak 15-min volume, v15	392	161		v
Trucks and buses	4	0		%
Recreational vehicles	0	0		%
Terrain type:	Level	Level		
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5		
Recreational vehicle PCE, ER	1.2	1.2		

Heavy vehicle adjustment, fHV 0.980 1.000
Driver population factor, fP 1.00 1.00
Flow rate, vp 1598 644 pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1598 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2242	4600	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1598 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2242	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 13.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.178

Space mean speed in ramp influence area, S_R = 56.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 56.8 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Brainard Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-14

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	2910	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	960	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	580	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	1700	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2910	960	580	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	808	267	161	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3298	1072	644	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.628 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2470 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3298	6900	No
$v_{FO} = v_F - v_R$	2226	6900	No
v_R	1072	2000	No
v_3 or v_{av34}	828 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2470 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2470	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 12.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.524	
Space mean speed in ramp influence area,	S_R = 50.6	mph
Space mean speed in outer lanes,	S_0 = 65.8	mph
Space mean speed for all vehicles,	S = 53.7	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Cedar Rd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-15

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	1950	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	2430	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	690	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1950	2430	690	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	542	675	192	v
Trucks and buses	4	1	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	0.995	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2210	2714	767	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2839.69 (Equation 13-6 or 13-7)

P_{FM} = 0.640 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1415 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4924	6900	No
v_3 or v_{av34}	795 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1415 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4129	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 27.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.458

Space mean speed in ramp influence area, S_R = 51.8 mph

Space mean speed in outer lanes, S_0 = 58.9 mph

Space mean speed for all vehicles, S = 52.8 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-16

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4380	vph

Off Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-Flow speed on ramp	60.0	mph
Volume on ramp	690	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	2430	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2200	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4380	690	2430	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1217	192	675	v
Trucks and buses	4	0	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.995	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4964	767	2714	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 21390.29 Equation 13-12 or 13-13)

P_{FD} = 0.601 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4964	6900	No
$v_{FO} = v - v_R$	4197	6900	No
v_R	767	2200	No
v_3 or v_{av34}	1676 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3288 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3288	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 20.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.172	
Space mean speed in ramp influence area,	S_R = 56.9	mph
Space mean speed in outer lanes,	S_0 = 63.8	mph
Space mean speed for all vehicles,	S = 58.8	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Expressway
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-19

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	3690	vph

On Ramp Data

Side of freeway	Left	
Number of lanes in ramp	1	
Free-flow speed on ramp	60.0	mph
Volume on ramp	400	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	650	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3690	400	650	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1025	111	181	v
Trucks and buses	4	0	2	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

Heavy vehicle adjustment, fHV	0.980	1.000	0.990	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4182	444	729	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2699.00 (Equation 13-6 or 13-7)

P_{FM} = 0.652 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2728 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4626	6900	No
v_3 or v_{av34}	1454 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2728 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3499	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 23.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.270

Space mean speed in ramp influence area, S_R = 55.1 mph

Space mean speed in outer lanes, S_0 = 57.7 mph

Space mean speed for all vehicles, S = 55.8 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date performed:	8/20/2014
Analysis time period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Junction:	Chagrin Blvd
Jurisdiction:	District 12
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build R-20

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	60.0	mph
Volume on freeway	4090	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	650	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	400	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1850	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	4090		650		400		vph
Peak-hour factor, PHF	0.90		0.90		0.90		
Peak 15-min volume, v15	1136		181		111		v
Trucks and buses	4		2		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

Heavy vehicle adjustment, fHV	0.980	0.990	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4635	729	444	pcph

Estimation of V12 Diverge Areas

L_{EQ} = 3633.36 (Equation 13-12 or 13-13)

P_{FD} = 0.611 Using Equation 5

$v_{12} = v_R + (v - v_F) P_{FD}$ = 3114 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4635	6900	No
$v_{FO} = v - v_R$	3906	6900	No
v_R	729	2000	No
v_3 or v_{av34}	1521 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3114 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3114	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 17.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.494	
Space mean speed in ramp influence area,	S_R = 51.1	mph
Space mean speed in outer lanes,	S_0 = 63.8	mph
Space mean speed for all vehicles,	S = 54.7	mph

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-1 Merge to R-2 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-1

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4000	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4110	200	0	160	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	1142	56	0	44	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4567	222	0	178	pc/h

Volume ratio, VR	0.036	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	4	lc/pc
Minimum weaving lane changes, LCMIN	712	lc/h
Weaving lane changes, LCW	1023	lc/h
Non-weaving vehicle index, INW	1149	
Non-weaving lane change, LCNW	2577	lc/h
Total lane changes, LCALL	3600	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.208	

Average weaving speed, SW	57.4	mi/h
Average non-weaving speed, SNW	46.9	mi/h

_____Weaving Segment Speed, Density, Level of Service and Capacity_____

Weaving segment speed, S	47.2	mi/h
Weaving segment density, D	35.1+	pc/mi/ln
Level of service, LOS	E	
Weaving segment v/c ratio	0.773	
Weaving segment flow rate, v	4967	veh/h
Weaving segment capacity, cW	6426	veh/h

_____Limitations on Weaving Segments_____

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6060	4000	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2142	c
		Maximum	Analyzed	
v/c ratio		1.00	0.773	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 NB (Expressway)
Weaving Location:	R-3 Merge to R-4 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-2

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	1400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1820	160	1180	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	506	44	328	0	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2022	178	1311	0	pc/h

Volume ratio, VR	0.424	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	1489	lc/h
Weaving lane changes, LCW	1659	lc/h
Non-weaving vehicle index, INW	170	
Non-weaving lane change, LCNW	598	lc/h
Total lane changes, LCALL	2257	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.329	

