U.S. Department of Transportation
Federal Highway Administration

Ohio Division

200 North High Street, Rm 328
Columbus, Ohio 43215
614-280-6896
614-280-6876

January 27, 2016

In Reply Refer To:
HDA-OH

Jerry Wray
Director
Ohio Department of Transportation
1980 West Broad Street
Columbus, OH 43223

Dear Director Wray:

This letter is in response to your request for FHWA Ohio Division to review the January 26, 2016, submittal for the January 4th, 2016 *CUY-82-2.93(I-71/SR-82/Shurmer Rd.) PID 96987Interchange Justification Study (IJS).*

This IJS proposes the following modifications:

- Construct a new I-71 SB exit ramp that originates just south of the SR 82 to I-71 SB entrance ramp and terminates at the Howe Rd./Shurmer Rd. intersection.
- Widen Howe Rd. to five lanes (about 2000') from the current five lane section just north of Pomeroy Boulevard to the Howe Rd./Shurmer Rd. intersection.
- Widen the southern and western intersection approaches of the Howe Rd./Shurmer Rd. intersection.
- Optimize signal timings and coordination.

FHWA has reviewed the IJS and understands that this concept will provide for a safe and operationally acceptable design in the future. The modifications will not have a significant adverse impact on the operation of the Interstate facility based on current and future traffic.

The access approval is a two-step process and based on the data provided in the Interchange Justification Study dated January 4th, 2016 FHWA is making a determination that the first step, engineering and operational acceptability is approved. The second step is the final FHWA approval which constitutes a Federal Action and requires that the NEPA procedures are followed. Upon your completion of the NEPA process, submit a request for final approval of the IJS that includes confirmation of completion of the NEPA process and if there were any changes required to the proposed design in the IJS.

If you have any questions or comments, please contact Naureen Dar, Transportation Engineer, at (614) 280-6846, or Naureen.Dar@dot.gov.

Sincerely,

Laura S. Leffler
Division Administrator

e-cc: A. Blalock
N. Dar
Brenton Bogard, ODOT ORES
Brian Blayney, ODOT District 12

File: CUY-96987/Design

OHIO DEPARTMENT OF TRANSPORTATION
CENTRAL OFFICE • 1980 WEST BROAD STREET • COLUMBUS, OH 43223
JOHN R. KASICH, GOVERNOR • JERRY WRAY, DIRECTOR

January 4th, 2016

Ms. Laura S. Leffler
Division Administrator
Federal Highway Administration
200 North High Street
Columbus, Ohio 43215

Re: Ohio Department of Transportation
Interchange Justification Study
CUY-82-2.93 (I-71/SR-82/Shurmer Rd.) PID 96987,
IJS dated December 2015

Dear Ms. Leffler:

Enclosed for your review and approval is the CUY-82-2.93 PID 96987 Interchange Justification Study (IJS).

Improvements include:

- Construct a new I-71 SB exit ramp that originates just south of the SR 82 to I-71 SB entrance ramp and terminates at the Howe Rd./Shurmer Rd. intersection.
- Widen Howe Road to five lanes (about 2000') from the current five lane section just north of Pomeroy Boulevard to the Howe Rd./Shurmer Rd. intersection.
- Widen the southern and western intersection approaches of the Howe Road/Shurmer Rd. intersection.
- Add an additional right turn lane to SR-82 EB to access I-71 NB (as part of a separate project to be constructed in 2017, PID 99435).
- Optimize signal timings and coordination.

The IJS meets the requirements of the ODOT and FHWA. The State recommends the study be approved and your concurrence is requested. If you require any additional information please contact Brenton Bogard at 614-752-5575.

Respectfully,

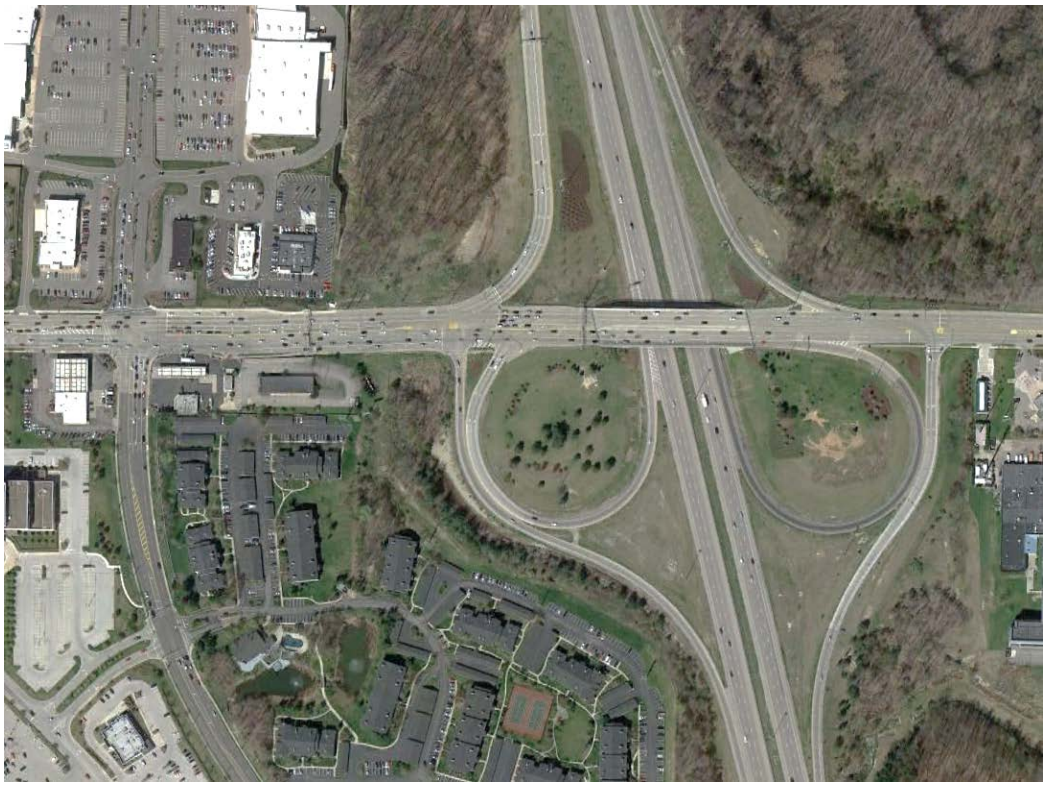
Jerry Wray DLH

Jerry Wray
Director

Enclosure
JW:DLH:blb
c: N. Dar, D. Holstein, R. Bruce, M. Cronebach, L. Hazapis, B. Blayney, File w/ enclosure, Reading File

I-71 at SR 82
Interchange Justification Study

December 28, 2015



Prepared for:

The Ohio Department of Transportation
District 12
5500 Transportation Boulevard
Garfield Heights, OH 44125

The City of Strongsville
16099 Foltz Parkway
Strongsville, OH 44149

Prepared by:

Hatch Mott MacDonald

18013 Cleveland Parkway Drive
Suite 200
Cleveland, OH 44135

Contents

I. Executive Summary

The City of Strongsville commissioned Hatch Mott MacDonald (HMM) to provide documentation to justify a new access point at the Interstate 71 (I-71)/SR 82 interchange (CUY-71-2.57) located in the City of Strongsville, Cuyahoga County, Ohio. The City of Strongsville is looking for a long-term solution to reduce congestion and decrease crashes in the study area. Several short to medium term countermeasures have been implemented or studied with little improvement to congestion or crashes.

HMM evaluated the Build Condition for traffic operations, safety, and to determine any impacts to the existing freeway network. The Build Condition includes adding an additional exit ramp to the I-71/SR 82 interchange from I-71 SB terminating at the Howe Road/Shurmer Road intersection. Additionally, the Build Condition includes widening Howe Road from Shurmer Road to the north and adding an additional SR 82 EB right turn lane to access I-71 NB (currently under design as a separate project).

Based on the analyses presented in this report, the Build Condition does not degrade or otherwise negatively affect freeway operations on I-71. In fact, the Build Condition is expected to improve the efficiency of the SR 82 coordinated signal system (US 42 to I-71 Interchange) and thus reduce travel times, fuel consumption, emissions, and crashes as well as eliminate queues that currently extend onto the I-71 mainline during periods of high traffic volumes.

Figure 1 – No Build LOS Summary

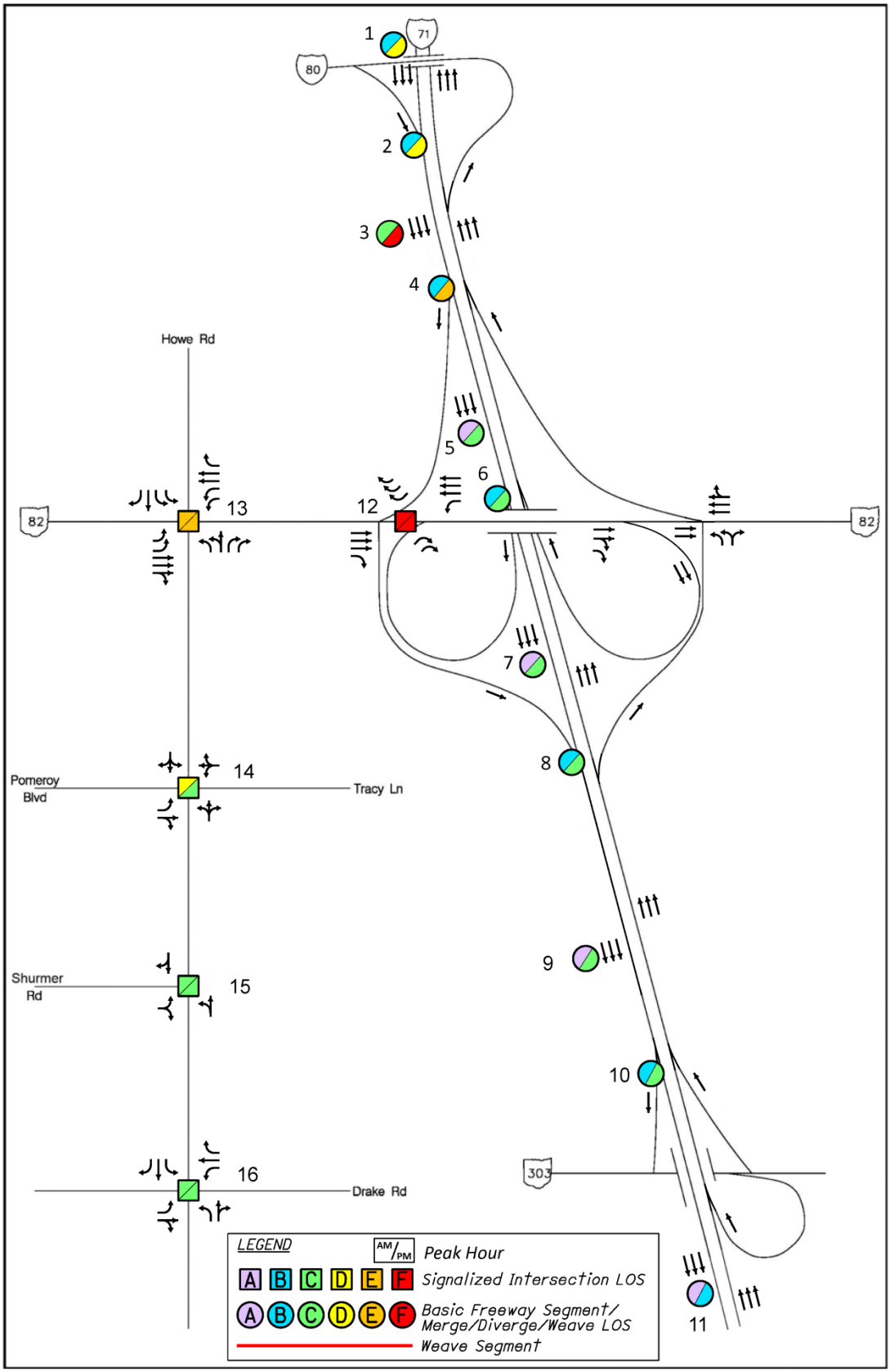
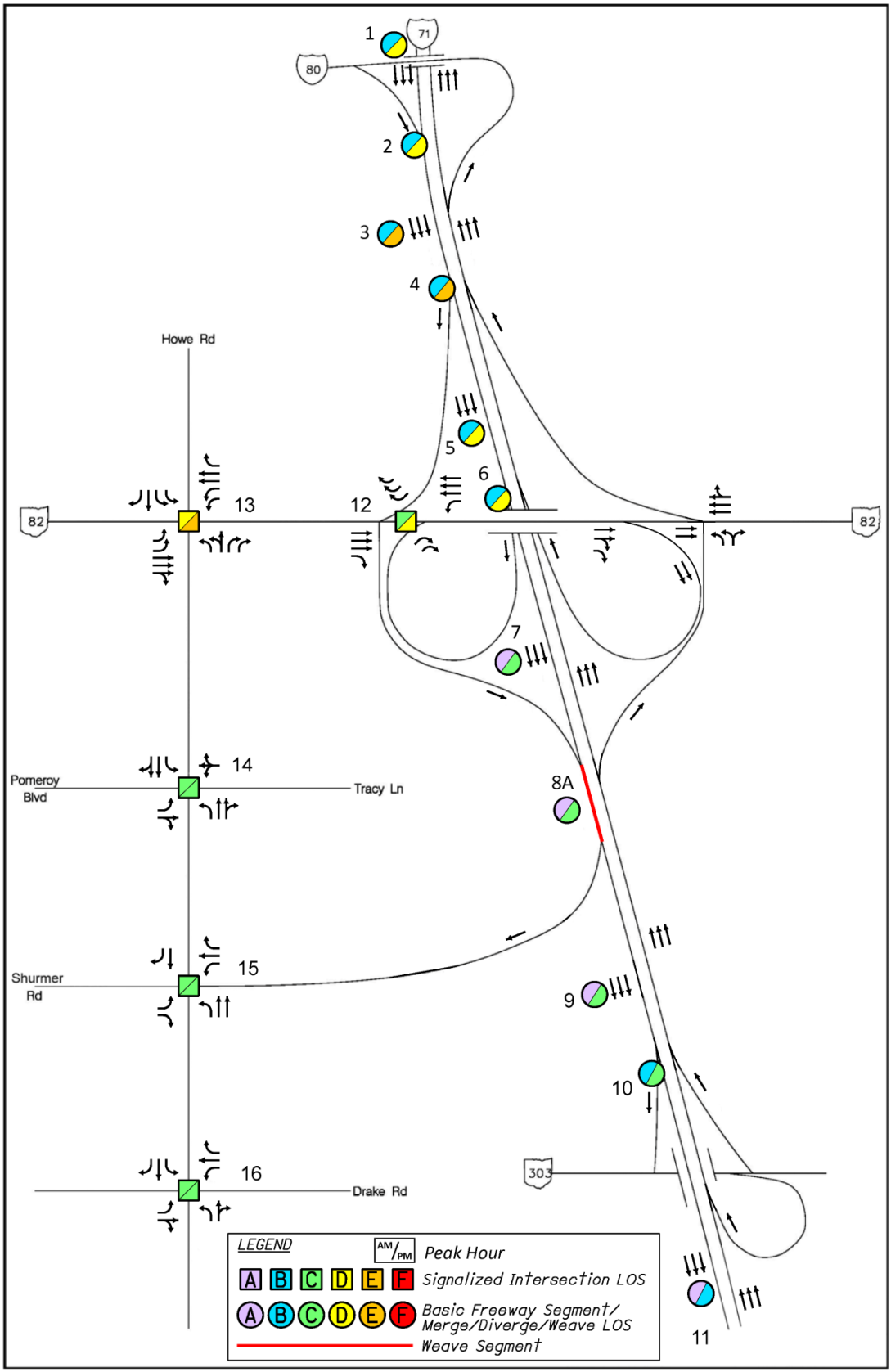


Figure 2 - 2035 Build Condition LOS Summary



II. Background

The City of Strongsville commissioned Hatch Mott MacDonald (HMM) to provide documentation to justify a new access point at the Interstate 71 (I-71) / SR 82 interchange (CUY-71-2.57) located in the City of Strongsville, Cuyahoga County, Ohio. This Interchange Justification Study (IJS) expands upon the preparation of the "*I-71 at SR 82 Interchange Operations Analysis*" completed by HMM on April 15, 2013 and incorporates ODOT comments and initial feedback from the *"I-71 at SR 82 Interchange Modification Study*" completed by HMM on July 18, 2013. This IJS follows ODOT procedures for an IJS as stated in the *Location and Design Manual (L&D), Volume 1, Section 550.5 and in the IJS Traffic Academy Manual*.

A formal safety study was also completed by ODOT District 12 in July of 2012. The study focused on approximately one mile of SR 82 centered at the SR 82/Howe intersection, including the I-71/SR 82 interchange. The safety study focused on short and medium term countermeasures. Several of the short-term countermeasures from the study have already been implemented by the City of Strongsville. Recently implemented short-term improvements include:

- All noted non-functioning loop detectors were repaired.
- All noted non-functioning pedestrian crossings were repaired.
- Made signal displays on Howe Road northbound OMUTCD compliant.
- Intersection dotted lines were re-positioned from the Howe Road northbound right turn lane to SR 82 and Southpark Center Road to SR 82.
- Additional left turn storage length was provided and a second left turn lane added to SR 82 eastbound at Howe Road.
- A signal progression study was performed and timings were improved to reduce queuing onto I-71 southbound to the extent possible. As part of this study, weekend and holiday timing plans were also evaluated and optimized (PID 94550).

In addition, Parsons Brinkerhoff (through District 12) prepared the "*Further Evaluation of Safety Improvements and Congestion Mitigation for the SR 82 Corridor near the I-71 Interchange*" (PID 96987, dated November 2014). This report provided an analysis of additional alternatives on SR 82 to alleviate congestion.

III. Purpose & Need

Congestion on SR 82 at the I-71 interchange and adjacent areas caused by high travel demand is pushing the limits of the existing transportation network. Howe Road from Drake Road to the south mall entrance is identified on NOACA's Long Range Transportation Plan (Connections 2035) as a regional congestion priority. This segment of Howe is ranked #1 in the NOACA region for existing congestion and in the top 10 for forecasted congestion. The congestion has also brought safety concerns as this area is high on ODOT's Highway Safety Program (HSP) Priority List (see Figure 5). The purpose of this study is to examine a long term countermeasure to improve safety by reducing congestion on SR 82 and eliminating queues from the I-71 exit ramps onto mainline I-71.

IV. Study Area

The study area consists of I-71 from the SR 303 interchange to the I-80 (Ohio Turnpike) interchange, SR 82 from west of Howe Road through the I-71 interchange (MP 3.1 through 3.7), and Howe Road from Drake Road to SR 82. See Figure 3 and Figure 4.