Average weaving speed, SW	56.3	mi/h
Average non-weaving speed, SNW	43.7	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	48.3	mi/h
Weaving segment density, D	24.3	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.624	
Weaving segment flow rate, v	3512	veh/h
Weaving segment capacity, cW	5625	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6953	1400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1875	c
		Maximum	Analyzed	
v/c ratio		1.00	0.624	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/25/2014
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 NB
Weaving Location:	R-5 Merge to R-6 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-3

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	3300	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3340	0	970	1180	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	928	0	269	328	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3711	0	1078	1311	pc/h
Volume ratio, VR		0.215			

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN		lc/h
Weaving lane changes, LCW		lc/h
Non-weaving vehicle index, INW		
Non-weaving lane change, LCNW		lc/h
Total lane changes, LCALL		lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W

Average weaving speed, SW		mi/h
Average non-weaving speed, SNW		mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S		mi/h
Weaving segment density, D		pc/mi/ln
Level of service, LOS	F	
Weaving segment v/c ratio	1.041	
Weaving segment flow rate, v	6100	veh/h
Weaving segment capacity, cW	5862	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7821	3300	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1954	c
		Maximum	Analyzed	
v/c ratio		1.00	1.041	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-11 Merge to R-12 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-4

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	4100	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2450	460	0	580	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	681	128	0	161	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2722	511	0	644	pc/h

Volume ratio, VR 0.166

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	2	lc/pc
Minimum weaving lane changes, LCMIN	1288	lc/h
Weaving lane changes, LCW	1603	lc/h
Non-weaving vehicle index, INW	795	
Non-weaving lane change, LCNW	2310	lc/h
Total lane changes, LCALL	3913	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.218

Average weaving speed, SW	57.3	mi/h
Average non-weaving speed, SNW	44.5	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	46.2	mi/h
Weaving segment density, D	27.9	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.630	
Weaving segment flow rate, v	3878	veh/h
Weaving segment capacity, cW	6159	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7325	4100	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	2053	c
		Maximum	Analyzed	
v/c ratio		1.00	0.630	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	8/26/2014
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-15 Merge to R-16 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-5

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	2400	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1950	1740	0	690	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	542	483	0	192	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2167	1933	0	767	pc/h

Volume ratio, VR	0.158	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN	2301	lc/h
Weaving lane changes, LCW	2535	lc/h
Non-weaving vehicle index, INW	590	
Non-weaving lane change, LCNW	1568	lc/h
Total lane changes, LCALL	4103	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.345	

Average weaving speed, SW	56.2	mi/h
Average non-weaving speed, SNW	35.6	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	37.8	mi/h
Weaving segment density, D	42.9	pc/mi/ln
Level of service, LOS	E	
Weaving segment v/c ratio	0.841	
Weaving segment flow rate, v	4867	veh/h
Weaving segment capacity, cW	5790	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7239	2400	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1930	c
		Maximum	Analyzed	
v/c ratio		1.00	0.841	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.60

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	Eric Brown
Agency/Co.:	Parsons Brinckerhoff
Date Performed:	9/11/14
Analysis Time Period:	PM Peak
Freeway/Dir of Travel:	I-271 SB
Weaving Location:	R-19 Merge to R-20 Diverge
Analysis Year:	2036
Description:	CUY-271-8.14 - No Build W-6

Inputs

Segment Type	Freeway	
Weaving configuration	Two-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	1900	ft
Freeway free-flow speed, FFS	60	mi/h
Minimum segment speed, SMIN	45	mi/h
Freeway maximum capacity, cIFL	2300	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3440	0	250	400	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	956	0	69	111	
Trucks and buses	0	0	0	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	1.000	1.000	1.000	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3822	0	278	444	pc/h

Volume ratio, VR	0.098	

Configuration Characteristics

Number of maneuver lanes, NWL	0	ln
Interchange density, ID	0.6	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR	3	lc/pc
Minimum weaving lane changes, LCMIN	1332	lc/h
Weaving lane changes, LCW	1536	lc/h
Non-weaving vehicle index, INW	467	
Non-weaving lane change, LCNW	1297	lc/h
Total lane changes, LCALL	2833	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.310	

Average weaving speed, SW	56.5	mi/h
Average non-weaving speed, SNW	43.1	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	44.2	mi/h
Weaving segment density, D	34.3	pc/mi/ln
Level of service, LOS	D	
Weaving segment v/c ratio	0.782	
Weaving segment flow rate, v	4545	veh/h
Weaving segment capacity, cW	5811	veh/h

Limitations on Weaving Segments

If limit reached, see note.

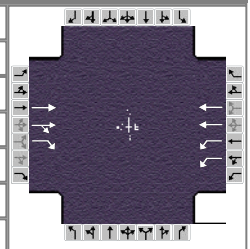
	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6649	1900	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2300	1937	c
		Maximum	Analyzed	
v/c ratio		1.00	0.782	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010 Signalized Intersection Results Summary

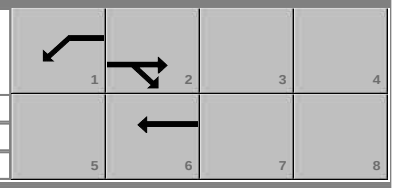
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 25, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak	PHF	0.92
Intersection	I-271 SB On Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name					
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h		1350	1390	1040	2320							

Signal Information			
Cycle, s	200.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	70.8	119.2	0.0	0.0	0.0	0.0	
Yellow	4.0	4.0	0.0	0.0	0.0	0.0	
Red	1.0	1.0	0.0	0.0	0.0	0.0	



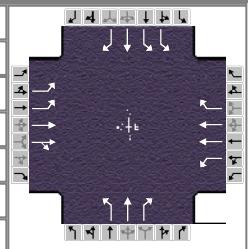
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				
Case Number		7.3	2.0	4.0				
Phase Duration, s		124.2	75.8	200.0				
Change Period, ($Y+R_c$), s		5.0	5.0	5.0				
Max Allow Headway (*MAH*), s		0.0	3.1	0.0				
Queue Clearance Time (g_s), s			72.8					
Green Extension Time (g_e), s		0.0	0.0	0.0				
Phase Call Probability			1.00					
Max Out Probability			1.00					

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6							
Adjusted Flow Rate (*v*), veh/h		1467	1511	1130	2522							
Adjusted Saturation Flow Rate (*s*), veh/h/ln		950	1579	887	950							
Queue Service Time (g_s), s		119.2	119.2	70.8	195.0							
Cycle Queue Clearance Time (g_c), s		119.2	119.2	70.8	195.0							
Green Ratio (*g/C*)		0.60	0.60	0.35	0.98							
Capacity (*c*), veh/h		1132	941	628	1853							
Volume-to-Capacity Ratio (*X*)		1.296	1.606	1.800	1.361							
Available Capacity (c_a), veh/h		1132	941	628	1853							
Back of Queue (*Q*), veh/ln (50th percentile)		49.1	117.6	47.9	42.7							
Queue Storage Ratio (*RQ*) (50th percentile)		0.00	14.93	1.87	0.00							
Uniform Delay (d_1), s/veh		40.4	40.4	64.6	2.5							
Incremental Delay (d_2), s/veh		139.8	277.6	366.3	166.2							
Initial Queue Delay (d_3), s/veh		0.0	0.0	0.0	0.0							
Control Delay (*d*), s/veh		180.2	318.0	430.9	168.7							
Level of Service (LOS)		F	F	F	F							
Approach Delay, s/veh / LOS	250.1	F		249.8	F		0.0			0.0		
Intersection Delay, s/veh / LOS	250.0						F					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	0.5	A	3.0	C	2.9	C
Bicycle LOS Score / LOS	2.9	C	3.5	D				

HCS 2010 Signalized Intersection Results Summary

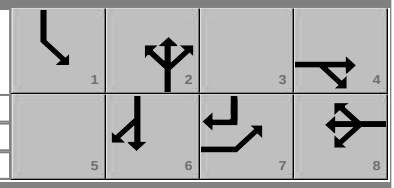
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak No Build	PHF	0.92
Intersection	Cedar Rd	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 PM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	750	490	110	40	1120	470	90	260	10	530	360	750

Signal Information			
Cycle, s	135.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	19.7	21.8	29.5	44.0	0.0	0.0
Yellow	3.6	3.6	3.6	3.6	0.0	0.0
Red	1.4	1.4	1.4	1.4	0.0	0.0



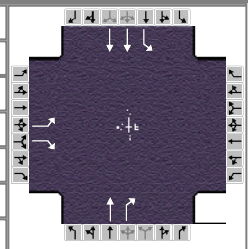
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4		8		2	1	6
Case Number	2.0	4.0		5.3		5.3	2.0	3.0
Phase Duration, s	34.5	83.5		49.0		26.8	24.7	51.5
Change Period, ($Y+R_c$), s	5.0	5.0		5.0		5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.1	3.2		3.2		0.0	3.1	0.0
Queue Clearance Time (g_s), s	31.5	14.5		46.0			21.7	
Green Extension Time (g_e), s	0.0	8.0		0.0		0.0	0.0	0.0
Phase Call Probability	1.00	1.00		1.00			1.00	
Max Out Probability	1.00	0.00		1.00			1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	815	336	316	43	1217	511	98	283	11	561	381	794
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757	1863	1744	792	1773	1610	1018	1881	1610	1757	1863	1610
Queue Service Time (g_s), s	29.5	12.4	12.5	5.3	44.0	42.3	12.0	20.0	0.8	19.7	23.8	46.5
Cycle Queue Clearance Time (g_c), s	29.5	12.4	12.5	5.3	44.0	42.3	12.0	20.0	0.8	19.7	23.8	46.5
Green Ratio (*g/C*)	0.22	0.58	0.58	0.33	0.33	0.33	0.16	0.16	0.16	0.15	0.34	0.56
Capacity (*c*), veh/h	768	1083	1014	312	1156	525	218	304	260	513	642	906
Volume-to-Capacity Ratio (*X*)	1.062	0.310	0.312	0.140	1.053	0.973	0.449	0.930	0.042	1.095	0.594	0.876
Available Capacity (c_a), veh/h	768	1083	1014	312	1156	525	218	304	260	513	642	906
Back of Queue (*Q*), veh/ln (50th percentile)	18.2	5.2	4.9	1.0	25.7	21.3	3.5	12.5	0.3	12.9	11.7	21.5
Queue Storage Ratio (*RQ*) (50th percentile)	0.78	0.00	0.00	0.21	0.00	1.44	0.25	0.00	0.08	1.11	0.00	1.85
Uniform Delay (d_1), s/veh	52.8	14.4	14.4	32.5	45.5	44.9	52.5	55.9	47.8	55.1	40.3	24.5
Incremental Delay (d_2), s/veh	50.1	0.1	0.1	0.1	41.6	32.3	6.6	36.5	0.3	62.8	3.0	8.9
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	102.8	14.5	14.5	32.5	87.1	77.2	59.1	92.4	48.1	117.9	43.2	33.4
Level of Service (LOS)	F	B	B	C	F	E	E	F	D	F	D	C
Approach Delay, s/veh / LOS	63.6	E		82.9	F		82.8	F		62.9	E	
Intersection Delay, s/veh / LOS	71.1						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.4	B	3.0	C	3.0	C	3.0	C
Bicycle LOS Score / LOS	1.7	A	1.9	A	1.1	A	3.4	C

HCS 2010 Signalized Intersection Results Summary

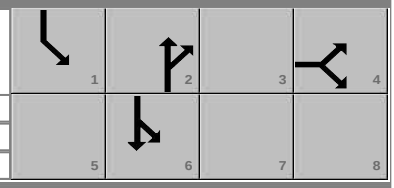
General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak No Build	PHF	0.92
Intersection	I-271 NB On/Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 PM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	500		250					400	1080	90	1390	