Figure 3 – Study Area

Figure 4 - I-71/SR 82 Interchange with Signal Spacing

V. Existing Conditions

a. Road Geometry & Access Locations

The existing I-71 / SR 82 interchange is a full-access, partial cloverleaf interchange. SR 82 is the major east-west roadway through the area and is heavily commerical from US 42 to I-71 with large retail centers on both the north and south sides of the roadway including Southpark Mall to the south. US 42 is a heavily commercial, major north-south arterial located about one mile to the west of I-71. Shurmer Road and areas to the south are largely residential.

Table 1 - Functional Classification

	Functional Class	Legal Speed Limit
I-71	Urban Interstate	60
SR 82	Urban Principal Arterial	35
Howe Rd	Urban Collector	35
Shurmer Rd	Urban Local	25

Current ADT on SR 82 in the project area is approximately 45,000 vehicles per day. The SR 82/Howe intersection averages approximately 60,000 vehicles per day. Signalized intersections along with distances between each are shown on Figure 4. SR 82 traffic signals are part of a coordinated, closed loop system.

b. Physical Conditions – Terrain

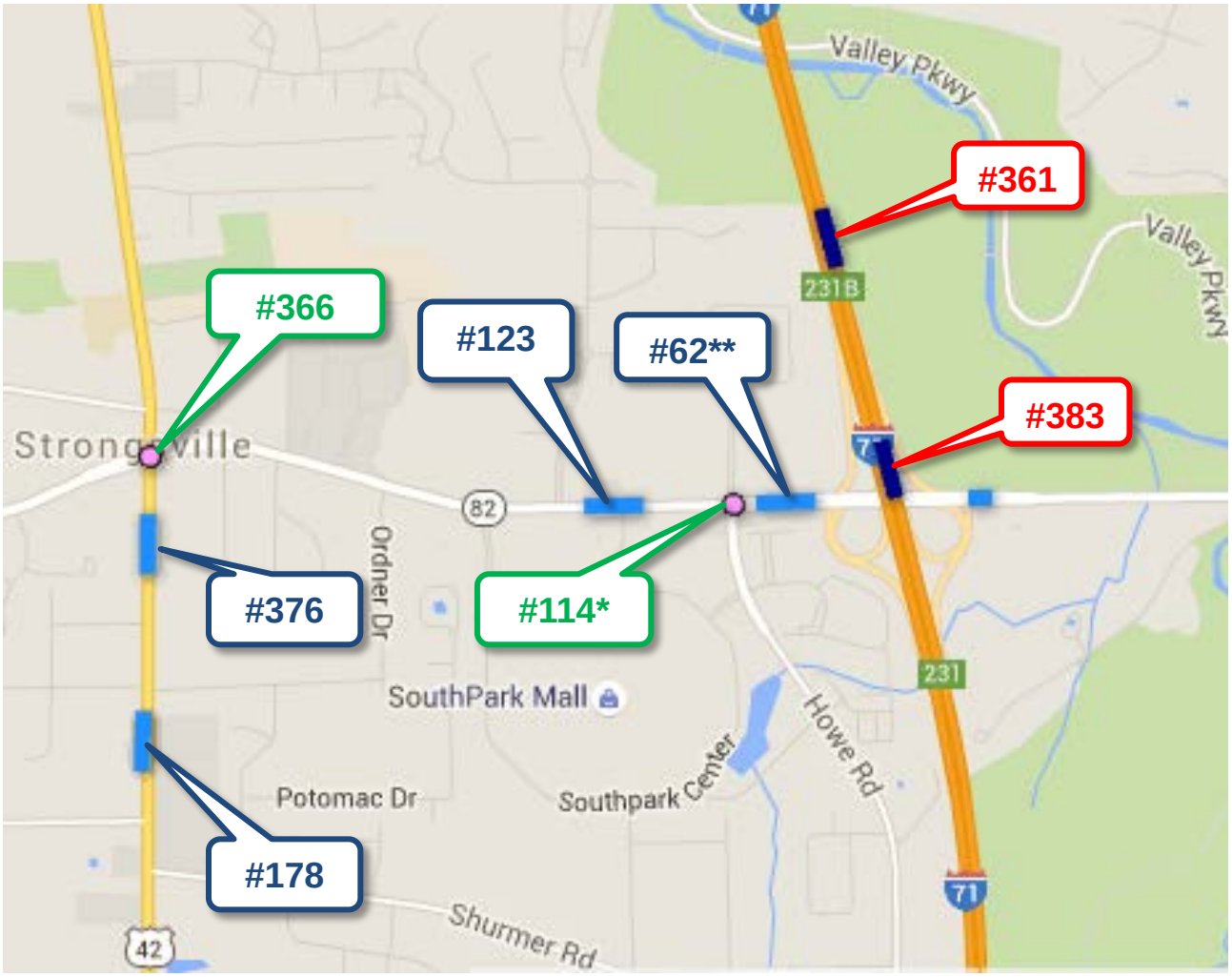
The terrain is relatively flat is this area. I-71 passes under SR 82.

c. Crash Data

Based on the Formal Safety Study completed in July of 2012, an analysis of traffic crashes from 2008 – 2010 revealed that 289 crashes occurred along the SR 82 corridor from MP 2.7 to 3.7 with about 25% of all crashes resulting in an injury. This included 113 crashes directly related to the SR 82/Howe intersection. Rear end crashes account for over 70% of all crashes. Crash frequency is highest during the weekday PM peak hours (4:00 – 7:00 PM), on Saturdays and during the months of November and December. The high crash frequency periods directly correlate with the highest traffic volume periods.

Figure 5 shows the number of ODOT Highway Safety Program safety priority locations that are within the project area.

Figure 5 – 2014 ODOT HSP Priority Rankings



Green = Urban Intersection Safety Priority Location and Rank
Blue = Urban Non-Freeway Safety Priority Location and Rank
Red = Urban Freeway Safety Priority Location and Rank

* SR 82 / Howe Rd - Urban Intersection, HSP Priority Ranking #12 (2012), #99 (2013)

** SR 82 3.26-3.36 - Urban Non-Freeway Segment, HSP Priority Ranking #27 (2012), #32 (2013)

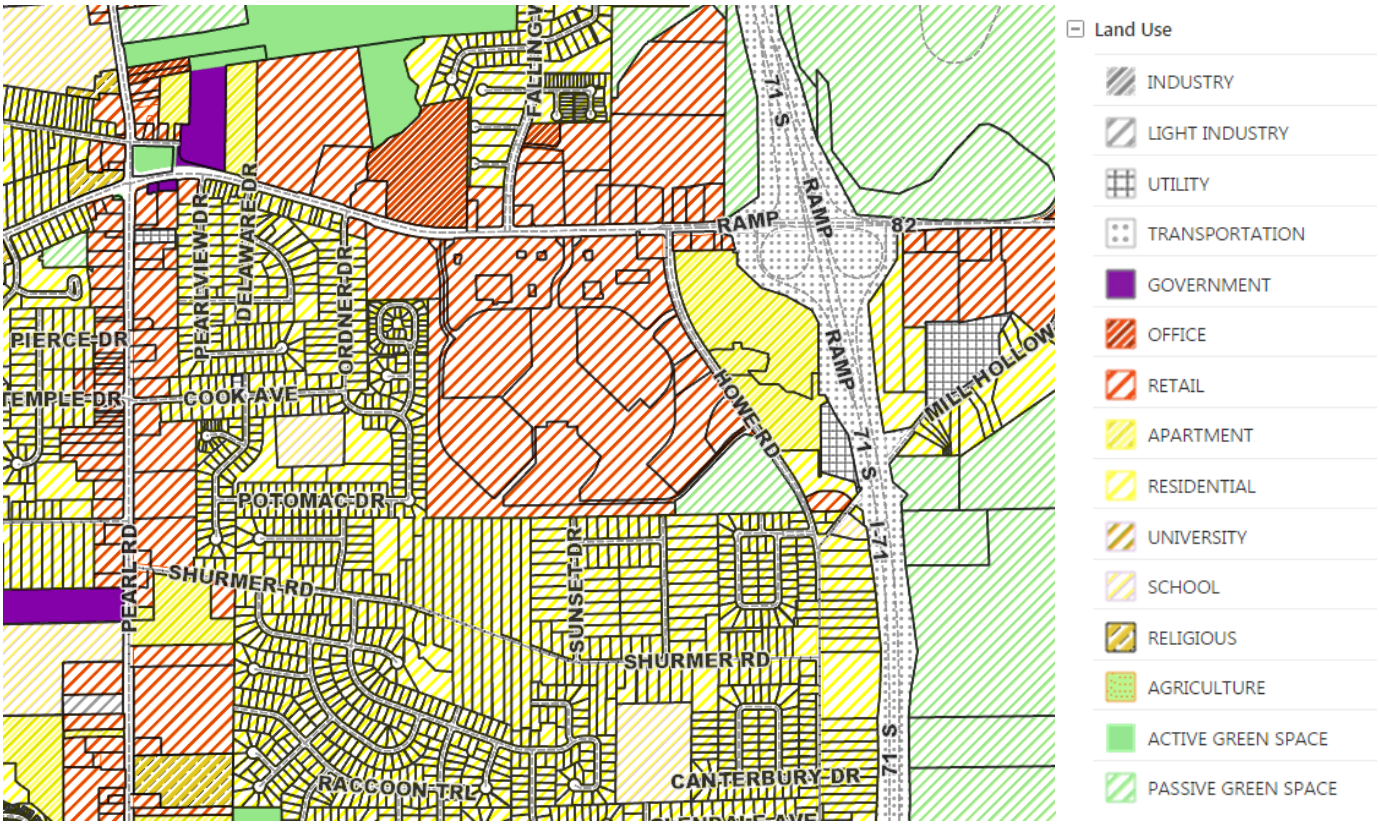
d. Demographics

Per 2013 Census data, The City of Strongsville has a total population of approximately 45,000 people while Cuyahoga County has approximately 1.26 million people. Refer to Appendix A for more detailed information.

e. Land Use

The land use along SR 82 and US 42 is largely commercial. The land use adjacent to these commercial areas is mostly single family residential. See Figure 6 for land use data retrieved from the Cuyahoga County GIS.

Figure 6 - Land Use Map



VI. Analysis Years

The current year traffic used for analysis is considered 2015 while the design year is established as 2035. Traffic analysis within this IJS uses 2035 design year volumes provided by ODOT's Office of Statewide Planning & Research. The No Build condition is defined as the existing geometry and lane use with revised traffic signal timing and coordination. The Build Condition is defined as the proposed improvements as presented in Figure 8. This includes an additional exit ramp from I-71 SB to the Howe Road/Shurmer Road intersection, widening Howe Road to five lanes from Shurmer Road to the existing five lane section north of Pomeroy Boulevard, and widening the SR 82 EB to I-71 NB loop ramp to provide two SR 82 EB right turn lanes. The I-71 NB loop widening is a separate project slated for 2017 construction (PID 99435) and is therefore included in the design year analysis. The proposed signing plan for I-71 SB is shown in Figure 9.

VII. Alternatives Considered

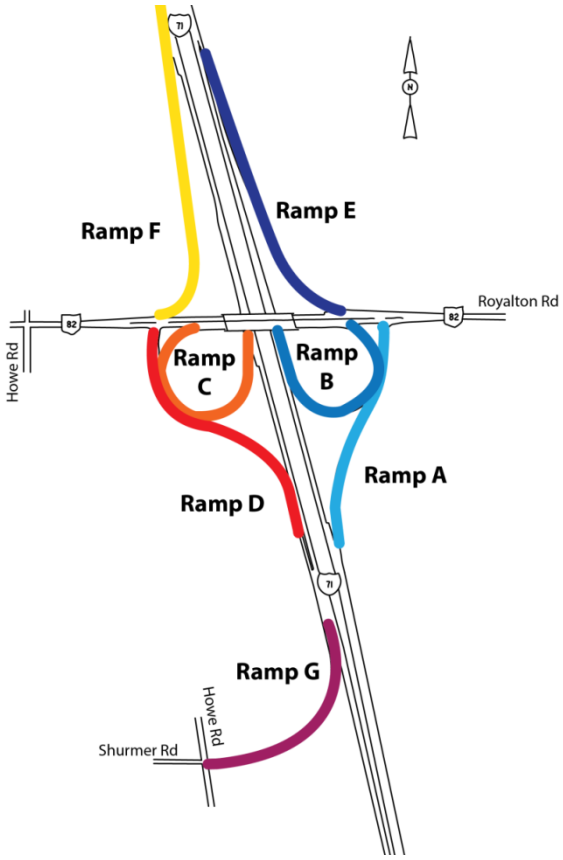
The following alternatives have been considered as part of this or prior studies:

1. No Build – The No Build condition is defined as the existing geometry and lane use.
2. Short-term – several short term improvements have been implemented, are in the process of being implemented, or have been previously studied. They are as follows.
    a. Pavement marking changes – based on the formal safety study from July of 2012, several pavement marking changes have occurred on SR 82 between I-71 and the mall entrances to improve turn lane use and efficiency (ex: the SR 82 EB left turn lane approaching Howe Road was extended based on updated traffic count information).
    b. Widening – HMM has explored widening Howe Road from south of Shurmer Road to the southern mall entrance. This widening is included in the Build condition.
    c. Signal timing / coordination optimization – ODOT completed a signal optimization study and implemented optimized timings for the SR 82 closed loop system which runs from US 42 through the I-71 interchange intersections. In addition, the City of Strongsville is sponsoring a city-wide traffic signal coordination and upgrade project which will include central monitoring and adaptive signal control.
    d. Intersection improvements – the City of Strongsville has studied improvements to the Howe Road/Shurmer Road intersection independent of the Build condition from this IJS.
3. Ramp Metering – ramp metering was dismissed as a viable option at this interchange because the congestion and crash problem is more prevalent on SR 82 and on the I-71 SB to SR 82 WB exit ramp and ramp storage would likely degrade operations of SR 82. In addition, metering is typically applied on a corridor-wide basis and at this ramp metering does not exist in this area. Ramp metering was tried at this interchange in the past for the SR 82 WB to I-71 NB ramp. The ramp metering signal was removed not long after installation.
4. SR 82/Howe Road Intersection Reconstruction – Parsons Brinckerhoff, through ODOT District 12, evaluated alternative intersection designs at the SR 82/Howe intersection such as a roundabout, Continuous Flow Intersection (CFI), and median U-turns in an alternatives study dated November 2014. The close proximately of the I-71 interchange, physical site constraints, major disruption of traffic, and high construction/ROW costs prohibited these options as being viable at this time.
5. New I-71 Interchange – Several studies have been conducted in the past to explore the feasibility of constructing a new interchange on I-71 between SR 303 and SR 82. Based on a teleconference

on March 2, 2015 between HMM, District 12, and the Office of Roadway Engineering, this alternative has been dismissed due to high costs, ROW needs, and a lack of support by local municipalities and ODOT.

6. Collector-Distributor Road – HMM explored a C-D road along I-71 southbound that would begin just south of the SR 82 eastbound exit ramp and tie back into I-71 south of the Howe Road ramp. This alternative was dismissed based on right of way costs, major utility impacts, and negligible operational improvements over the Build Condition.
7. Howe Road/Shurmer Road Entrance Ramp to I-71 – HMM explored adding an entrance ramp to I-71 from the Howe/Shurmer intersection but dismissed this alternative based on negligible operational improvements and the cost of the ramp.
8. Build – The Build condition studied in this report will represent the following proposed conditions:
    a. Construct a new I-71 SB exit ramp that originates just south of the SR 82 to I-71 SB entrance ramp and terminates at the Howe Road/Shurmer Road intersection.
    b. Widen Howe Road to five lanes (about 2000') from the current five lane section just north of Pomeroy Boulevard to the Howe Road/Shurmer Road intersection.
    c. Widen the southern and western intersection approaches of the Howe Road/Shurmer Road intersection.
    d. Add an additional right turn lane to SR 82 EB to access I-71 NB (as part of a separate project to be constructed in 2017, PID 99435).
    e. Optimize signal timings and coordination.

Figure 7 - Build Interchange Ramp Configuration



Build Condition Design Standards

The proposed Build condition improvements meet ODOT design standards pertaining to roadway geometrics and interchange elements.

Build Condition Limits of L/A ROW

Given the Build conditions of an additional I-71 SB exit ramp that terminates at the Howe Road / Shurmer Road intersection, the intent would be to permit all residential driveways to remain while not allowing commercial driveways to be constructed within 600 feet of the ramp terminus. This restricts future commercial growth without the need to acquire residential properties.

Figure 8 - Build Condition

Figure 9 - Proposed I-71 SB Signing Plan

VIII. Traffic Volumes

ODOT's Office of Statewide Planning & Research provided certified traffic forecasts on June 19, 2013. Certified traffic was provided for AM/PM peaks, ADT's, and truck factors for 2015 (current year) and 2035 (design year). See Appendix B for certified traffic.

To assist in the development of certified traffic forecasts, HMM completed an Origin-Destination (O-D) Study in 2013 to determine traffic patterns in the area and in particular to help determine proposed volumes on the new I-71 SB to Howe Road exit ramp. The results of this study are available in the *I-71 at SR 82 Origin-Destination Study* dated April 5, 2013.

IX. Traffic Analyses

Level of Service

Per the Highway Capacity Manual, a Level of Service (LOS) C is desired for the interstate/freeway system and interchange components of the Build condition. The Northeast Ohio Areawide Coordinating Agency (NOACA) accepts LOS D or better within their MPO boundaries. Regardless of delay, any intersection which has a volume-to-capacity (v/c) ratio over 1.0 is considered failing and will be labeled LOS F. Analysis was based on a cycle length of 150 seconds (AM and PM) for all intersections on SR 82 and 110 seconds (AM and PM) for all intersections on Howe Road. The SR 82/Howe Road intersection was analyzed at 150 second cycles. Full capacity reports are available in Appendix C.

Intersections

Traffic analysis was completed for intersection locations in Figure 10 for AM and PM peaks for the No Build and Build Alternatives. All intersections were analyzed using *Highway Capacity Software* (*HCS) 2010* to determine LOS for existing conditions (No Build) and to appropriately size the intersections for proposed conditions (Build). No Build analyses followed ODOT balancing procedures where the worst east-west approach was balanced within three seconds of the worst north-south approach where possible. In addition, the signals along SR 82 were analyzed in *Synchro 8* to measure coordination parameters and the interaction between signals within the SR 82 closed loop system (see Figure 11).

HCS Results for No Build and Build design year traffic are presented on the following page. Note that the intersection of I-71 SB and SR 82 was not analyzed in HCS because the existing signal phasing and intersection geometrics exceeds the capabilities of HCS and therefore any analysis in HCS would not be reliable. This intersection was analyzed in Synchro as an isolated intersection (presented on the following page) as well as part of the SR 82 coordinated system.

<u>HCS/Isolated Intersection Build Analysis</u>

- All intersections operate at an acceptable LOS D or better in the AM Build condition.
- The SR 82/Howe intersection operates at a LOS E in the PM Build condition.
- All other intersections operate at an acceptable LOS D or better in the PM Build condition.