Signal Information			
Cycle, s	135.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	6.0	78.4	35.6	0.0	0.0	0.0	
Yellow	3.6	3.6	3.6	0.0	0.0	0.0	
Red	1.4	1.4	1.4	0.0	0.0	0.0	



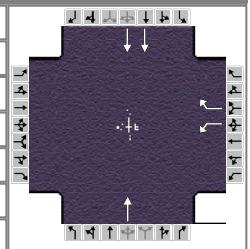
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		9.0				7.3	1.0	4.0
Phase Duration, s		40.6				83.4	11.0	94.4
Change Period, ($Y+R_c$), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.2				0.0	3.1	0.0
Queue Clearance Time (g_s), s		37.6					4.7	
Green Extension Time (g_e), s		0.0				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		1.00					1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	543		272					422	1139	95	1465	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1757		1563					1863	1594	1792	1756	
Queue Service Time (g_s), s	35.6		20.9					18.7	78.4	2.7	33.6	
Cycle Queue Clearance Time (g_c), s	35.6		20.9					18.7	78.4	2.7	33.6	
Green Ratio (*g/C*)	0.26		0.26					0.58	0.58	0.64	0.66	
Capacity (*c*), veh/h	463		412					1082	926	562	2326	
Volume-to-Capacity Ratio (*X*)	1.173		0.659					0.390	1.231	0.169	0.630	
Available Capacity (c_a), veh/h	463		412					1082	926	562	2326	
Back of Queue (*Q*), veh/ln (50th percentile)	28.1		8.4					8.3	26.9	1.1	12.9	
Queue Storage Ratio (*RQ*) (50th percentile)	0.00		0.00					0.00	0.00	0.08	0.00	
Uniform Delay (d_1), s/veh	49.7		44.3					18.5	46.2	11.2	14.0	
Incremental Delay (d_2), s/veh	98.7		3.1					0.1	104.7	0.0	0.7	
Initial Queue Delay (d_3), s/veh	0.0		0.0					0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	148.4		47.4					18.6	150.9	11.2	14.7	
Level of Service (LOS)	F		D					B	F	B	B	
Approach Delay, s/veh / LOS	114.7		F	0.0			115.2		F	14.5		B
Intersection Delay, s/veh / LOS	75.2						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.8	C	2.5	B	1.9	A	1.7	A
Bicycle LOS Score / LOS		F			3.1	C	1.8	A

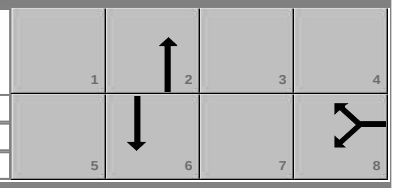
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Parsons Brinckerhoff			Duration, h	0.25
Analyst	Eric Brown	Analysis Date	Aug 29, 2014	Area Type	Other
Jurisdiction	ODOT District 12	Time Period	PM Peak No Build	PHF	0.92
Intersection	I-271 SB Off Ramp	Analysis Year	2036	Analysis Period	1> 7:00
File Name	I-2, I-3, I-4 CUY-271-8.14 PM Peak.xus				
Project Description					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				830		130		900			650	

Signal Information			
Cycle, s	135.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	62.3	63.7	0.0	0.0	0.0	0.0		
Yellow	3.6	4.0	0.0	0.0	0.0	0.0		
Red	1.4	0.0	0.0	0.0	0.0	0.0		

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2		6
Case Number				9.0		8.0		8.0
Phase Duration, s				67.7		67.3		67.3
Change Period, ($Y+R_c$), s				4.0		5.0		5.0
Max Allow Headway (*MAH*), s				3.1		0.0		0.0
Queue Clearance Time (g_s), s				65.7				
Green Extension Time (g_e), s				0.0		0.0		0.0
Phase Call Probability				1.00				
Max Out Probability				1.00				

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2			6	
Adjusted Flow Rate (*v*), veh/h				902		141		885			707	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1900			1809	
Queue Service Time (g_s), s				63.7		6.9		62.3			17.6	
Cycle Queue Clearance Time (g_c), s				63.7		6.9		62.3			17.6	
Green Ratio (*g/C*)				0.47		0.47		0.46			0.46	
Capacity (*c*), veh/h				854		760		877			1669	
Volume-to-Capacity Ratio (*X*)				1.057		0.186		1.010			0.423	
Available Capacity (c_a), veh/h				854		760		877			1669	
Back of Queue (*Q*), veh/ln (50th percentile)				38.1		2.6		36.5			7.7	
Queue Storage Ratio (*RQ*) (50th percentile)				0.00		0.18		0.00			0.00	
Uniform Delay (d_1), s/veh				35.7		20.6		51.0			24.3	
Incremental Delay (d_2), s/veh				46.9		0.0		22.7			0.8	
Initial Queue Delay (d_3), s/veh				0.0		0.0		0.0			0.0	
Control Delay (*d*), s/veh				82.5		20.7		73.7			25.1	
Level of Service (LOS)				F		C		F			C	
Approach Delay, s/veh / LOS	0.0			74.1		E	73.7		E	25.1		C
Intersection Delay, s/veh / LOS	60.9						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.6	B	2.3	B	1.7	A	0.7	A
Bicycle LOS Score / LOS				F	2.1	B	1.1	A

Appendix E

Turn Lane Storage Calculations

CUY-271-9.9/10.5 Safety Study
Turn Lane Length Calculations
Cedar Road @ Brainard Road

MOVEMENT: AM PEAK HOUR (2035)		
Movement	NBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume (T-TR)	150	vph
Number of Through Lanes	2	
Turning Volume	58	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	28%	
Vehicles Per Cycle	1.9	
Storage Length	95	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	145	feet
No Block Distance	125	feet
No Block Turn Lane Length	145	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	WBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	397	vph
Number of Through Lanes	2	
Turning Volume	36	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	8%	
Vehicles Per Cycle	1.2	
Storage Length	60	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	110	feet
No Block Distance	265	feet
No Block Turn Lane Length	265	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	EBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	354	vph
Number of Through Lanes	2	
Turning Volume	390	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	52%	
Vehicles Per Cycle	6.5	
Storage Length	263	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	313	feet
No Block Distance	245	feet
No Block Turn Lane Length	313	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	WBRT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	397	vph
Number of Through Lanes	2	
Turning Volume	73	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	16%	
Vehicles Per Cycle	2.4	
Storage Length	120	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	170	feet
No Block Distance	265	feet
No Block Turn Lane Length	265	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	SBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	523	vph
Number of Through Lanes	1	
Turning Volume	932	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	64%	
Vehicles Per Cycle	15.5	
Storage Length	538	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	588	feet
No Block Distance	610	feet
No Block Turn Lane Length	610	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	SBRT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	523	vph
Number of Through Lanes	1	
Turning Volume	523	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	50%	
Vehicles Per Cycle	17.4	
Storage Length	610	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	660	feet
No Block Distance	610	feet
No Block Turn Lane Length	660	feet

Source: CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CUY-271-9.9/10.5 Safety Study
Turn Lane Length Calculations
Cedar Road @ Brainard Road

MOVEMENT: PM PEAK HOUR (2035)		
Movement	NBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	251	vph
Number of Through Lanes	2	
Turning Volume	72	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	22%	
Vehicles Per Cycle	2.7	
Storage Length	135	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	185	feet
No Block Distance	193	feet
No Block Turn Lane Length	193	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	WBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	1005	vph
Number of Through Lanes	2	
Turning Volume	35	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	3%	
Vehicles Per Cycle	1.3	
Storage Length	65	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	115	feet
No Block Distance	645	feet
No Block Turn Lane Length	645	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	EBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	487	vph
Number of Through Lanes	2	
Turning Volume	609	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	56%	
Vehicles Per Cycle	11.4	
Storage Length	420	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	470	feet
No Block Distance	353	feet
No Block Turn Lane Length	470	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	WBRT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	1005	vph
Number of Through Lanes	2	
Turning Volume	451	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	31%	
Vehicles Per Cycle	16.9	
Storage Length	595	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	645	feet
No Block Distance	645	feet
No Block Turn Lane Length	645	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	SBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	530.5	vph
Number of Through Lanes	1	
Turning Volume	368	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	41%	
Vehicles Per Cycle	6.9	
Storage Length	273	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	323	feet
No Block Distance	670	feet
No Block Turn Lane Length	670	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	SBRT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	530.5	vph
Number of Through Lanes	1	
Turning Volume	530.5	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	50%	
Vehicles Per Cycle	19.9	
Storage Length	673	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	723	feet
No Block Distance	670	feet
No Block Turn Lane Length	723	feet

Source: CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CUY-271-9.9/10.5 Safety Study

Turn Lane Length Calculations

Brainard Road @ NB I-271 Ramps

MOVEMENT: AM PEAK HOUR (2035)		
Movement	NBRT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	98	vph
Number of Through Lanes	1	
Turning Volume	504	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	84%	
Vehicles Per Cycle	8.4	
Storage Length	335	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	385	feet
No Block Distance	155	feet
No Block Turn Lane Length	385	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	SBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	1395	vph
Number of Through Lanes	2	
Turning Volume	103	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	7%	
Vehicles Per Cycle	3.4	
Storage Length	160	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	210	feet
No Block Distance	780	feet
No Block Turn Lane Length	780	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	EBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	625	vph
Number of Through Lanes	2	
Turning Volume	210	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	25%	
Vehicles Per Cycle	7.0	
Storage Length	275	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	325	feet
No Block Distance	385	feet
No Block Turn Lane Length	385	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	EBRT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	210	vph
Number of Through Lanes	1	
Turning Volume	625	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	75%	
Vehicles Per Cycle	10.4	
Storage Length	385	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	435	feet
No Block Distance	275	feet
No Block Turn Lane Length	435	feet

Source: CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CUY-271-9.9/10.5 Safety Study

Turn Lane Length Calculations

Brainard Road @ NB I-271 Ramps

MOVEMENT: PM PEAK HOUR (2035)		
Movement	NBRT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	285	vph
Number of Through Lanes	1	
Turning Volume	1049	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	79%	
Vehicles Per Cycle	19.7	
Storage Length	668	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	718	feet
No Block Distance	390	feet
No Block Turn Lane Length	718	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	SBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	1233	vph
Number of Through Lanes	2	
Turning Volume	96	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	7%	
Vehicles Per Cycle	3.6	
Storage Length	165	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	215	feet
No Block Distance	778	feet
No Block Turn Lane Length	778	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	EBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	213	vph
Number of Through Lanes	1	
Turning Volume	533	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	71%	
Vehicles Per Cycle	10.0	
Storage Length	375	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	425	feet
No Block Distance	320	feet
No Block Turn Lane Length	425	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	EBRT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	533	vph
Number of Through Lanes	2	
Turning Volume	213	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	29%	
Vehicles Per Cycle	8.0	
Storage Length	325	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	375	feet
No Block Distance	373	feet
No Block Turn Lane Length	375	feet

Source: CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CUY-271-9.9/10.5 Safety Study