<u>Synchro Coordination Analysis</u>

- All intersections operate at a LOS D or better for both AM and PM in the Build condition.

Figure 10 – Intersection LOS Summary

AM No Build vs Build

ID	Location	2035 No Build		2035 Build	
		LOS	Delay	LOS	Delay
12	**SR 82 & I-71 SB[1]**	**F**	**85.2**	**C**	**26.7**
	EB Approach	F	111.6	C	23.6
	WB Approach	C	29.8	C	22.9
	NB Approach	E	60.1	C	33.1
	SB Approach	F	110.0	D	43.1
13	**SR 82 & Howe**	**E**	**61.1**	**D**	**54.6**
	EB Approach	D	43.9	D	54.5
	WB Approach	F*	70.1	D	54.5
	NB Approach	E	67.8	D	54.8
	SB Approach	E	56.2	D	54.7
14	**Howe & Pomeroy/Tracy**	**D**	**37.7**	**C**	**34.7**
	EB Approach	D	46.1	C	34.4
	WB Approach	D	46.6	D	35.1
	NB Approach	D	45.0	D	35.0
	SB Approach	A	8.7	C	29.4
15	**Howe & Shurmer**	**C**	**30.5**	**C**	**25.2**
	EB Approach	C	30.5	C	25.5
	WB Approach	-	-	C	26.7
	NB Approach	C	33.1	C	24.6
	SB Approach	C	20.2	C	27.6
16	**Howe & Drake**	**C**	**27.9**	*(same as No Build)*	
	EB Approach	C	22.1		
	WB Approach	C	32.5		
	NB Approach	C	31.5		
	SB Approach	C	23.4		

PM No Build vs Build

ID	Location	2035 No Build		2035 Build	
		LOS	Delay	LOS	Delay
12	**SR 82 & I-71 SB[1]**	**F**	**104.2**	**D**	**41.6**
	EB Approach	F	145.7	D	41.8
	WB Approach	F*	54.9	D	39.9
	NB Approach	F	145.1	D	42.9
	SB Approach	F*	70.3	D	43.0
13	**SR 82 & Howe**	**E**	**73.2**	**E**	**61.9**
	EB Approach	F*	79.0	E	57.8
	WB Approach	F*	73.7	F*	63.2
	NB Approach	E	55.7	E	64.7
	SB Approach	E	78.6	E	65.6
14	**Howe & Pomeroy/Tracy**	**C**	**33.9**	**C**	**31.3**
	EB Approach	D	45.1	C	33.6
	WB Approach	D	46.0	C	33.7
	NB Approach	B	15.9	C	33.8
	SB Approach	D	45.7	C	26.0
15	**Howe & Shurmer**	**C**	**27.5**	**C**	**27.7**
	EB Approach	C	34.9	C	28.6
	WB Approach	-	-	C	28.2
	NB Approach	B	14.3	C	26.6
	SB Approach	D	35.2	C	28.2
16	**Howe & Drake**	**C**	**26.4**	*(same as No Build)*	
	EB Approach	C	24.8		
	WB Approach	C	33.1		
	NB Approach	C	32.9		
	SB Approach	C	21.7		

[1] *SR 82 & I-71 SB analysis completed in Synchro. Unable to analyze in HCS due to limits of software*

** LOS is F because v/c > 1.0*

Figure 11 – SR 82 Coordinated System LOS Summary

AM No Build vs Build

ID	Location	2035 No Build		2035 Build	
		LOS	Delay	LOS	Delay
	SR 82 & I-71 NB	**B**	**17.9**	**B**	**12.9**
	EB Approach	A	4.7	B	12.2
	WB Approach	B	11.1	A	8.8
	NB Approach	E	61.8	C	31.7
12	**SR 82 & I-71 SB**	**E**	**57.7**	**C**	**29.3**
	EB Approach	F	80.2	C	25.0
	WB Approach	C	28.3	C	23.8
	NB Approach	E	58.8	D	35.4
	SB Approach	D	43.9	D	51.4
13	**SR 82 & Howe**	**F**	**125.4**	**D**	**36.4**
	EB Approach	F	221.4	D	42.9
	WB Approach	C	34.4	B	19.7
	NB Approach	F	174.2	D	53.3
	SB Approach	D	51.9	D	51.9

PM No Build vs Build

ID	Location	2035 No Build		2035 Build	
		LOS	Delay	LOS	Delay
	SR 82 & I-71 NB	**B**	**16.5**	**B**	**10.7**
	EB Approach	A	7.2	A	6.9
	WB Approach	A	9.6	A	6.8
	NB Approach	E	63.7	D	40.6
12	**SR 82 & I-71 SB**	**F**	**105.5**	**D**	**47.3**
	EB Approach	F	137.4	D	50.9
	WB Approach	D	54.3	D	42.2
	NB Approach	F	139.7	D	50.4
	SB Approach	F	91.0	D	45.4
13	**SR 82 & Howe**	**F**	**130.4**	**D**	**46.3**
	EB Approach	F	204.8	D	43.0
	WB Approach	F	117.5	D	35.9
	NB Approach	D	53.5	E	65.1
	SB Approach	E	69.1	E	67.7

Freeway Segment Analysis

HMM analyzed freeway segments on I-71 SB following ODOT methodology using *HCS 2010*. Segments were analyzed between interchanges and within interchanges between merge and diverge points.

Note that the segment from I-80 to SR 82 (ID 3) cannot be accurately modeled in HCS using basic freeway segment analysis due to downstream congestion and rolling queues from the SR 82 interchange, largely stemming from the SR 82 WB Exit. HCS cannot factor preferential lane use of Lane 3 (the outside, western-most lane). To account for this, HMM calculated capacity for Lanes 1 and 2 separately from Lane 3. Lane 3 volume was assumed to be all of SR 82 WB exiting traffic plus half of SR 82 EB exiting traffic. This methodology produces a density and LOS that is more reflective of observed conditions. The Build Condition is expected to improve this condition by rebalancing the lane distribution given the additional exit ramp to Howe Road. A summary of the segment analysis is below.

- In the PM, the SB segment of I-71 SB from the I-80 to the SR 82 WB Exit is LOS F for the No Build Condition and LOS E for the Build Condition.
- The proposed Build conditions do not degrade freeway segment operations as defined in the IJS Traffic Academy Manual.

Figure 12 – Freeway Segment LOS Summary

AM No Build vs Build

ID	I-71 Southbound	Lanes	2035 No Build		2035 Build	
			LOS	Density	LOS	Density
@ I-80						
1	@ I-80	3	B	12.3	*same as No Build*	
3	I-80 to SR 82	3	C	19.0	B	15.0
@ SR 82						
5	SR 82 WB Exit to EB Exit	3	A	9.7	B	11.2
7	SR 82 EB Exit to SR 82 Enter	3	A	7.7	A	9.2
@ Howe						
9	Howe to SR 303	3	A	9.8	*same as No Build*	
11	@ SR 303	3	A	6.2	*same as No Build*	

PM No Build vs Build

ID	I-71 Southbound	Lanes	2035 No Build		2035 Build	
			LOS	Density	LOS	Density
@ I-80						
1	@ I-80	3	D	32.6	*same as No Build*	
3	I-80 to SR 82	3	F	49.7	E	37.9
@ SR 82						
5	SR 82 WB Exit to EB Exit	3	C	23.0	D	26.9
7	SR 82 EB Exit to SR 82 Enter	3	C	18.4	C	21.8
@ Howe						
9	Howe to SR 303	3	C	21.4	*same as No Build*	
11	@ SR 303	3	B	13.6	*same as No Build*	

Figure 13 - I-71 SB Queues at SR 82 WB Exit Ramp

Merge / Diverge Analysis

HMM analyzed LOS at merge and diverge points along I-71 SB within the project area following ODOT methodology using *HCS 2010*. Note that the SR 82 entrance ramp merge to I-71 SB is a weave in the Build condition and is discussed in the subsequent section.

- In the PM, the I-71 SB diverge to SR 82 WB operates at LOS E for the No Build & Build conditions.
- The proposed Build conditions do not degrade freeway operations for merge and diverge points.

Figure 14 – Merge/Diverge LOS Summary

AM No Build vs Build

ID	I-71 Southbound	2035 No Build		2035 Build	
		LOS	Density	LOS	Density
@ I-80					
2	Merge - from I-80	B	16.3	*(same as No Build)*	
@ SR 82					
4	Diverge - to SR 82 WB	B	19.5	B	18.8
6	Diverge - to SR 82 EB	B	13.4	B	15.1
8	Merge - from SR 82	B	10.8	-	-
@ SR 303					
10	Diverge - to SR 303	B	14.2	*(same as No Build)*	

PM No Build vs Build

ID	I-71 Southbound	2035 No Build		2035 Build	
		LOS	Density	LOS	Density
@ I-80					
2	Merge - from I-80	D	32.9	*(same as No Build)*	
@ SR 82					
4	Diverge - to SR 82 WB	**E**	38.7	**E**	36.2
6	Diverge - to SR 82 EB	C	27.5	D	30.3
8	Merge - from SR 82	C	21.9	-	-
@ SR 303					
10	Diverge - to SR 303	C	27.6	*(same as No Build)*	

Weave Analysis

HMM analyzed the weave segment on I-71 SB between the SR 82 entrance ramp and the Howe Road exit ramp following ODOT methodology using *HCS 2010*. The analysis only accounted for the Build condition as the No Build condition is a merge.

- The Build Condition does not degrade freeway operations at the weave segment.

Figure 15 – Weave LOS Summary

AM Build				PM Build			
ID	I-71 Southbound	2035 Build		ID	I-71 Southbound	2035 Build	
		LOS	Density			LOS	Density
	SR 82 Entrance to Howe Exit				**SR 82 Entrance to Howe Exit**		
8A	Weave - I-71	A	9.9	8A	Weave - I-71	C	24.1

Turn Lane Storage Length Recommendations

HMM calculated turn lane storage lengths based on 2035 Build condition turning movement traffic volumes as per the ODOT L&D Volume 1 using the same cycle lengths as the capacity analysis. Below is a summary of calculated and recommended turn lane lengths at locations with proposed changes. Full calculations are provided in Appendix D.

Figure 16 – Turn Lane Calculation Summary

Build Intersection *(cycle length in sec)*	Volume (vph)			Lanes			L&D Length (ft)*		Thru Backup (ft)	**Recommend Length (ft)***		Reason
	LT	THRU	RT	LT	THRU	RT	LT	RT		**LT**	**RT**	
Howe & Shurmer *(110)*												
EB Shurmer	100	-	50	1	1	^	225	150	150	**225**	-	
WB I-71 Exit Ramp	520	90	210	1	1	^	600	325	150	**600**	**600**	form both lanes at same pt.
NB Howe	50	660	-	1	2	-	150	-	365	**150**	-	limit ROW impacts, low turn vol.
SB Howe	-	440	50	-	1	1	-	150	525	-	-	rt lane will form from thru lane
Howe & Pomeroy/Tracy *(110)*												
NB Howe	10	1210	10	1	2	-	100	-	600	**150**	-	lack of turn traffic, presence of TWLTL, & drives
SB Howe	20	590	20	1	1	-	100	-	625	**150**	-	lack of turn traffic & presence of TWLTL
SR 82 & I-71 SB *(150)*												
WB SR 82	310	1190	-	1	3	-	525	-	517	**300**	-	constrained by existing bridge

**includes 50 ft taper*

^shared thru/right lane

X. Cost Estimates

The cost estimates provided below breakdown the improvements for the Build Condition. A detailed cost estimate is provided in Appendix E.

Table 2 - Build Condition Cost Estimate

Summary of I71_SR82 Interchange Improvements Probable Costs Build Condition		
Section	**Cost**	
Howe Road Off Ramp and Intersection Improvements	$	4,700,000
Howe Road Widening (5 lanes) North of Shurmer	$	3,000,000
Total	***$***	***7,700,000***

XI. Environmental Overview

At this time the full scope of the environmental impacts is unknown until more detailed environmental analysis is completed. Preliminarily, the Build Condition will have permanent right of way impacts but no major utility impacts. Noise walls will likely be needed. The CE document level will be determined with further development of the Build Condition.

XII. Conclusion and Recommendations

The I-71/SR 82 interchange is heavily congested due traffic demand from commercial areas adjacent to the interchange as well as the large residential population surrounding the commercial areas. Travel delays are high due to the congestion and a number of closely spaced signalized intersections. In addition, crash frequency is high within the study area as many locations fall under ODOT's Highway Safety Program Priority List.

The Build Condition is expected to reduce delay at the SR 82/Howe and SR 82/I-71 SB intersections, particularly in the PM peak (which is similar to Saturday and holiday season volumes per recent ODOT traffic counts and studies). This delay reduction is based on redirecting vehicles currently utilizing the I-71 SB to SR 82 exit ramp as well as the SR 82 corridor and redirecting them to the Howe Road exit ramp. Nearly 7,000 vehicles a day are expected to utilize to the Howe Road exit ramp in the Build Conditions with nearly 400 vehicles in the AM peak and over 800 in the PM peak. Removing these vehicles from the SR 82/Howe Road intersection allows the existing roadway system to work better.

The Build Condition does not degrade freeway operations. All intersections, freeway segments, merge, diverge, and weave segments operate with equal or improved LOS between No Build and Build conditions.

The Build Condition is expected to operate with similar levels of service for freeway segments and merge/diverge conditions. The weave between the SR 82 to I-71 SB entrance ramp and the Howe Road exit ramp is expected to operate at a LOS C or better.

The Build Condition is expected to improve traffic operations at the I-71/SR 82 interchange and the SR 82 corridor within and adjacent to the interchange without degrading freeway operations.

Appendix A

2013 Census Data

OH - Cuyahoga County

Population

Total Population	1,280,122

Housing Status

(in housing units unless noted)

Total	621,763
Occupied	545,056
Owner-occupied	331,876
Population in owner-occupied (number of individuals)	804,136
Renter-occupied	213,180
Population in renter-occupied (number of individuals)	446,735
Households with individuals under 18	154,582
Vacant	76,707
Vacant: for rent	32,522
Vacant: for sale	9,679

Population by Sex/Age

Male	607,362
Female	672,760
Under 18	290,262
18 & over	989,860
20 - 24	78,335
25 - 34	157,986
35 - 49	254,121
50 - 64	266,049
65 & over	198,541

Population by Ethnicity

Hispanic or Latino	61,270
Non Hispanic or Latino	1,218,852

Population by Race

White	814,103
African American	380,198
Asian	32,883
American Indian and Alaska Native	2,578
Native Hawaiian and Pacific Islander	285
Other	23,339
Identified by two or more	26,73

OH - Strongsville city

Population

Total Population	44,750

Housing Status

(in housing units unless noted)

Total	18,476
Occupied	17,659
Owner-occupied	14,270
Population in owner-occupied (number of individuals)	37,978
Renter-occupied	3,389
Population in renter-occupied (number of individuals)	6,468
Households with individuals under 18	5,571
Vacant	817
Vacant: for rent	316
Vacant: for sale	205

Population by Sex/Age

Male	21,766
Female	22,984
Under 18	10,405
18 & over	34,345
20 - 24	1,951
25 - 34	4,014
35 - 49	9,567
50 - 64	10,686
65 & over	7,189

Population by Ethnicity

Hispanic or Latino	912
Non Hispanic or Latino	43,838

Population by Race

White	41,185
African American	845
Asian	1,833
American Indian and Alaska Native	42
Native Hawaiian and Pacific Islander	14
Other	190
Identified by two or more	641

OH - Medina County

Population

Total Population	172,332

Housing Status

(in housing units unless noted)

Total	69,181
Occupied	65,143
Owner-occupied	52,536
Population in owner-occupied (number of individuals)	143,720
Renter-occupied	12,607
Population in renter-occupied (number of individuals)	27,414
Households with individuals under 18	22,966
Vacant	4,038
Vacant: for rent	1,400
Vacant: for sale	880

Population by Sex/Age

Male	84,941
Female	87,391
Under 18	43,741
18 & over	128,591
20 - 24	7,801
25 - 34	17,926
35 - 49	39,633
50 - 64	36,696
65 & over	22,601

Population by Ethnicity

Hispanic or Latino	2,747
Non Hispanic or Latino	169,585

Population by Race

White	165,642
African American	2,027
Asian	1,660
American Indian and Alaska Native	247
Native Hawaiian and Pacific Islander	18
Other	652
Identified by two or more	2,086

OH - Brunswick city

Population

Total Population	34,255

Housing Status

(in housing units unless noted)

Total	13,600
Occupied	12,967
Owner-occupied	10,190
Population in owner-occupied (number of individuals)	27,816
Renter-occupied	2,777
Population in renter-occupied (number of individuals)	6,239
Households with individuals under 18	4,695
Vacant	633
Vacant: for rent	322
Vacant: for sale	135

Population by Sex/Age

Male	16,830
Female	17,425
Under 18	8,644
18 & over	25,611
20 - 24	1,738
25 - 34	3,983
35 - 49	8,040
50 - 64	6,949
65 & over	4,079

Population by Ethnicity

Hispanic or Latino	790
Non Hispanic or Latino	33,465

Population by Race

White	32,706
African American	422
Asian	420
American Indian and Alaska Native	51
Native Hawaiian and Pacific Islander	6
Other	204
Identified by two or more	44

Appendix B

Certified Traffic

INTER-OFFICE COMMUNICATION

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

FROM: Becky Salak, Transportation Planner, Office of Statewide Planning and Research

SUBJECT: **CUY-71-2.57, No PID *Revised***

DATE: June 19, 2013

The attached plates have been revised, and replace the plates sent with the June 14, 2013 IOC.