Turn Lane Length Calculations

Brainard Road @ SB I-271 Exit Ramp

MOVEMENT: AM PEAK HOUR (2035)		
Movement	WBRT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	934	vph
Number of Through Lanes	2	
Turning Volume	65	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	7%	
Vehicles Per Cycle	2.2	
Storage Length	110	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	160	feet
No Block Distance	538	feet
No Block Turn Lane Length	538	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	WBLT	
Design Speed	35	mph
Cycle Length	120	seconds
Control (Stop or Signal)	Signal	
Through Volume	65	vph
Number of Through Lanes	1	
Turning Volume	934	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	93%	
Vehicles Per Cycle	15.6	
Storage Length	540	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	590	feet
No Block Distance	105	feet
No Block Turn Lane Length	590	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	WBRT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	821	vph
Number of Through Lanes	2	
Turning Volume	135	vph
Number of Turning Lanes	1	
Design Condition	A	A, B, or C
Turning Percentage	14%	
Vehicles Per Cycle	5.1	
Storage Length	205	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	255	feet
No Block Distance	533	feet
No Block Turn Lane Length	533	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	WBLT	
Design Speed	35	mph
Cycle Length	135	seconds
Control (Stop or Signal)	Signal	
Through Volume	135	vph
Number of Through Lanes	1	
Turning Volume	821	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	86%	
Vehicles Per Cycle	15.4	
Storage Length	535	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	585	feet
No Block Distance	200	feet
No Block Turn Lane Length	585	feet

Source: CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CUY-271-9.9/10.5 Safety Study

Turn Lane Length Calculations

Brainard Road @ SB I-271 Entrance Ramp

MOVEMENT: AM PEAK HOUR (2035)		
Movement	WBLT	
Design Speed	35	mph
Cycle Length	200	seconds
Control (Stop or Signal)	Signal	
Through Volume	2167	vph
Number of Through Lanes	2	
Turning Volume	599	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	22%	
Vehicles Per Cycle	16.6	
Storage Length	580	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	630	feet
No Block Distance	1850	feet
No Block Turn Lane Length	1850	feet

MOVEMENT: AM PEAK HOUR (2035)		
Movement	EBRT	
Design Speed	35	mph
Cycle Length	200	seconds
Control (Stop or Signal)	Signal	
Through Volume	703	vph
Number of Through Lanes	1	
Turning Volume	1506	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	68%	
Vehicles Per Cycle	41.8	
Storage Length	1304	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	1354	feet
No Block Distance	1225	feet
No Block Turn Lane Length	1354	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	WBLT	
Design Speed	35	mph
Cycle Length	200	seconds
Control (Stop or Signal)	Signal	
Through Volume	2037	vph
Number of Through Lanes	2	
Turning Volume	988	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	33%	
Vehicles Per Cycle	27.4	
Storage Length	897	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	947	feet
No Block Distance	1745	feet
No Block Turn Lane Length	1745	feet

MOVEMENT: PM PEAK HOUR (2035)		
Movement	EBRT	
Design Speed	35	mph
Cycle Length	200	seconds
Control (Stop or Signal)	Signal	
Through Volume	1057	vph
Number of Through Lanes	1	
Turning Volume	1148	vph
Number of Turning Lanes	2	
Design Condition	A	A, B, or C
Turning Percentage	52%	
Vehicles Per Cycle	31.9	
Storage Length	1032	feet
Deceleration/Taper	50	feet
Calculated Turn Lane Length	1082	feet
No Block Distance	1811	feet
No Block Turn Lane Length	1811	feet

Source: CUY-271-9.9/10.5 Safety Study, July 25, 2014.

Appendix F

Cost Estimate

CUY-271-10.87 NB EXIT AT BRAINARD ROAD
CUYAHOGA COUNTY, OHIO
PRELIMINARY CONSTRUCTION ESTIMATE - MARCH 10, 2014 (Revised BMB 4/30/2014)

BRAINARD ROAD IMPROVEMENTS

ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
201	CLEARING AND GRUBBING	1 LS	$ 15,000.00	$ 15,000.00
202	PAVEMENT REMOVED, ASHPALT ON CONCRETE	2675 SY	$ 15.00	$ 40,125.00
202	WALK REMOVED	2775 SF	$ 1.50	$ 4,162.50
202	CURB REMOVED	2655 FT	$ 3.00	$ 7,965.00
202	CATCH BASIN OR INLET REMOVED	11 EA	$ 350.00	$ 3,850.00
203	EXCAVATION	1225 CY	$ 15.00	$ 18,375.00
203	EMBANKMENT	625 CY	$ 12.00	$ 7,500.00
204	SUBGRADE COMPACTION	4610 SY	$ 2.00	$ 9,220.00
206	CEMENT STABILIZED SUBGRADE, 16" DEEP	4430 SY	$ 5.50	$ 24,365.00
252	FULL DEPTH PAVEMENT SAWING	2720 FT	$ 2.00	$ 5,440.00
254	PAVEMENT PLANING, ASPHALT CONCRETE	11485 SY	$ 2.50	$ 28,712.50
304	AGGREGATE BASE, 10"	1200 CY	$ 60.00	$ 72,000.00
407	TACK COAT	1940 GAL	$ 3.00	$ 5,820.00
448	ASPHALT CONCRETE SURFACE COURSE 3"	1335 CY	$ 175.00	$ 233,625.00
452	8" CONCRETE PAVEMENT	3270 SY	$ 75.00	$ 245,250.00
452	6" CONCRETE DRIVE APPROACHES	15 EA	$ 1,500.00	$ 22,500.00
603	15" CONDUIT, TYPE B	380 FT	$ 50.00	$ 19,000.00
604	CATCH BASIN, NO. 3	10 EA	$ 2,500.00	$ 25,000.00
SPEC	HAND RAIL	175 FT	$ 50.00	$ 8,750.00
605	6" BASE PIPE UNDERDRAIN	3445 FT	$ 10.00	$ 34,450.00
606	GUARD RAIL	300 FT	$ 20.00	$ 6,000.00
608	4" CONCRETE WALK	5275 SF	$ 5.00	$ 26,375.00
608	CURB RAMPS	10 EA	$ 1,000.00	$ 10,000.00
609	CURB, TYPE 6	2730 FT	$ 16.00	$ 43,680.00
609	CURB, TYPE SPECIAL 18'	100 FT	$ 50.00	$ 5,000.00
609	CONCRETE TRAFFIC ISLAND	300 SY	$ 75.00	$ 22,500.00
630	SIGNAGE INCLUDING OVERHEAD SIGNS	1 LS	$ 32,500.00	$ 32,500.00
632	TRAFFIC SIGNAL UPGRADES	3 EA	$ 120,000.00	$ 360,000.00
638	FIRE HYDRANT RELOCATED	3 EA	$ 7,500.00	$ 22,500.00
644	PAVEMENT MARKINGS	1 LS	$ 20,000.00	$ 20,000.00
659	TOPSOIL	230 CY	$ 25.00	$ 5,750.00
659	SEEDING AND MULCHING	1150 SY	$ 2.00	$ 2,300.00
832	SWPPP	1 LS	$ 15,000.00	$ 15,000.00
832	EROSION CONTROL	18000 EA	$ 1.00	$ 18,000.00
			Subtotal	$ 1,421,000.00
614	MAINTAINING TRAFFIC	1 LS	$ 25,000.00	$ 25,000.00
619	FIELD OFFICE, TYPE B	9 MN	$ 2,000.00	$ 18,000.00
623	CONSTRUCTION LAYOUT STAKES	1 LS	$ 10,000.00	$ 10,000.00
624	MOBILIZATION	1 LS	$ 100,000.00	$ 100,000.00
			Subtotal	$ 1,574,000.00
			CE&I Costs (7%)	$ 111,000.00
			Total Base Cost Estimate	**$ 1,685,000.00**

Source: Data from CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CY14'-18' Business Plan Inflation Calculator:

Not sure if you have the latest calculator? Click here.

Last Modified: March 28, 2014

Today's Date:
April 28, 2014

Please Enter Values in the Yellow Areas Only:

Estimation Start Date:
Less than or Equal to Today's Date
(mm/dd/yyyy)

4/28/2014
Start Date:

Enter Construction Mid-Point Date:
(cannot exceed 06/01/2025)
(mm/dd/yyyy)

6/30/2015
Construction Mid-Point Date:

Present-Day Estimated Cost:

$1,000,000.00
Estimated Dollar Amount:

Estimate Start Date to Construction Mid-Point Date: **14** **Months**

Inflation - Start to Mid-Point of Construction:

	(compounded growth rate)	Inflated Dollar Amount:
Business Plan	**5.8%**	**$1,058,064.09**

Estimator's Name:

County - Route - Section: CUY-271-11.10

PID: 97676

Estimator's Notes:

Source: Data from CUY-271-9.9/10.5 Safety Study, July 25, 2014.

Source: Data from CUY-271-9.9/10.5 Safety Study, July 25, 2014.

Project Cost Estimate

Project Name	CUY-271-9.90/10.50 Safety Study	Contact Email	brian.blayney@dot.state.oh.us
Project Description	IR-271/Cedar/Brainard Interchange Improvements	Contact Phone	216-584-2102
Reference Number	201405D12-01	Date Performed	3/26/2014
Analyst	Prepared by LJB, Modified by BMB	Analysis Year	2011
Agency/Company	ODOT District 12		

Engineering Design %	10%
Contingency %	30%

Countermeasures	Construction Costs	Right of Way Costs	Engineering Design Costs	Contingency Amount	Total Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value
Site Characteristic Improvements (i.e. Lane widening)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Lighting)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Signal Phasing)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Added Right Turn Lane)			$0.00	$0.00	**$0.00**		
CMF 1 - Provide a left turn lane on one major road approach (ID:4644)	$741,400.00	$0.00	$96,382.00	$222,420.00	**$1,060,202.00**		
CMF 2 - Provide a right turn lane on one major road approach -Signalized (ID:288)	$572,900.00	$0.00	$74,477.00	$171,870.00	**$819,247.00**		
CMF 3 - Improve visibility of signal heads (ID:1430)	$370,700.00	$0.00	$48,191.00	$111,210.00	**$530,101.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
Totals	**$1,685,000.00**	**$0.00**	**$219,050.00**	**$505,500.00**	**$2,409,550.00**	**$0.00**	**$0.00**