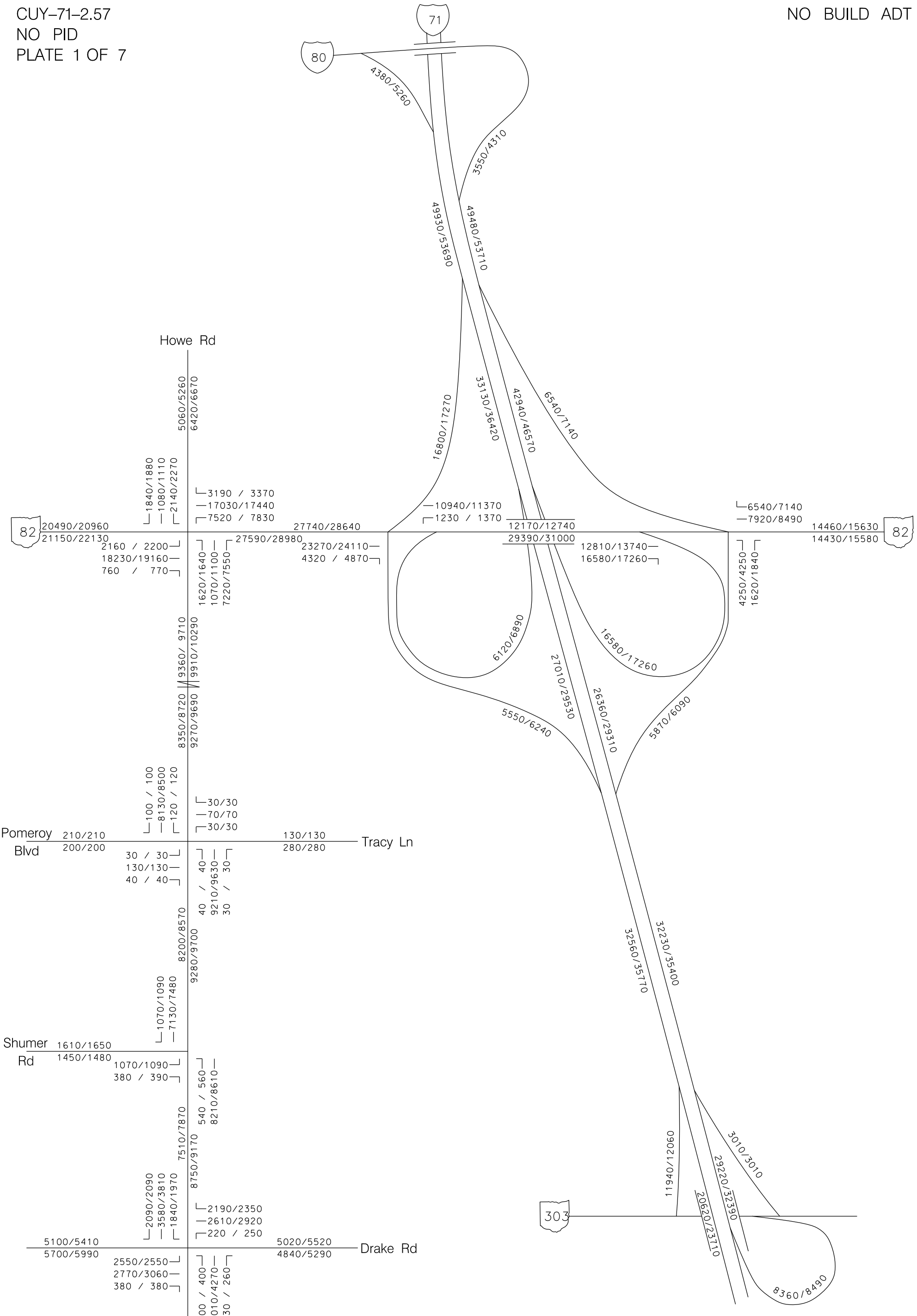
In reply to a request received May 24, 2013, plates are attached showing 2015/2035 ADT, A.M. DHV, and P.M. DHV turning movement forecasts for the no build and build scenarios. K & D factors can be calculated as needed. Truck factors are shown on a separate plate.

If you have any questions, please contact me at (614) 644-8195.

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

CUY–71–2.57
NO PID
PLATE 1 OF 7

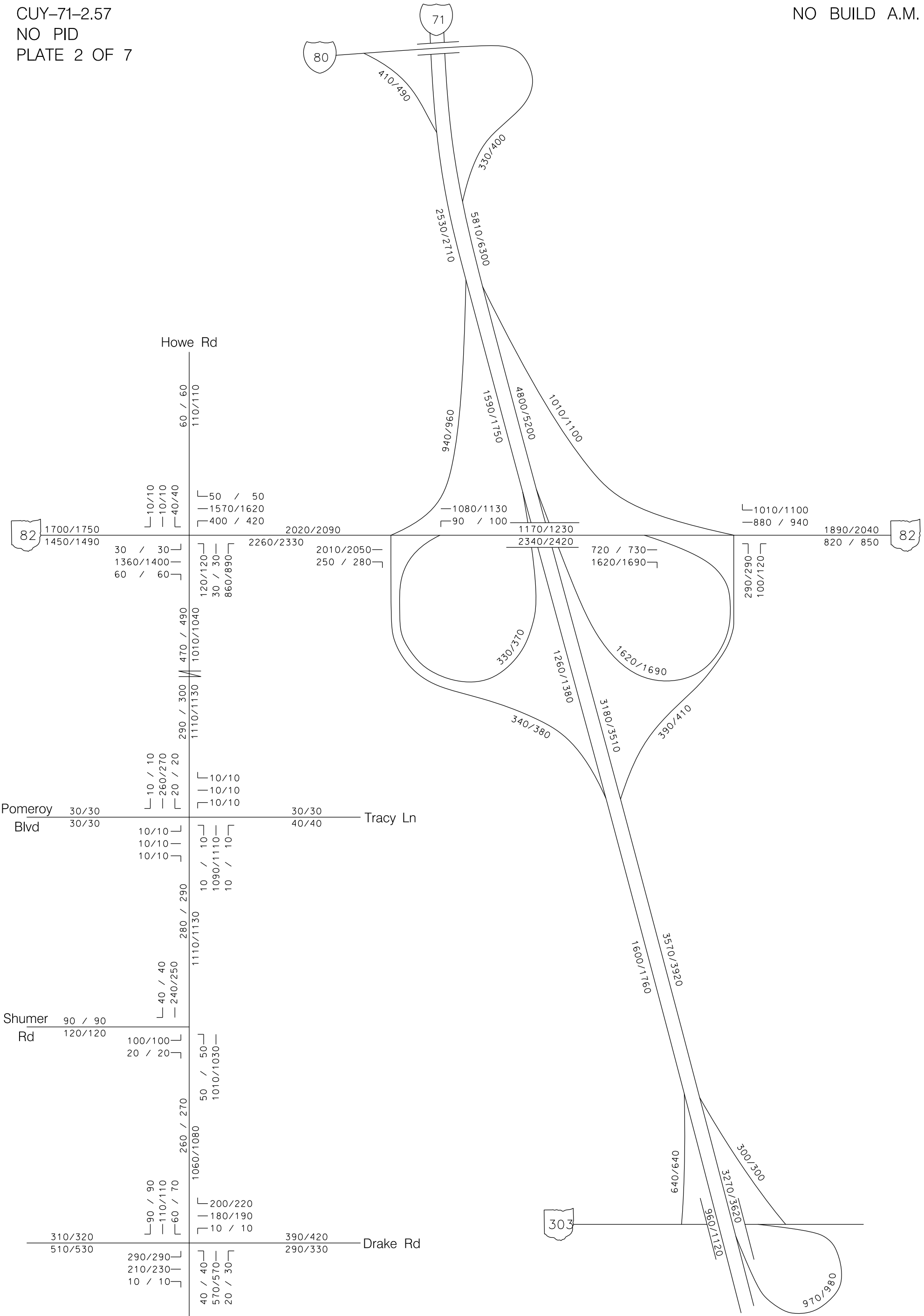
NO BUILD ADT



CUY–71–2.57	NO PID
2015/2035 ADT NO BUILD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

CUY–71–2.57
NO PID
PLATE 2 OF 7

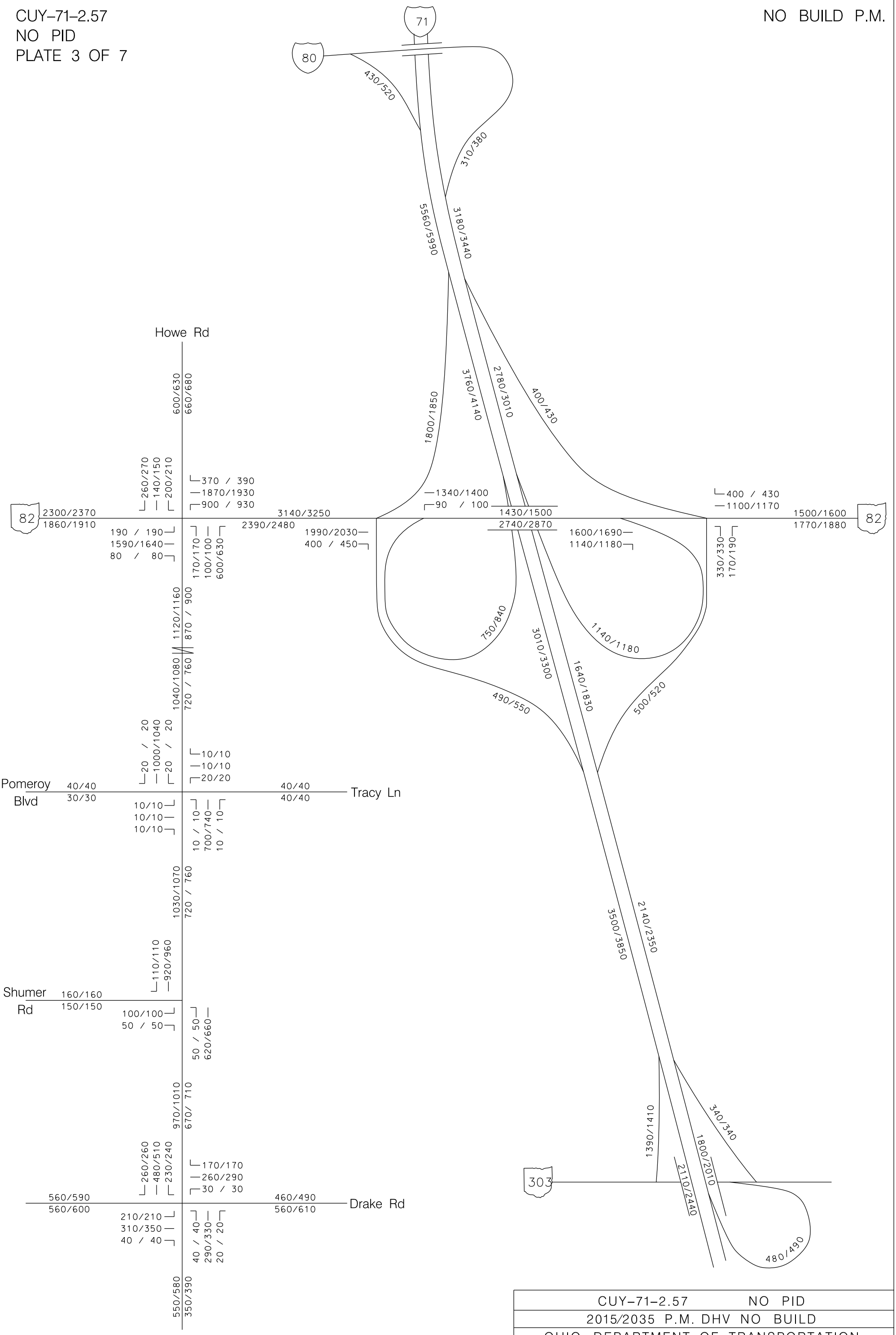
NO BUILD A.M.



CUY–71–2.57	NO PID
2015/2035 A.M. DHV NO BUILD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

CUY–71–2.57
NO PID
PLATE 3 OF 7

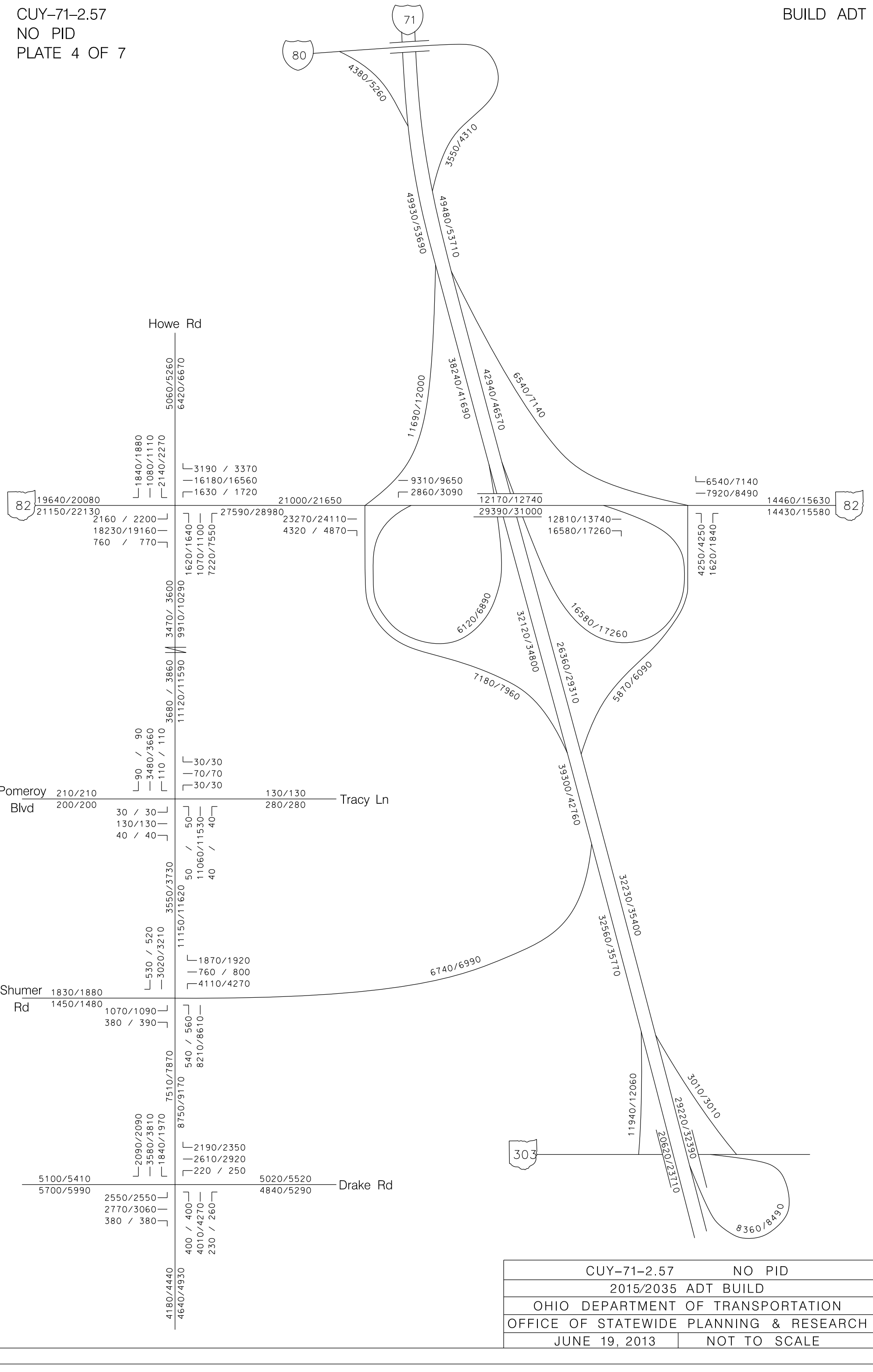
NO BUILD P.M.



CUY–71–2.57	NO PID
2015/2035 P.M. DHV NO BUILD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

CUY–71–2.57
NO PID
PLATE 4 OF 7

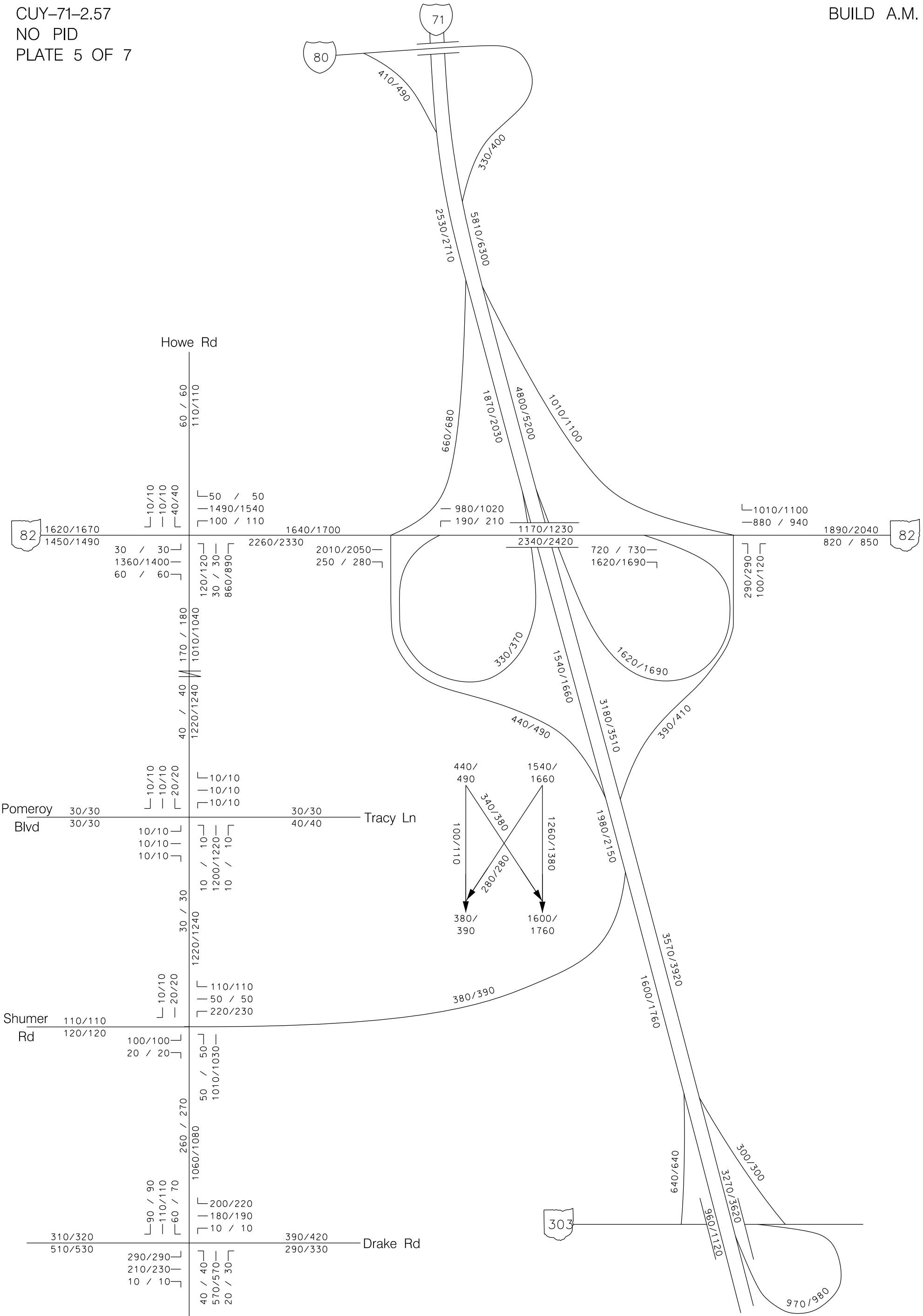
BUILD ADT



CUY–71–2.57	NO PID
2015/2035 ADT BUILD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

CUY–71–2.57
NO PID
PLATE 5 OF 7

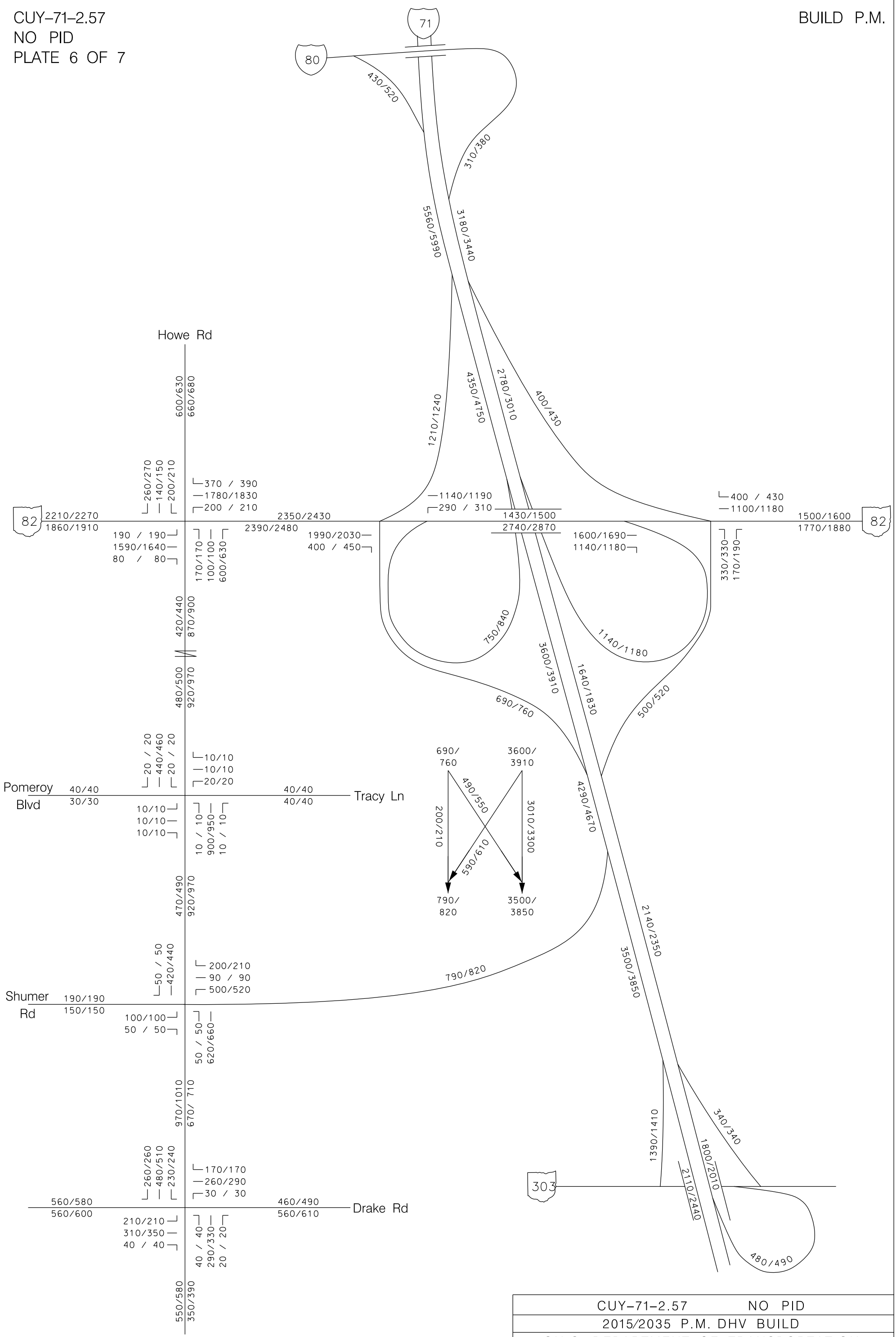
BUILD A.M.



CUY–71–2.57	NO PID
2015/2035 A.M. DHV BUILD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

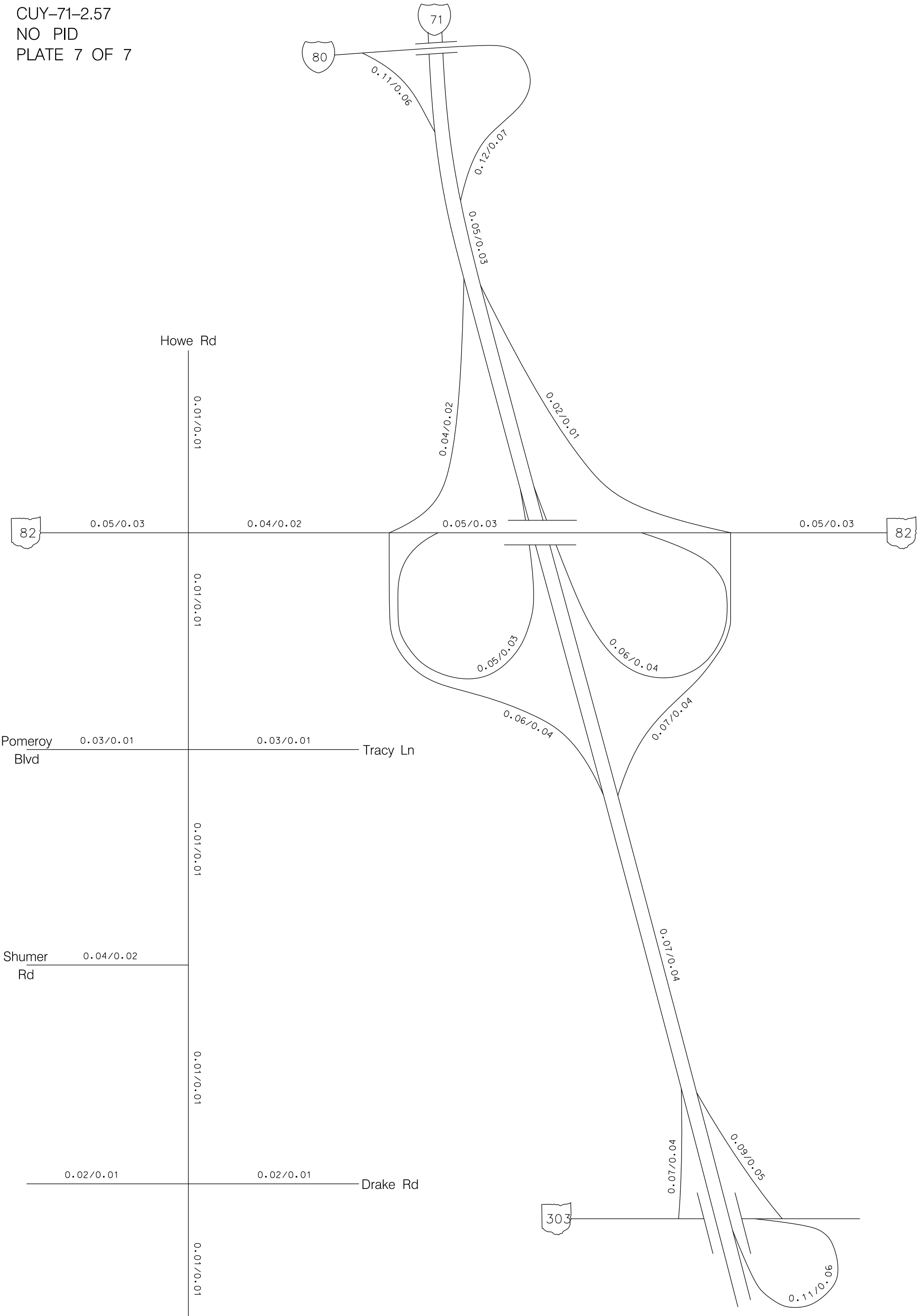
CUY–71–2.57
NO PID
PLATE 6 OF 7

BUILD P.M.



CUY–71–2.57	NO PID
2015/2035 P.M. DHV BUILD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

CUY–71–2.57
NO PID
PLATE 7 OF 7



CUY–71–2.57	NO PID
TRUCK FACTORS: T24/TD	
OHIO DEPARTMENT OF TRANSPORTATION	
OFFICE OF STATEWIDE PLANNING & RESEARCH	
JUNE 19, 2013	NOT TO SCALE

Appendix C

Capacity Analysis

Intersections

2035 No Build Condition

AM

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

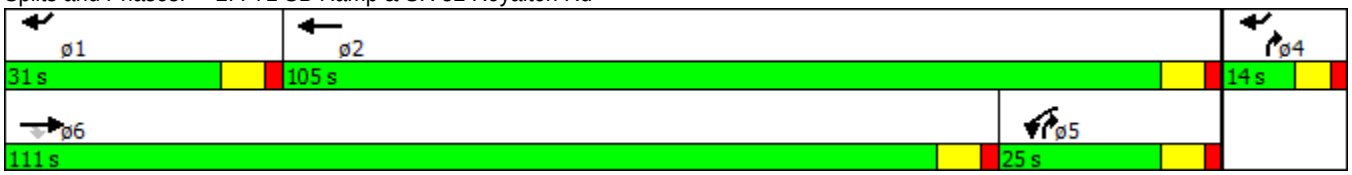
10/6/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø1	ø4
Lane Configurations								
Volume (vph)	2050	280	100	1130	370	960		
Turn Type	NA	Perm	Prot	NA	pt+ov	custom		
Protected Phases	6		5	2	4 5	1 4	1	4
Permitted Phases	6	6		2		1 4		
Detector Phase	6	6	5	2	4 5	1 4		
Switch Phase								
Minimum Initial (s)	25.0	25.0	10.0	25.0			1.0	7.0
Minimum Split (s)	32.0	32.0	17.0	32.0			20.0	20.0
Total Split (s)	111.0	111.0	25.0	105.0			31.0	14.0
Total Split (%)	74.0%	74.0%	16.7%	70.0%			21%	9%
Yellow Time (s)	5.0	5.0	5.0	5.0			5.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0			2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0				
Total Lost Time (s)	7.0	7.0	7.0	7.0				
Lead/Lag	Lead	Lead	Lag	Lag			Lead	
Lead-Lag Optimize?	Yes	Yes						
Recall Mode	None	None	None	None			None	Max
Act Effct Green (s)	104.0	104.0	18.0	98.0	33.0	38.0		
Actuated g/C Ratio	0.69	0.69	0.12	0.65	0.22	0.25		
v/c Ratio	1.22	0.27	1.03	0.40	0.68	1.09		
Control Delay	126.6	1.3	133.5	12.6	60.1	110.0		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	126.6	1.3	133.5	12.6	60.1	110.0		
LOS	F	A	F	B	E	F		
Approach Delay	111.6			29.8				
Approach LOS	F			C				

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.22
Intersection Signal Delay: 85.2 — Intersection LOS: F
Intersection Capacity Utilization Err% — ICU Level of Service H
Analysis Period (min) 15

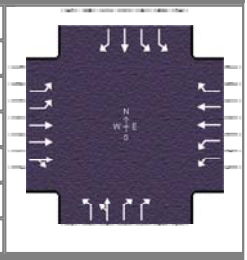
Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



HCS 2010 Signalized Intersection Results Summary

No Build | 13

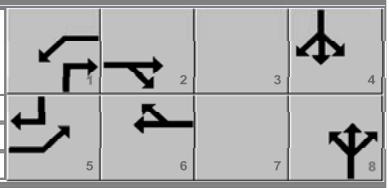
General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	SR 82 @ Howe Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	16_SR82 & Howe 2035 AM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	30	1400	60	420	1620	50	120	30	890	40	10	10

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	32.0	33.5	18.0	21.0	18.0	0.0
Yellow	4.0	4.0	4.0	4.0	4.0	0.0
Red	1.5	1.5	1.5	1.5	1.5	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6		8		4
Case Number	2.0	4.0	2.0	3.0		9.0		9.0
Phase Duration, s	23.5	62.5	37.5	76.5		26.5		23.5
Change Period, (*Y*+*Rc*), s	5.5	5.5	5.5	5.5		5.5		5.5
Max Allow Headway (*MAH*), s	3.0	3.0	3.1	3.0		3.3		3.3
Queue Clearance Time (g_s), s	3.3	39.9	20.0	73.0		23.0		3.7
Green Extension Time (g_e), s	3.8	0.0	0.9	0.0		0.0		0.1
Phase Call Probability	1.00	1.00	1.00	1.00		1.00		1.00
Max Out Probability	0.08	1.00	0.00	1.00		1.00		0.00

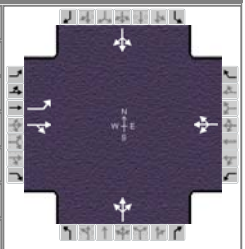
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	1069	518	457	1761	54	130	33	967	43	11	11
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1706	1845	1789	1723	1773	1577	1792	1881	1411	1740	1881	1586
Queue Service Time (g_s), s	1.3	37.9	37.9	18.0	71.0	2.8	10.1	2.3	21.0	1.7	0.8	0.8
Cycle Queue Clearance Time (g_c), s	1.3	37.9	37.9	18.0	71.0	2.8	10.1	2.3	21.0	1.7	0.8	0.8
Green Ratio (*g*/*C*)	0.12	0.38	0.38	0.21	0.47	0.47	0.14	0.14	0.35	0.12	0.12	0.24
Capacity (*c*), veh/h	409	1402	680	735	1679	746	251	263	997	418	226	382
Volume-to-Capacity Ratio (*X*)	0.080	0.762	0.762	0.621	1.049	0.073	0.520	0.124	0.970	0.104	0.048	0.028
Available Capacity (c_a), veh/h	409	1402	680	735	1679	746	251	263	997	418	226	382
Back of Queue (*Q*), veh/ln (50th percentile)	0.6	17.5	17.5	7.9	38.4	1.1	4.7	1.1	20.5	0.8	0.4	0.3
Queue Storage Ratio (*RQ*) (50th percentile)	0.04	0.00	0.00	0.35	0.00	0.11	0.39	0.00	0.00	0.17	0.00	0.00
Uniform Delay (d_1), s/veh	58.6	40.6	40.6	53.5	39.5	21.5	59.8	56.4	47.7	58.8	58.4	43.6
Incremental Delay (d_2), s/veh	0.0	2.3	4.6	1.2	36.0	0.0	0.9	0.1	21.4	0.0	0.0	0.0
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	58.7	42.9	45.2	54.7	75.5	21.6	60.7	56.5	69.1	58.9	58.4	43.6
Level of Service (LOS)	E	D	D	D	F	C	E	E	E	E	E	D
Approach Delay, s/veh / LOS	43.9	D		70.1	E		67.8	E		56.2	E	
Intersection Delay, s/veh / LOS	61.1						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

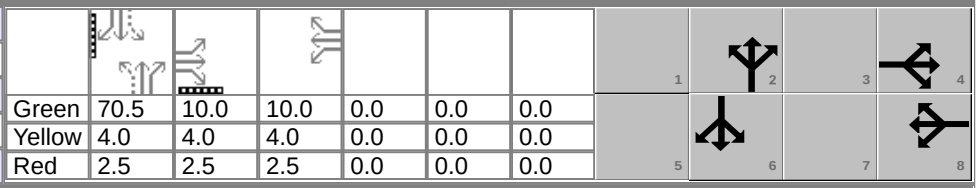
No Build | 14

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	Howe Rd & Pomeroy Blvd/	Analysis Year	2035	Analysis Period	1> 7:00
File Name	17_Howe & Pomeroy-Tracy 2035 AM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	10	10	10	10	10	10	10	1110	10	20	270	10

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	70.5	10.0	10.0	0.0	0.0	0.0			
Yellow	4.0	4.0	4.0	0.0	0.0	0.0			
Red	2.5	2.5	2.5	0.0	0.0	0.0			

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4		8		2		6
Case Number		10.0		12.0		8.0		8.0
Phase Duration, s		16.5		16.5		77.0		77.0
Change Period, ($Y+R_c$), s		6.5		6.5		6.5		6.5
Max Allow Headway (*MAH*), s		3.3		3.3		3.1		3.1
Queue Clearance Time (g_s), s		3.3		3.9		72.5		10.3
Green Extension Time (g_e), s		0.0		0.0		0.0		5.0
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.01		1.00		0.00

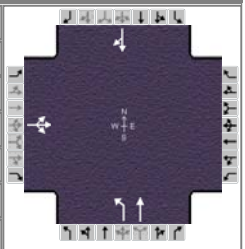
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	11	22			33			1228			326	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1792	1716			1740			1874			1195	
Queue Service Time (g_s), s	0.6	1.3			1.9			26.6			0.0	
Cycle Queue Clearance Time (g_c), s	0.6	1.3			1.9			70.5			8.3	
Green Ratio (*g/C*)	0.09	0.09			0.09			0.64			0.64	
Capacity (*c*), veh/h	163	156			158			1234			801	
Volume-to-Capacity Ratio (*X*)	0.067	0.139			0.206			0.996			0.407	
Available Capacity (c_a), veh/h	163	156			158			1234			801	
Back of Queue (*Q*), veh/ln (50th percentile)	0.3	0.6			0.8			36.3			3.1	
Queue Storage Ratio (*RQ*) (50th percentile)	0.00	0.00			0.00			0.00			0.00	
Uniform Delay (d_1), s/veh	45.7	46.0			46.3			20.5			8.6	
Incremental Delay (d_2), s/veh	0.1	0.1			0.2			24.5			0.1	
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0			0.0			0.0	
Control Delay (*d*), s/veh	45.8	46.2			46.6			45.0			8.7	
Level of Service (LOS)	D	D			D			D			A	
Approach Delay, s/veh / LOS	46.1	D		46.6	D		45.0	D		8.7	A	
Intersection Delay, s/veh / LOS	37.7						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

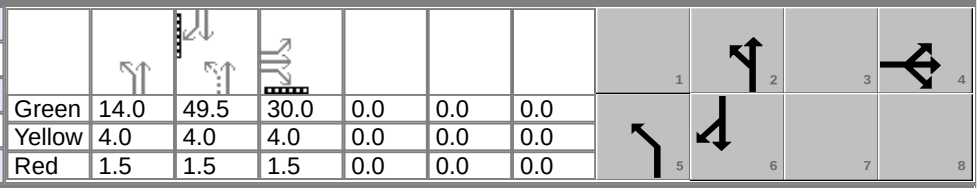
No Build | 15

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	Howe Rd @ Shurmer Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	18_Howe & Shurmer 2035 AM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	100	0	20				50	1030			250	40

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	14.0	49.5	30.0	0.0	0.0	0.0			
Yellow	4.0	4.0	4.0	0.0	0.0	0.0			
Red	1.5	1.5	1.5	0.0	0.0	0.0			

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4			5	2		6
Case Number		12.0			1.0	4.0		8.3
Phase Duration, s		35.5			19.5	74.5		55.0
Change Period, ($Y+R_c$), s		5.5			5.5	5.5		5.5
Max Allow Headway (*MAH*), s		3.3			3.1	3.0		3.0
Queue Clearance Time (g_s), s		8.5			3.4	62.3		14.5
Green Extension Time (g_e), s		0.2			0.0	2.4		3.9
Phase Call Probability		1.00			1.00	1.00		1.00
Max Out Probability		0.00			0.00	0.48		0.00