Inflation %	6%

Final Costruction Cost:	**$2,551,713.45**

*Final construction cost should match the Project Cost Estimate

CUY-271-9.9-10.5 LONG TERM NB OFF-RAMP
CUYAHOGA COUNTY, OHIO
PRELIMINARY CONSTRUCTION ESTIMATE - JUNE 18, 2013

Add NB lane on NB 271 off ramp at Brainard/Cedar

ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
201	CLEARING AND GRUBBING	1 LS	$ 15,000.00	$ 15,000.00
202	PAVEMENT REMOVED, ASPHALT ON CONCRETE	10000 SY	$ 15.00	$ 150,000.00
202	CATCH BASIN OR INLET REMOVED	8 EA	$ 500.00	$ 4,000.00
203	EXCAVATION	24000 CY	$ 8.00	$ 192,000.00
203	EMBANKMENT	12700 CY	$ 6.00	$ 76,200.00
204	SUBGRADE COMPACTION	19000 SY	$ 1.50	$ 28,500.00
206	CEMENT STABILIZED SUBGRADE, 16" DEEP	10000 SY	$ 5.50	$ 55,000.00
252	FULL DEPTH PAVEMENT SAWING	5000 FT	$ 1.50	$ 7,500.00
254	PAVEMENT PLANING, ASPHALT CONCRETE	500 SY	$ 2.50	$ 1,250.00
448	ASPHALT CONCRETE SURFACE COURSE 6"	3200 CY	$ 175.00	$ 560,000.00
304	AGGREGATE BASE, 10"	5300 CY	$ 50.00	$ 265,000.00
407	TACK COAT	3000 GAL	$ 2.00	$ 6,000.00
452	8" CONCRETE PAVEMENT	19000 SY	$ 75.00	$ 1,425,000.00
603	15" CONDUIT, TYPE B	400 FT	$ 50.00	$ 20,000.00
603	10' X 10' CONDUIT, TYPE A	40 FT	$ 1,500.00	$ 60,000.00
604	CATCH BASIN, NO. 2-2-B	8 EA	$ 2,000.00	$ 16,000.00
604	CONCRETE FLUME	1 EA	$ 20,000.00	$ 20,000.00
605	6" BASE PIPE UNDERDRAIN	5000 FT	$ 6.00	$ 30,000.00
606	GUARD RAIL	1500 FT	$ 15.00	$ 22,500.00
610	RETAINING WALL SOUTH OF STRUCTURE	2250 SF	$ 35.00	$ 78,750.00
622	CONCRETE BARRIER	250 FT	$ 60.00	$ 15,000.00
622	CONCRETE BARRIER END SECTIONS	8 EA	$ 2,500.00	$ 20,000.00
630	SIGNAGE	1 LS	$ 5,000.00	$ 5,000.00
632	OVERHEAD SIGN RELOCATED/REPLACED	4 EA	$ 15,000.00	$ 60,000.00
632	TRAFFIC COUNTER RELOCATED	1 EA	$ 5,000.00	$ 5,000.00
644	PAVEMENT MARKINGS	1 LS	$ 15,000.00	$ 15,000.00
659	SEEDING AND MULCHING	8000 SY	$ 1.50	$ 12,000.00
832	SWPPP	1 LS	$ 5,000.00	$ 5,000.00
832	EROSION CONTROL	40000 EA	$ 1.00	$ 40,000.00
SPEC	RETAINING WALL UNDER STRUCTURE	1 EA	$ 400,000.00	$ 400,000.00
			Subtotal	$ 3,210,000.00
614	MAINTAINING TRAFFIC	1 LS	$ 35,000.00	$ 35,000.00
619	FIELD OFFICE, TYPE B	18 MN	$ 2,000.00	$ 36,000.00
623	CONSTRUCTION LAYOUT STAKES	1 LS	$ 25,000.00	$ 25,000.00
624	MOBILIZATION	1 LS	$ 150,000.00	$ 150,000.00
			Subtotal	$ 3,456,000.00

Notes:

1 R/W and utlilities are not included in this estimate. (New R/W not anticipated)
2 Existing pavement is assumed to be concrete and asphalt on concrete.
3 Pavement widening is assumed to be asphalt on concrete.
4 Construction assumed in 2018

Source: Data from CUY-271-9.9/10.5 Safety Study, July 25, 2014.

CUY-271-9.9-10.5
HOCKING COUNTY, OHIO
PRELIMINARY RIGHT OF WAY ESTIMATE - JUNE 19 2013
RAMP LONG TERM

cel ID	Land Use	Land Value	Structure Value	Total	TOTAL ACREAGE (ACRES)	Structure Impact	Area of Take (SF)	Area: Fee Simple	Area: Temporary	Labor costs	Cost: Fee Simple	Cost: Temporary	Relocation	Sub-Total Cost	Cost to Cure	Comments
17	COMMERCIAL	$492,200	$0	$492,200	5.480	NO	3500	0.080		$8,950	$16,167	$0		$16,167		
									Sub-Totals		**$16,167**	**$0**	**$0**	**$16,167**	**$0**	
	Administrative Costs		[(sub-total)x0.15]x1.20											$2,910		
	Jury trial Costs		[(sub-total)x0.10]x1.50											$2,425		
	Incidental transfer Costs		[(sub-total)x0.90]x0.025											$364		
	All areas are in acres.								**Estimated Cost**					**$21,866**		
									Contingency (50%)					**$10,933**		
									TOTAL COST					**$32,798**		

* Labor Cost Includes the following: (per ODOT Cost Estimating Procedures For Acquiring Rights of Way)	Titles		Detailed Appraisal		Detailed Appraisal Review	Negotiation	Closings	Project Management
	$400		$4,500		$2,000	$1,100	$400	$550

TEMPORARY R/W & COST TO CURE NOT CONSIDERED

Notes:
1 Existing R/W estimated using GIS parcel lines, where available
2 New R/W along substation

Source: Data from CUY-271-9.9/10.5 Safety Study, July 25, 2014.

Source: Data from CUY-271-9.9/10.5 Safety Study, July 25, 2014.

Project Cost Estimate

Project Name	CUY-271-9.9/10.5 SAFETY STUDY	Contact Email	
Project Description	IR-271-Cedar-Brainard Interchange - Safety Improvements	Contact Phone	937-259-5000
Reference Number		Date Performed	7/3/2014
Analyst	VM	Analysis Year	2012
Agency/Company	LJB Inc		IR-271 NB Exit ramp to Cedar/Brainard

Engineering Design %	10%
Contingency %	35%

Countermeasures	Construction Costs	Right of Way Costs	Engineering Design Costs	Contingency Amount	Total Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value
Site Characteristic Improvements (i.e. Lane widening)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Lighting)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Signal Phasing)			$0.00	$0.00	**$0.00**		
Site Characteristic Improvements (i.e. Added Right Turn Lane)			$0.00	$0.00	**$0.00**		
CMF 1 - Change number of lanes on freeway exit ramp from 1 to 2	$3,456,000.00	$32,798.00	$348,879.80	$1,221,079.30	**$5,058,757.10**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
			$0.00	$0.00	**$0.00**		
Totals	**$3,456,000.00**	**$32,798.00**	**$348,879.80**	**$1,221,079.30**	**$5,058,757.10**	**$0.00**	**$0.00**

Inflation %	28%

Final Costruction Cost:	**$6,454,974.06**

*Final construction cost should match the Project Cost Estimate