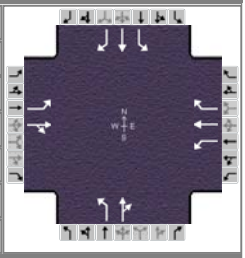
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		130					54	1120			315	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1737					1792	1881			1835	
Queue Service Time (g_s), s		6.5					1.4	60.3			12.5	
Cycle Queue Clearance Time (g_c), s		6.5					1.4	60.3			12.5	
Green Ratio (*g/C*)		0.27					0.60	0.63			0.45	
Capacity (*c*), veh/h		474					653	1180			826	
Volume-to-Capacity Ratio (*X*)		0.275					0.083	0.949			0.382	
Available Capacity (c_a), veh/h		474					653	1180			826	
Back of Queue (*Q*), veh/ln (50th percentile)		2.8					0.5	27.9			5.2	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00					0.26	0.00			0.00	
Uniform Delay (d_1), s/veh		31.5					10.3	18.9			20.1	
Incremental Delay (d_2), s/veh		0.1					0.0	15.4			0.1	
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	
Control Delay (*d*), s/veh		31.6					10.3	34.2			20.2	
Level of Service (LOS)		C					B	C			C	
Approach Delay, s/veh / LOS	31.6	C		0.0			33.1	C		20.2	C	
Intersection Delay, s/veh / LOS	30.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

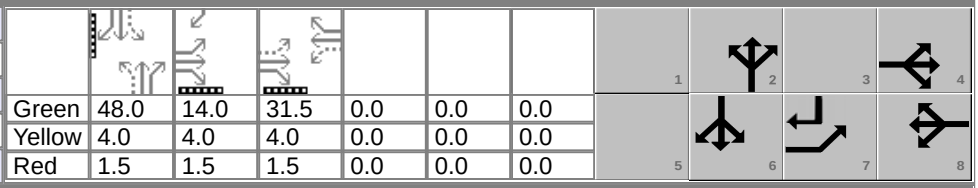
No Build | 16

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	Howe Rd @ Drake Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	19_Howe & Drake 2035 AM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	290	230	10	10	190	220	40	570	30	70	110	90

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	48.0	14.0	31.5	0.0	0.0	0.0			
Yellow	4.0	4.0	4.0	0.0	0.0	0.0			
Red	1.5	1.5	1.5	0.0	0.0	0.0			

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4		8		2		6
Case Number	1.0	4.0		5.3		6.0		5.0
Phase Duration, s	19.5	56.5		37.0		53.5		53.5
Change Period, ($Y+R_c$), s	5.5	5.5		5.5		5.5		5.5
Max Allow Headway (*MAH*), s	3.1	3.2		3.2		3.2		3.2
Queue Clearance Time (g_s), s	15.3	11.7		15.9		35.4		45.6
Green Extension Time (g_e), s	0.0	1.4		1.3		2.1		0.8
Phase Call Probability	1.00	1.00		1.00		1.00		1.00
Max Out Probability	1.00	0.00		0.00		0.05		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	315	261		11	207	239	43	652		76	120	98
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1792	1852		1122	1881	1589	1169	1864		784	1881	1578
Queue Service Time (g_s), s	13.3	9.7		0.8	9.7	13.9	2.6	33.4		10.2	4.2	3.2
Cycle Queue Clearance Time (g_c), s	13.3	9.7		0.8	9.7	13.9	6.8	33.4		43.6	4.2	3.2
Green Ratio (*g/C*)	0.43	0.46		0.29	0.29	0.29	0.44	0.44		0.44	0.44	0.56
Capacity (*c*), veh/h	482	859		387	539	455	531	813		170	821	890
Volume-to-Capacity Ratio (*X*)	0.654	0.304		0.028	0.383	0.526	0.082	0.802		0.448	0.146	0.110
Available Capacity (c_a), veh/h	482	859		387	539	455	531	813		170	821	890
Back of Queue (*Q*), veh/ln (50th percentile)	5.8	4.1		0.2	4.4	5.3	0.7	15.4		2.0	1.8	1.1
Queue Storage Ratio (*RQ*) (50th percentile)	0.44	0.00		0.02	0.00	0.46	0.12	0.00		0.16	0.00	0.08
Uniform Delay (d_1), s/veh	22.5	18.4		28.3	31.5	33.0	20.7	26.9		45.8	18.7	11.2
Incremental Delay (d_2), s/veh	2.5	0.1		0.0	0.2	0.6	0.0	5.4		0.7	0.0	0.0
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
Control Delay (*d*), s/veh	25.0	18.5		28.3	31.6	33.5	20.7	32.2		46.5	18.7	11.2
Level of Service (LOS)	C	B		C	C	C	C	C		D	B	B
Approach Delay, s/veh / LOS	22.1	C		32.5	C		31.5	C		23.4	C	
Intersection Delay, s/veh / LOS	27.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

Intersections

2035 No Build Condition

PM

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

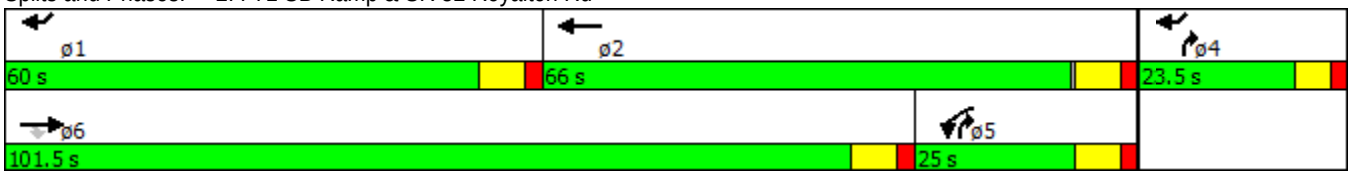
10/6/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø1	ø4
Lane Configurations								
Volume (vph)	2030	450	100	1400	840	1850		
Turn Type	NA	Perm	Prot	NA	pt+ov	custom		
Protected Phases	6		5	2	4 5	1 4	1	4
Permitted Phases	6	6		2		1 4		
Detector Phase	6	6	5	2	4 5	1 4		
Switch Phase								
Minimum Initial (s)	25.0	25.0	10.0	25.0			1.0	7.0
Minimum Split (s)	32.0	32.0	17.0	32.0			20.0	20.0
Total Split (s)	101.5	101.5	25.0	66.0			60.0	23.5
Total Split (%)	67.7%	67.7%	16.7%	44.0%			40%	16%
Yellow Time (s)	5.0	5.0	5.0	5.0			5.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0			2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0				
Total Lost Time (s)	7.0	7.0	7.0	7.0				
Lead/Lag	Lead	Lead	Lag	Lag			Lead	
Lead-Lag Optimize?	Yes	Yes						
Recall Mode	None	None	None	None			None	Max
Act Effct Green (s)	94.5	94.5	18.0	59.5	42.5	76.5		
Actuated g/C Ratio	0.63	0.63	0.12	0.40	0.28	0.51		
v/c Ratio	1.33	0.44	1.03	0.82	1.19	1.05		
Control Delay	177.5	2.6	133.5	44.5	145.1	70.3		
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		
Total Delay	177.5	2.6	133.5	44.5	145.1	70.3		
LOS	F	A	F	D	F	E		
Approach Delay	145.7			54.9				
Approach LOS	F			D				

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.33
Intersection Signal Delay: 104.2 — Intersection LOS: F
Intersection Capacity Utilization Err% — ICU Level of Service H
Analysis Period (min) 15

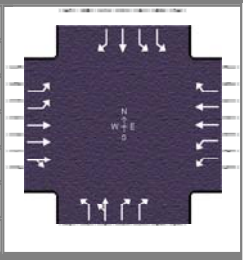
Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



HCS 2010 Signalized Intersection Results Summary

No Build | 13

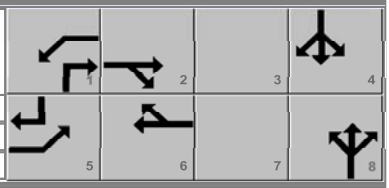
General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	SR 82 @ Howe Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	16_SR82 & Howe 2035 PM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	190	1640	80	930	1930	390	170	100	630	210	150	270

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	44.0	32.5	13.0	16.0	17.0	0.0
Yellow	4.0	4.0	4.0	4.0	4.0	0.0
Red	1.5	1.5	1.5	1.5	1.5	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6		8		4
Case Number	2.0	4.0	2.0	3.0		9.0		9.0
Phase Duration, s	18.5	56.5	49.5	87.5		21.5		22.5
Change Period, (*Y*+*Rc*), s	5.5	5.5	5.5	5.5		5.5		5.5
Max Allow Headway (*MAH*), s	3.1	3.1	3.1	3.1		3.3		3.3
Queue Clearance Time (g_s), s	10.8	53.0	46.0	84.0		18.0		19.0
Green Extension Time (g_e), s	1.4	0.0	0.0	0.0		0.0		0.0
Phase Call Probability	1.00	1.00	1.00	1.00		1.00		1.00
Max Out Probability	1.00	1.00	1.00	1.00		1.00		1.00

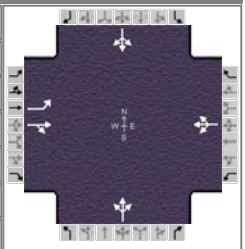
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	207	1259	610	1011	2098	424	185	109	685	228	163	293
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1706	1845	1784	1723	1773	1577	1792	1881	1411	1740	1881	1586
Queue Service Time (g_s), s	8.8	51.0	51.0	44.0	82.0	25.0	15.4	8.2	16.0	9.3	12.6	17.0
Cycle Queue Clearance Time (g_c), s	8.8	51.0	51.0	44.0	82.0	25.0	15.4	8.2	16.0	9.3	12.6	17.0
Green Ratio (*g*/*C*)	0.09	0.34	0.34	0.29	0.55	0.55	0.11	0.11	0.40	0.11	0.11	0.20
Capacity (*c*), veh/h	296	1254	606	1011	1939	862	191	201	1129	394	213	318
Volume-to-Capacity Ratio (*X*)	0.698	1.004	1.006	1.000	1.082	0.492	0.967	0.542	0.607	0.579	0.765	0.923
Available Capacity (c_a), veh/h	296	1254	606	1011	1939	862	191	201	1129	394	213	318
Back of Queue (*Q*), veh/ln (50th percentile)	4.1	27.8	28.8	22.8	46.3	9.2	9.9	4.0	10.0	4.3	6.9	8.0
Queue Storage Ratio (*RQ*) (50th percentile)	0.32	0.00	0.00	1.02	0.00	0.93	0.84	0.00	0.00	0.98	0.00	0.00
Uniform Delay (d_1), s/veh	66.6	49.5	49.5	53.0	34.0	21.1	66.7	63.5	35.7	63.1	64.6	58.8
Incremental Delay (d_2), s/veh	6.0	26.4	38.0	28.4	46.6	0.2	55.0	1.7	0.7	1.4	13.8	30.9
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	72.6	75.9	87.5	81.4	80.6	21.2	121.8	65.2	36.3	64.5	78.3	89.7
Level of Service (LOS)	E	F	F	F	F	C	F	E	D	E	E	F
Approach Delay, s/veh / LOS	79.0	E		73.7	E		55.7	E		78.6	E	
Intersection Delay, s/veh / LOS	73.2						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

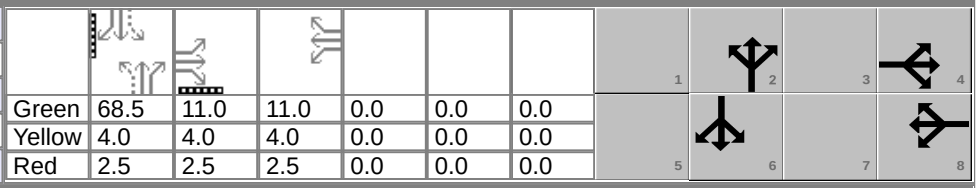
No Build | 14

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	Howe Rd & Pomeroy Blvd/	Analysis Year	2035	Analysis Period	1> 7:00
File Name	17_Howe & Pomeroy-Tracy 2035 PM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	10	10	10	20	10	10	10	740	10	20	1040	20

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	68.5	11.0	11.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	2.5	2.5	2.5	0.0	0.0	0.0

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4		8		2		6
Case Number		10.0		12.0		8.0		8.0
Phase Duration, s		17.5		17.5		75.0		75.0
Change Period, ($Y+R_c$), s		6.5		6.5		6.5		6.5
Max Allow Headway (*MAH*), s		3.3		3.3		3.1		3.1
Queue Clearance Time (g_s), s		3.3		4.5		34.6		70.5
Green Extension Time (g_e), s		0.0		0.0		6.5		0.0
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.01		0.03		1.00

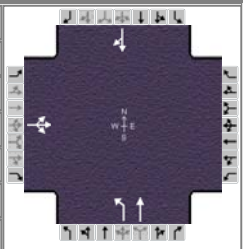
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	11	22			43			826			1174	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1792	1716			1753			1791			1844	
Queue Service Time (g_s), s	0.6	1.3			2.5			0.0			35.3	
Cycle Queue Clearance Time (g_c), s	0.6	1.3			2.5			32.6			68.5	
Green Ratio (*g/C*)	0.10	0.10			0.10			0.62			0.62	
Capacity (*c*), veh/h	179	172			175			1148			1182	
Volume-to-Capacity Ratio (*X*)	0.061	0.127			0.248			0.719			0.993	
Available Capacity (c_a), veh/h	179	172			175			1148			1182	
Back of Queue (*Q*), veh/ln (50th percentile)	0.3	0.6			1.1			13.1			35.1	
Queue Storage Ratio (*RQ*) (50th percentile)	0.00	0.00			0.00			0.00			0.00	
Uniform Delay (d_1), s/veh	44.8	45.1			45.7			14.0			21.2	
Incremental Delay (d_2), s/veh	0.1	0.1			0.3			1.9			24.5	
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0			0.0			0.0	
Control Delay (*d*), s/veh	44.9	45.2			46.0			15.9			45.7	
Level of Service (LOS)	D	D			D			B			D	
Approach Delay, s/veh / LOS	45.1	D		46.0	D		15.9	B		45.7	D	
Intersection Delay, s/veh / LOS	33.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

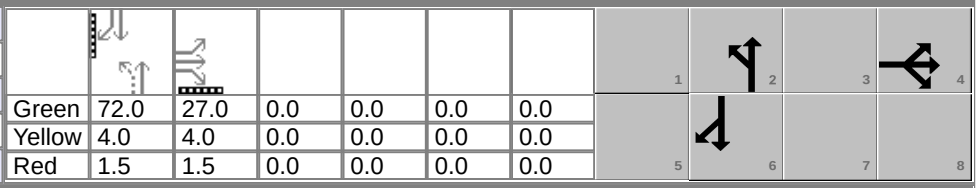
No Build | 15

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	Howe Rd @ Shurmer Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	18_Howe & Shurmer 2035 PM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	100	0	50				50	660			960	110

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	72.0	27.0	0.0	0.0	0.0	0.0						
Yellow	4.0	4.0	0.0	0.0	0.0	0.0						
Red	1.5	1.5	0.0	0.0	0.0	0.0						

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2		6
Case Number		12.0				6.0		8.0
Phase Duration, s		32.5				77.5		77.5
Change Period, ($Y+R_c$), s		5.5				5.5		5.5
Max Allow Headway (*MAH*), s		3.3				3.2		3.2
Queue Clearance Time (g_s), s		10.8				74.0		66.6
Green Extension Time (g_e), s		0.3				0.0		3.0
Phase Call Probability		1.00				1.00		1.00
Max Out Probability		0.00				1.00		0.78

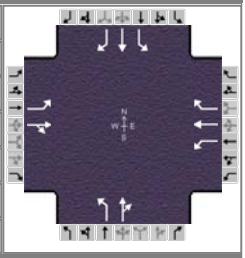
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h		163					54	717			1163	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1701					486	1881			1847	
Queue Service Time (g_s), s		8.8					7.4	23.4			64.6	
Cycle Queue Clearance Time (g_c), s		8.8					72.0	23.4			64.6	
Green Ratio (*g/C*)		0.25					0.65	0.65			0.65	
Capacity (*c*), veh/h		418					98	1231			1209	
Volume-to-Capacity Ratio (*X*)		0.390					0.555	0.583			0.962	
Available Capacity (c_a), veh/h		418					98	1231			1209	
Back of Queue (*Q*), veh/ln (50th percentile)		3.7					1.6	8.8			29.2	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00					0.81	0.00			0.00	
Uniform Delay (d_1), s/veh		34.6					52.8	10.6			17.7	
Incremental Delay (d_2), s/veh		0.2					4.1	0.5			17.4	
Initial Queue Delay (d_3), s/veh		0.0					0.0	0.0			0.0	
Control Delay (*d*), s/veh		34.9					56.9	11.1			35.2	
Level of Service (LOS)		C					E	B			D	
Approach Delay, s/veh / LOS	34.9	C		0.0			14.3	B		35.2	D	
Intersection Delay, s/veh / LOS	27.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

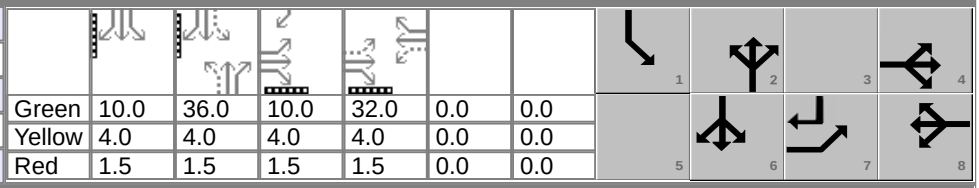
No Build | 16

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	Howe Rd @ Drake Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	19_Howe & Drake 2035 PM No Build.xus				
Project Description	NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	210	350	40	30	290	170	40	330	20	240	510	260

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	10.0	36.0	10.0	32.0	0.0	0.0
Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Red	1.5	1.5	1.5	1.5	0.0	0.0

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4		8		2	1	6
Case Number	1.0	4.0		5.3		6.3	1.0	3.0
Phase Duration, s	15.5	53.0		37.5		41.5	15.5	57.0
Change Period, (Y+R_c), s	5.5	5.5		5.5		5.5	5.5	5.5
Max Allow Headway (*MAH*), s	3.1	3.1		3.1		3.2	3.1	3.2
Queue Clearance Time (g_s), s	11.6	20.8		17.7		21.0	12.0	26.4
Green Extension Time (g_e), s	0.0	1.9		1.8		2.7	0.0	2.8
Phase Call Probability	1.00	1.00		1.00		1.00	1.00	1.00
Max Out Probability	1.00	0.00		0.02		0.05	1.00	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	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	228	424		33	315	185	43	380		261	554	283
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1792	1832		967	1881	1589	660	1862		1792	1881	1578
Queue Service Time (g_s), s	9.6	18.8		2.8	15.7	10.3	5.8	19.0		10.0	24.4	10.6
Cycle Queue Clearance Time (g_c), s	9.6	18.8		6.2	15.7	10.3	14.8	19.0		10.0	24.4	10.6
Green Ratio (*g*/*C*)	0.40	0.43		0.29	0.29	0.29	0.33	0.33		0.44	0.47	0.56
Capacity (*c*), veh/h	362	791		318	547	462	228	609		384	881	883
Volume-to-Capacity Ratio (*X*)	0.630	0.536		0.103	0.576	0.400	0.191	0.624		0.679	0.629	0.320
Available Capacity (c_a), veh/h	362	791		318	547	462	228	609		384	881	883
Back of Queue (*Q*), veh/ln (50th percentile)	4.2	8.0		0.7	7.2	3.9	0.9	8.6		4.7	10.6	3.6
Queue Storage Ratio (*RQ*) (50th percentile)	0.32	0.00		0.06	0.00	0.34	0.16	0.00		0.37	0.00	0.28
Uniform Delay (d_1), s/veh	24.6	23.1		31.1	33.2	31.3	33.5	31.3		24.0	22.1	13.0
Incremental Delay (d_2), s/veh	2.7	0.4		0.1	1.0	0.2	0.1	1.5		4.0	1.1	0.1
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
Control Delay (*d*), s/veh	27.3	23.5		31.2	34.2	31.5	33.6	32.8		28.0	23.2	13.1
Level of Service (LOS)	C	C		C	C	C	C	C		C	C	B
Approach Delay, s/veh / LOS	24.8	C		33.1	C		32.9	C		21.7	C	
Intersection Delay, s/veh / LOS	26.4						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

Intersections

2035 Build Condition

AM

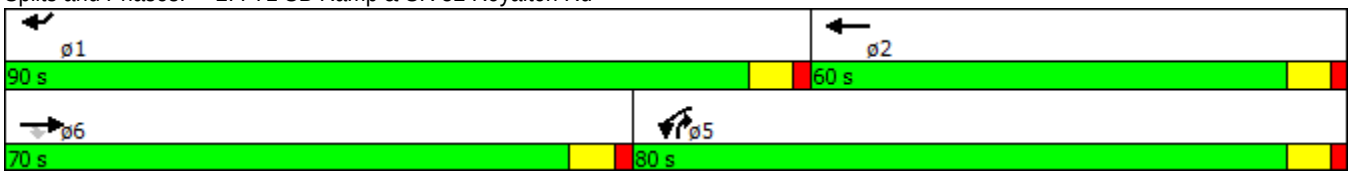
Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

10/8/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR
Lane Configurations						
Volume (vph)	2050	280	210	1020	370	680
Turn Type	NA	Perm	Prot	NA	Over	Prot
Protected Phases	6		5	2	5	1
Permitted Phases	6	6		2		1
Detector Phase	6	6	5	2	5	1
Switch Phase						
Minimum Initial (s)	25.0	25.0	10.0	25.0	10.0	1.0
Minimum Split (s)	32.0	32.0	17.0	32.0	17.0	20.0
Total Split (s)	70.0	70.0	80.0	60.0	80.0	90.0
Total Split (%)	46.7%	46.7%	53.3%	40.0%	53.3%	60.0%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.0	7.0	7.0	7.0	7.0	7.0
Lead/Lag	Lead	Lead	Lag	Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes				
Recall Mode	None	None	None	None	None	None
Act Effct Green (s)	63.3	63.3	34.6	68.4	34.6	29.5
Actuated g/C Ratio	0.57	0.57	0.31	0.61	0.31	0.26
v/c Ratio	0.87	0.31	0.84	0.39	0.49	0.75
Control Delay	26.5	2.5	50.9	12.1	33.1	43.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.5	2.5	50.9	12.1	33.1	43.1
LOS	C	A	D	B	C	D
Approach Delay	23.6			22.9		
Approach LOS	C			C		

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 112	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.87	
Intersection Signal Delay: 26.7	Intersection LOS: C
Intersection Capacity Utilization Err%	ICU Level of Service H
Analysis Period (min) 15	

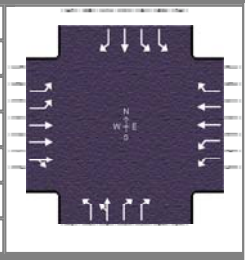
Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



HCS 2010 Signalized Intersection Results Summary

Build | 13

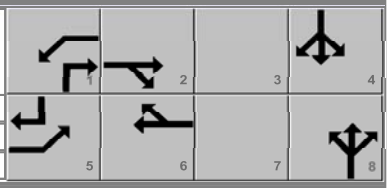
General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJT	Analysis Date	Jun 8, 2015	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	SR 82 @ Howe Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	16_SR82 & Howe 2035 AM Build.xus				
Project Description	Build				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	30	1400	60	110	1540	50	120	30	890	40	10	10

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	35.0	31.5	13.5	20.5	22.0	0.0
Yellow	4.0	4.0	4.0	4.0	4.0	0.0
Red	1.5	1.5	1.5	1.5	1.5	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6		8		4
Case Number	2.0	4.0	2.0	3.0		9.0		9.0
Phase Duration, s	19.0	56.0	40.5	77.5		27.5		26.0
Change Period, ($Y+R_c$), s	5.5	5.5	5.5	5.5		5.5		5.5
Max Allow Headway (*MAH*), s	3.0	3.0	3.1	3.0		3.3		3.3
Queue Clearance Time (g_s), s	3.3	42.6	6.1	71.7		24.0		3.6
Green Extension Time (g_e), s	3.3	2.9	0.3	0.2		0.0		0.1
Phase Call Probability	1.00	1.00	1.00	1.00		1.00		1.00
Max Out Probability	0.22	0.36	0.00	1.00		1.00		0.00

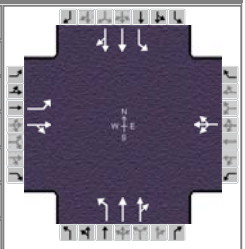
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	1069	518	120	1674	54	130	33	967	43	11	11
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1706	1845	1789	1723	1773	1577	1792	1881	1411	1740	1881	1587
Queue Service Time (g_s), s	1.3	40.6	40.6	4.1	69.7	2.8	10.1	2.3	22.0	1.6	0.8	0.8
Cycle Queue Clearance Time (g_c), s	1.3	40.6	40.6	4.1	69.7	2.8	10.1	2.3	22.0	1.6	0.8	0.8
Green Ratio (*g/C*)	0.09	0.34	0.34	0.23	0.48	0.48	0.15	0.15	0.38	0.14	0.14	0.23
Capacity (*c*), veh/h	307	1242	602	804	1702	757	263	276	1072	476	257	360
Volume-to-Capacity Ratio (*X*)	0.106	0.860	0.861	0.149	0.983	0.072	0.496	0.118	0.902	0.091	0.042	0.030
Available Capacity (c_a), veh/h	307	1242	602	804	1702	757	263	276	1072	476	257	360
Back of Queue (*Q*), veh/ln (50th percentile)	0.6	19.5	19.8	1.8	33.6	1.0	4.6	1.1	18.2	0.7	0.4	0.3
Queue Storage Ratio (*RQ*) (50th percentile)	0.05	0.00	0.00	0.08	0.00	0.11	0.39	0.00	0.00	0.17	0.00	0.00
Uniform Delay (d_1), s/veh	62.7	46.5	46.5	45.7	38.4	21.0	58.9	55.6	43.9	56.6	56.2	45.2
Incremental Delay (d_2), s/veh	0.1	6.1	11.6	0.0	17.9	0.0	0.5	0.1	10.3	0.0	0.0	0.0
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	62.8	52.5	58.0	45.7	56.3	21.0	59.4	55.6	54.2	56.6	56.3	45.2
Level of Service (LOS)	E	D	E	D	E	C	E	E	D	E	E	D
Approach Delay, s/veh / LOS	54.5	D		54.5	D		54.8	D		54.7	D	
Intersection Delay, s/veh / LOS	54.6						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

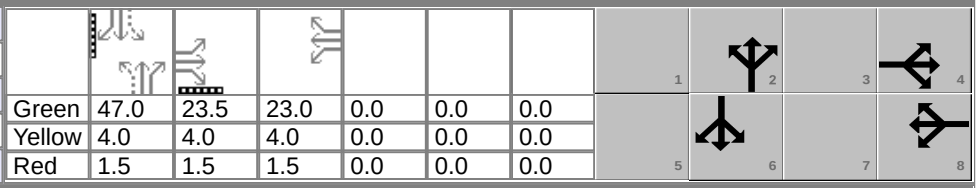
Build | 14

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJT	Analysis Date	Jun 8, 2015	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	Howe Rd & Pomeroy Blvd/	Analysis Year	2035	Analysis Period	1> 7:00
File Name	17_Howe & Pomeroy-Tracy 2035 AM Build.xus				
Project Description	Build ALT 1 & 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	10	10	10	10	10	10	10	1220	10	20	20	10

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	47.0	23.5	23.0	0.0	0.0	0.0						
Yellow	4.0	4.0	4.0	0.0	0.0	0.0						
Red	1.5	1.5	1.5	0.0	0.0	0.0						

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4		8		2		6
Case Number		10.0		12.0		6.0		6.0
Phase Duration, s		29.0		28.5		52.5		52.5
Change Period, (Y+R_c), s		5.5		5.5		5.5		5.5
Max Allow Headway (*MAH*), s		3.3		3.3		3.1		3.1
Queue Clearance Time (g_s), s		3.1		3.7		36.8		42.3
Green Extension Time (g_e), s		0.0		0.0		2.7		1.8
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.00		0.21		0.70

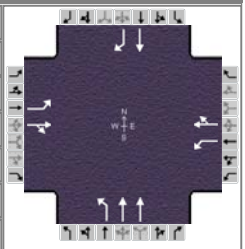
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	11	22			33		11	669	668	22	16	16
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1792	1723			1745		1381	1881	1876	411	1881	1662
Queue Service Time (g_s), s	0.5	1.1			1.7		0.5	34.8	34.8	5.5	0.6	0.6
Cycle Queue Clearance Time (g_c), s	0.5	1.1			1.7		1.1	34.8	34.8	40.3	0.6	0.6
Green Ratio (*g*/*C*)	0.21	0.21			0.21		0.43	0.43	0.43	0.43	0.43	0.43
Capacity (*c*), veh/h	383	368			365		648	804	801	111	804	710
Volume-to-Capacity Ratio (*X*)	0.028	0.059			0.089		0.017	0.833	0.833	0.196	0.020	0.023
Available Capacity (c_a), veh/h	383	368			365		648	804	801	111	804	710
Back of Queue (*Q*), veh/ln (50th percentile)	0.2	0.5			0.7		0.2	16.5	16.5	0.6	0.2	0.2
Queue Storage Ratio (*RQ*) (50th percentile)	0.00	0.00			0.00		0.03	0.00	0.00	0.09	0.00	0.00
Uniform Delay (d_1), s/veh	34.2	34.4			35.1		18.5	28.0	28.0	45.9	18.2	18.2
Incremental Delay (d_2), s/veh	0.0	0.0			0.0		0.0	7.1	7.1	0.3	0.0	0.0
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
Control Delay (*d*), s/veh	34.2	34.5			35.1		18.5	35.1	35.1	46.2	18.2	18.2
Level of Service (LOS)	C	C			D		B	D	D	D	B	B
Approach Delay, s/veh / LOS	34.4	C		35.1	D		35.0	C		29.4	C	
Intersection Delay, s/veh / LOS	34.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

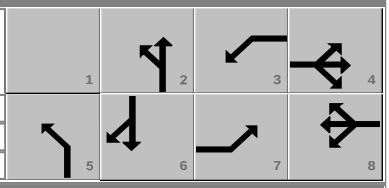
Build | 15

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	AM	PHF	0.92
Intersection	Howe Rd @ Shurmer Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	18_Howe & Shurmer 2035 AM Build.xus				
Project Description	BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	100	0	20	230	50	110	50	1030			20	10

Signal Information					EB			WB			NB		
Cycle, s	110.0	Reference Phase	2										
Offset, s	0	Reference Point	End	Green	12.0	32.5		14.0	4.0	26.0	0.0		
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	4.0	4.0		4.0	0.0	4.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.5	1.5		1.0	0.0	1.5	0.0		



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2		6
Case Number	1.1	4.0	1.1	4.0	1.0	4.0		7.3
Phase Duration, s	19.0	31.5	23.0	35.5	17.5	55.5		38.0
Change Period, ($Y+R_c$), s	5.0	5.5	5.0	5.5	5.5	5.5		5.5
Max Allow Headway (*MAH*), s	3.3	3.3	3.1	3.3	3.1	3.0		3.0
Queue Clearance Time (g_s), s	6.6	3.2	12.7	11.4	4.0	29.3		2.9
Green Extension Time (g_e), s	0.1	0.4	0.2	0.4	0.0	2.8		3.1
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00		1.00
Max Out Probability	0.01	0.00	0.14	0.00	0.00	0.02		0.00

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			6	16
Adjusted Flow Rate (*v*), veh/h	109	22		250	174		54	1120			22	11
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1774	1572		1774	1658		1792	1791			1881	1576
Queue Service Time (g_s), s	4.6	1.2		10.7	9.4		2.0	27.3			0.9	0.5
Cycle Queue Clearance Time (g_c), s	4.6	1.2		10.7	9.4		2.0	27.3			0.9	0.5
Green Ratio (*g/C*)	0.36	0.24		0.41	0.27		0.42	0.45			0.30	0.30
Capacity (*c*), veh/h	495	372		668	452		658	1628			556	466
Volume-to-Capacity Ratio (*X*)	0.219	0.059		0.374	0.385		0.083	0.688			0.039	0.023
Available Capacity (c_a), veh/h	495	372		668	452		658	1628			556	466
Back of Queue (*Q*), veh/ln (50th percentile)	1.9	0.5		4.4	3.7		0.8	11.3			0.4	0.2
Queue Storage Ratio (*RQ*) (50th percentile)	0.00	0.00		0.00	0.00		0.41	0.00			0.00	0.00
Uniform Delay (d_1), s/veh	24.0	32.5		22.4	32.5		18.9	23.8			27.6	27.5
Incremental Delay (d_2), s/veh	0.1	0.0		0.1	0.2		0.0	1.0			0.0	0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh	24.1	32.5		22.5	32.7		19.0	24.8			27.6	27.5
Level of Service (LOS)	C	C		C	C		B	C			C	C
Approach Delay, s/veh / LOS	25.5	C		26.7	C		24.6	C		27.6	C	
Intersection Delay, s/veh / LOS	25.2						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

Intersections

2035 Build Condition

PM

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

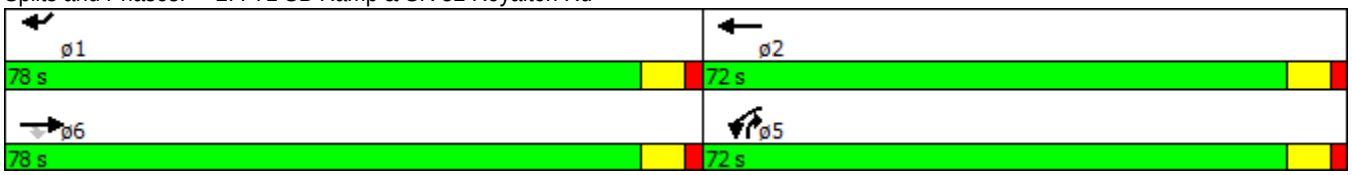
10/8/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR
Lane Configurations						
Volume (vph)	2030	450	310	1190	840	1240
Turn Type	NA	Perm	Prot	NA	Over	Prot
Protected Phases	6		5	2	5	1
Permitted Phases	6	6		2		1
Detector Phase	6	6	5	2	5	1
Switch Phase						
Minimum Initial (s)	25.0	25.0	10.0	25.0	10.0	1.0
Minimum Split (s)	32.0	32.0	17.0	32.0	17.0	20.0
Total Split (s)	78.0	78.0	72.0	72.0	72.0	78.0
Total Split (%)	52.0%	52.0%	48.0%	48.0%	48.0%	52.0%
Yellow Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.0	7.0	7.0	7.0	7.0	7.0
Lead/Lag	Lead	Lead	Lag	Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes				
Recall Mode	None	None	None	None	None	None
Act Effct Green (s)	71.2	71.2	59.6	69.4	59.6	61.5
Actuated g/C Ratio	0.49	0.49	0.41	0.48	0.41	0.42
v/c Ratio	0.93	0.61	0.93	0.57	0.79	0.84
Control Delay	43.5	23.3	61.6	29.3	42.9	43.0
Queue Delay	2.4	0.0	0.0	0.0	0.0	0.0
Total Delay	45.9	23.3	61.6	29.3	42.9	43.0
LOS	D	C	E	C	D	D
Approach Delay	41.8			39.9		
Approach LOS	D			D		

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 144.9
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.93
Intersection Signal Delay: 41.6 — Intersection LOS: D
Intersection Capacity Utilization Err% — ICU Level of Service H
Analysis Period (min) 15

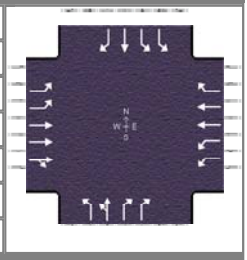
Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



HCS 2010 Signalized Intersection Results Summary

Build | 13

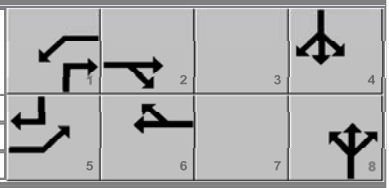
General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJT	Analysis Date	Jun 8, 2015	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	SR 82 @ Howe Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	16_SR82 & Howe 2035 PM Build.xus				
Project Description	Build ALT 1 & 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	190	1640	80	210	1830	390	170	100	630	210	150	270

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	32.0	42.0	10.0	22.5	16.0	0.0
Yellow	4.0	4.0	4.0	4.0	4.0	0.0
Red	1.5	1.5	1.5	1.5	1.5	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6		8		4
Case Number	2.0	4.0	2.0	3.0		9.0		9.0
Phase Duration, s	15.5	63.0	37.5	85.0		21.5		28.0
Change Period, (*Y*+*Rc*), s	5.5	5.5	5.5	5.5		5.5		5.5
Max Allow Headway (*MAH*), s	3.1	3.1	3.1	3.1		3.3		3.3
Queue Clearance Time (g_s), s	11.0	50.1	10.4	81.5		18.0		24.5
Green Extension Time (g_e), s	0.0	1.0	0.5	0.0		0.0		0.0
Phase Call Probability	1.00	1.00	1.00	1.00		1.00		1.00
Max Out Probability	1.00	1.00	0.00	1.00		1.00		1.00

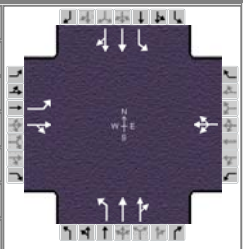
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	207	1259	610	228	1989	424	185	109	685	228	163	293
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1706	1845	1784	1723	1773	1577	1792	1881	1411	1740	1881	1588
Queue Service Time (g_s), s	9.0	47.9	48.1	8.4	79.5	25.9	15.4	8.2	16.0	9.0	12.1	22.5
Cycle Queue Clearance Time (g_c), s	9.0	47.9	48.1	8.4	79.5	25.9	15.4	8.2	16.0	9.0	12.1	22.5
Green Ratio (*g*/*C*)	0.07	0.38	0.38	0.21	0.53	0.53	0.11	0.11	0.32	0.15	0.15	0.22
Capacity (*c*), veh/h	227	1414	684	735	1880	836	191	201	903	522	282	344
Volume-to-Capacity Ratio (*X*)	0.908	0.891	0.892	0.311	1.058	0.507	0.967	0.542	0.758	0.437	0.578	0.852
Available Capacity (c_a), veh/h	227	1414	684	735	1880	836	191	201	903	522	282	344
Back of Queue (*Q*), veh/ln (50th percentile)	5.0	23.0	23.6	3.6	42.9	9.6	9.9	4.0	11.8	4.0	6.0	8.0
Queue Storage Ratio (*RQ*) (50th percentile)	0.40	0.00	0.00	0.16	0.00	0.98	0.84	0.00	0.00	0.92	0.00	0.00
Uniform Delay (d_1), s/veh	69.5	43.3	43.3	49.7	35.3	22.7	66.7	63.5	45.8	58.0	59.3	56.4
Incremental Delay (d_2), s/veh	35.1	7.2	13.6	0.1	38.1	0.2	55.0	1.7	3.4	0.2	1.9	17.4
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	104.7	50.5	57.0	49.8	73.4	22.9	121.8	65.2	49.2	58.2	61.3	73.8
Level of Service (LOS)	F	D	E	D	F	C	F	E	D	E	E	E
Approach Delay, s/veh / LOS	57.8	E		63.2	E		64.7	E		65.6	E	
Intersection Delay, s/veh / LOS	61.9						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

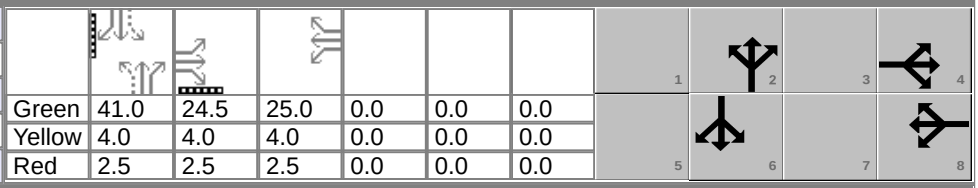
Build | 14

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJT	Analysis Date	Jun 8, 2015	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	Howe Rd & Pomeroy Blvd/	Analysis Year	2035	Analysis Period	1> 7:00
File Name	17_Howe & Pomeroy-Tracy 2035 PM Build.xus				
Project Description	Build ALT 1 & 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	10	10	10	20	10	10	10	950	10	20	460	20

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



							1	2	3	4		
Green	41.0	24.5	25.0	0.0	0.0	0.0	5	6	7	8		
Yellow	4.0	4.0	4.0	0.0	0.0	0.0						
Red	2.5	2.5	2.5	0.0	0.0	0.0						

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4		8		2		6
Case Number		10.0		12.0		6.0		6.0
Phase Duration, s		31.0		31.5		47.5		47.5
Change Period, ($Y+R_c$), s		6.5		6.5		6.5		6.5
Max Allow Headway (*MAH*), s		3.3		3.3		3.1		3.1
Queue Clearance Time (g_s), s		3.1		4.2		28.6		32.5
Green Extension Time (g_e), s		0.0		0.1		3.0		2.6
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.00		0.16		0.34

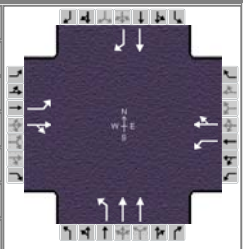
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	11	22			43		11	523	521	22	263	258
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1792	1723			1757		885	1881	1874	544	1881	1838
Queue Service Time (g_s), s	0.5	1.1			2.2		1.0	26.6	26.6	4.0	11.2	11.3
Cycle Queue Clearance Time (g_c), s	0.5	1.1			2.2		12.3	26.6	26.6	30.5	11.2	11.3
Green Ratio (*g/C*)	0.22	0.22			0.23		0.37	0.37	0.37	0.37	0.37	0.37
Capacity (*c*), veh/h	399	384			399		304	701	699	137	701	685
Volume-to-Capacity Ratio (*X*)	0.027	0.057			0.109		0.036	0.746	0.746	0.159	0.376	0.377
Available Capacity (c_a), veh/h	399	384			399		304	701	699	137	701	685
Back of Queue (*Q*), veh/ln (50th percentile)	0.2	0.5			0.9		0.2	12.4	12.3	0.5	4.9	4.8
Queue Storage Ratio (*RQ*) (50th percentile)	0.00	0.00			0.00		0.04	0.00	0.00	0.09	0.00	0.00
Uniform Delay (d_1), s/veh	33.4	33.7			33.7		29.7	30.0	30.0	43.2	25.2	25.2
Incremental Delay (d_2), s/veh	0.0	0.0			0.0		0.0	3.9	3.9	0.2	0.1	0.1
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
Control Delay (*d*), s/veh	33.4	33.7			33.7		29.7	33.8	33.9	43.4	25.3	25.3
Level of Service (LOS)	C	C			C		C	C	C	D	C	C
Approach Delay, s/veh / LOS	33.6	C		33.7	C		33.8	C		26.0	C	
Intersection Delay, s/veh / LOS	31.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

HCS 2010 Signalized Intersection Results Summary

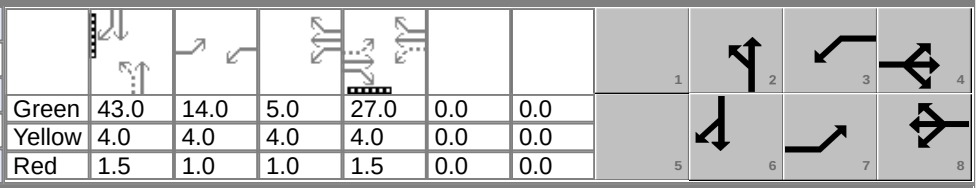
Build | 15

General Information				Intersection Information	
Agency	Hatch Mott MacDonald			Duration, h	0.25
Analyst	SJB	Analysis Date	Mar 25, 2013	Area Type	Other
Jurisdiction	Strongsville	Time Period	PM	PHF	0.92
Intersection	Howe Rd @ Shurmer Rd	Analysis Year	2035	Analysis Period	1> 7:00
File Name	18_Howe & Shurmer 2035 PM Build .xus				
Project Description	BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	100	0	50	520	90	210	50	660			440	50

Signal Information			
Cycle, s	110.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	43.0	14.0	5.0	27.0	0.0	0.0
Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Red	1.5	1.0	1.0	1.5	0.0	0.0

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8		2		6
Case Number	1.1	4.0	1.1	4.0		6.0		7.0
Phase Duration, s	19.0	32.5	29.0	42.5		48.5		48.5
Change Period, ($Y+R_c$), s	5.0	5.5	5.0	5.5		5.5		5.5
Max Allow Headway (*MAH*), s	3.3	3.3	3.1	3.3		3.1		3.1
Queue Clearance Time (g_s), s	6.5	5.0	26.0	39.0		30.8		24.8
Green Extension Time (g_e), s	0.1	0.8	0.0	0.0		2.7		3.0
Phase Call Probability	1.00	1.00	1.00	1.00		1.00		1.00
Max Out Probability	0.01	0.00	1.00	1.00		0.08		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	7	4	14	3	8	18	5	2			6	16
Adjusted Flow Rate (*v*), veh/h	109	54		565	326		54	717			478	54
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1774	1572		1774	1654		876	1791			1881	1577
Queue Service Time (g_s), s	4.5	3.0		24.0	17.9		5.9	16.8			22.8	2.4
Cycle Queue Clearance Time (g_c), s	4.5	3.0		24.0	17.9		28.8	16.8			22.8	2.4
Green Ratio (*g/C*)	0.37	0.25		0.48	0.34		0.39	0.39			0.39	0.39
Capacity (*c*), veh/h	291	386		746	556		226	1400			735	617
Volume-to-Capacity Ratio (*X*)	0.373	0.141		0.758	0.586		0.240	0.512			0.650	0.088
Available Capacity (c_a), veh/h	291	386		746	556		226	1400			735	617
Back of Queue (*Q*), veh/ln (50th percentile)	1.9	1.2		11.4	7.1		1.3	7.0			10.3	0.9
Queue Storage Ratio (*RQ*) (50th percentile)	0.00	0.00		0.00	0.00		0.64	0.00			0.00	0.00
Uniform Delay (d_1), s/veh	26.4	32.4		22.3	30.2		39.1	25.5			27.4	21.1
Incremental Delay (d_2), s/veh	0.3	0.1		4.0	1.1		0.2	0.1			1.6	0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh	26.7	32.5		26.4	31.3		39.3	25.7			29.0	21.2
Level of Service (LOS)	C	C		C	C		D	C			C	C
Approach Delay, s/veh / LOS	28.6	C		28.2	C		26.6	C		28.2	C	
Intersection Delay, s/veh / LOS	27.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS								
Bicycle LOS Score / LOS								

SR 82 Corridor

2035 No Build Condition

AM

Timings
1: I-71 NB Off Ramp

10/7/2015

Lane Group	EBT	WBT	NBL
Lane Configurations			
Volume (vph)	730	2040	290
Turn Type	NA	NA	Prot
Protected Phases	2	6	8
Permitted Phases			
Detector Phase	2	6	8
Switch Phase			
Minimum Initial (s)	32.0	32.0	10.0
Minimum Split (s)	53.0	38.0	20.0
Total Split (s)	102.0	102.0	48.0
Total Split (%)	68.0%	68.0%	32.0%
Yellow Time (s)	3.6	3.6	3.0
All-Red Time (s)	2.2	2.2	3.0
Lost Time Adjust (s)	-1.4	-2.0	-1.4
Total Lost Time (s)	4.4	3.8	4.6
Lead/Lag			
Lead-Lag Optimize?			
Recall Mode	C-Max	C-Max	None
Act Effct Green (s)	109.1	109.7	31.9
Actuated g/C Ratio	0.73	0.73	0.21
v/c Ratio	0.31	0.61	0.81
Control Delay	4.7	11.1	61.8
Queue Delay	0.0	0.0	0.0
Total Delay	4.7	11.1	61.8
LOS	A	B	E
Approach Delay	4.7	11.1	61.8
Approach LOS	A	B	E

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 42 (28%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 75	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.81	
Intersection Signal Delay: 17.9	Intersection LOS: B
Intersection Capacity Utilization 58.6%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 1: I-71 NB Off Ramp

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

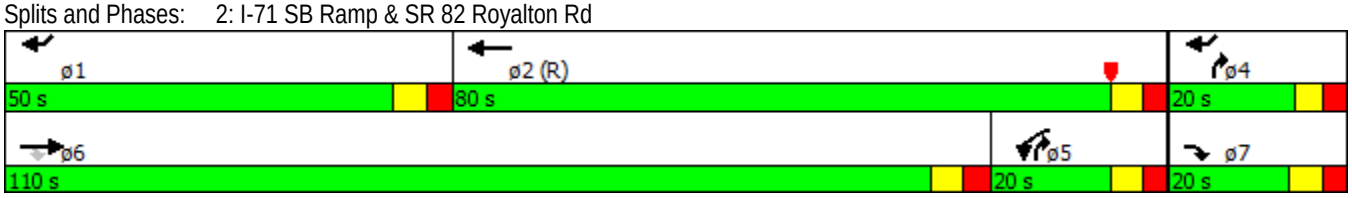
10/7/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø1	ø4
Lane Configurations								
Volume (vph)	2050	280	100	1130	370	960		
Turn Type	NA	custom	Prot	NA	pt+ov	custom		
Protected Phases	6	7	5	2	4 5	1 4	1	4
Permitted Phases	6	6 7		2		1 4		
Detector Phase	6	7	5	2	4 5	1 4		
Switch Phase								
Minimum Initial (s)	25.0	4.0	10.0	25.0			1.0	7.0
Minimum Split (s)	32.0	10.6	17.0	32.0			20.0	20.0
Total Split (s)	110.0	20.0	20.0	80.0			50.0	20.0
Total Split (%)	73.3%	13.3%	13.3%	53.3%			33%	13%
Yellow Time (s)	3.6	3.6	3.6	3.6			3.6	3.0
All-Red Time (s)	3.0	3.0	3.0	3.0			3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0				
Total Lost Time (s)	6.6	6.6	6.6	6.6				
Lead/Lag	Lead		Lag	Lag			Lead	
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Max			None	Max
Act Effct Green (s)	103.4	123.4	13.4	75.9	34.0	60.9		
Actuated g/C Ratio	0.69	0.82	0.09	0.51	0.23	0.41		
v/c Ratio	1.14	0.27	0.85	0.58	0.67	0.80		
Control Delay	91.9	2.9	96.8	22.0	58.8	43.9		
Queue Delay	0.0	0.0	0.0	0.2	0.0	0.0		
Total Delay	91.9	2.9	96.8	22.2	58.8	43.9		
LOS	F	A	F	C	E	D		
Approach Delay	80.2			28.3				
Approach LOS	F			C				

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 148 (99%), Referenced to phase 2:WBT, Start of Yellow
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.14
Intersection Signal Delay: 57.7 Intersection LOS: E
Intersection Capacity Utilization Err% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



Timings
3: Howe Road & SR 82 Royalton Rd

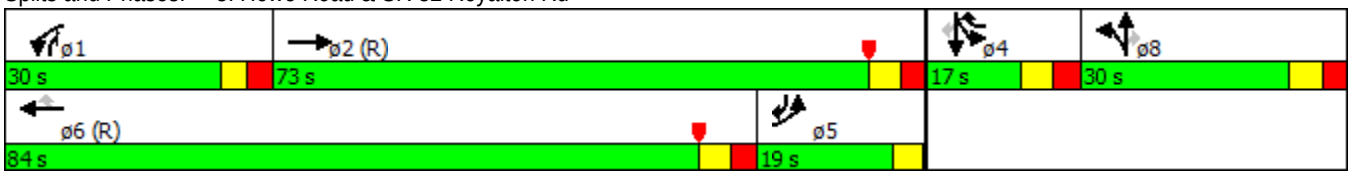
10/7/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	30	1400	420	1620	50	120	30	890	40	10	10
Turn Type	Prot	NA	Prot	NA	pm+ov	Split	NA	pm+ov	Split	NA	pm+ov
Protected Phases	5	2	1	6	4	8	8	1	4	4	5
Permitted Phases					6			8			4
Detector Phase	5	2	1	6	4	8	8	1	4	4	5
Switch Phase											
Minimum Initial (s)	4.0	27.0	10.0	27.0	10.0	10.0	10.0	10.0	10.0	10.0	4.0
Minimum Split (s)	8.0	40.6	16.0	46.6	41.6	20.0	20.0	16.0	41.6	41.6	8.0
Total Split (s)	19.0	73.0	30.0	84.0	17.0	30.0	30.0	30.0	17.0	17.0	19.0
Total Split (%)	12.7%	48.7%	20.0%	56.0%	11.3%	20.0%	20.0%	20.0%	11.3%	11.3%	12.7%
Yellow Time (s)	3.5	3.6	3.0	3.6	3.6	3.6	3.6	3.0	3.6	3.6	3.5
All-Red Time (s)	0.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.5
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Total Lost Time (s)	2.0	4.6	4.0	4.6	4.6	5.0	5.0	4.4	5.0	5.0	2.4
Lead/Lag	Lag	Lag	Lead	Lead				Lead			Lag
Lead-Lag Optimize?											
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None	None	None
Act Effct Green (s)	15.1	68.4	35.5	92.7	105.6	15.9	15.9	56.0	11.6	11.6	30.8
Actuated g/C Ratio	0.10	0.46	0.24	0.62	0.70	0.11	0.11	0.37	0.08	0.08	0.21
v/c Ratio	0.11	1.42	0.64	0.86	0.05	0.55	0.55	1.33	0.18	0.18	0.05
Control Delay	53.2	225.0	58.8	28.8	1.0	74.6	74.2	194.9	66.6	68.0	0.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	53.2	225.0	58.8	28.8	1.0	74.6	74.2	194.9	66.6	68.0	0.2
LOS	D	F	E	C	A	E	E	F	E	E	A
Approach Delay		221.4		34.4			174.2			51.9	
Approach LOS		F		C			F			D	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.42
Intersection Signal Delay: 125.4 — Intersection LOS: F
Intersection Capacity Utilization 79.5% — ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 3: Howe Road & SR 82 Royalton Rd



Zone A Totals

Number of Intersections	4
Control Delay / Veh (s/v)	53
Queue Delay / Veh (s/v)	0
Total Delay / Veh (s/v)	53
Total Delay (hr)	258
Stops / Veh	0.51
Stops (#)	8948
Average Speed (mph)	7
Total Travel Time (hr)	327
Distance Traveled (mi)	2395
Fuel Consumed (gal)	353
Fuel Economy (mpg)	6.8
CO Emissions (kg)	24.68
NOx Emissions (kg)	4.80
VOC Emissions (kg)	5.72
Unserved Vehicles (#)	903
Vehicles in dilemma zone (#)	172
Performance Index	282.9

SR 82 Corridor

2035 No Build Condition

PM

Timings
1: I-71 NB Off Ramp

10/7/2015

Lane Group	EBT	WBT	NBL
Lane Configurations			
Volume (vph)	1690	1600	330
Turn Type	NA	NA	Prot
Protected Phases	2	6	8
Permitted Phases			
Detector Phase	2	6	8
Switch Phase			
Minimum Initial (s)	32.0	32.0	10.0
Minimum Split (s)	53.0	38.0	20.0
Total Split (s)	107.0	107.0	43.0
Total Split (%)	71.3%	71.3%	28.7%
Yellow Time (s)	3.6	3.6	3.0
All-Red Time (s)	2.2	2.2	3.0
Lost Time Adjust (s)	-1.4	-2.0	-1.4
Total Lost Time (s)	4.4	3.8	4.6
Lead/Lag			
Lead-Lag Optimize?			
Recall Mode	C-Max	C-Max	None
Act Effct Green (s)	108.0	108.6	33.0
Actuated g/C Ratio	0.72	0.72	0.22
v/c Ratio	0.73	0.47	0.84
Control Delay	7.2	9.6	63.7
Queue Delay	0.0	0.0	0.0
Total Delay	7.2	9.6	63.7
LOS	A	A	E
Approach Delay	7.2	9.6	63.7
Approach LOS	A	A	E

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 136 (91%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.84
Intersection Signal Delay: 16.5 — Intersection LOS: B
Intersection Capacity Utilization 69.6% — ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: I-71 NB Off Ramp

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

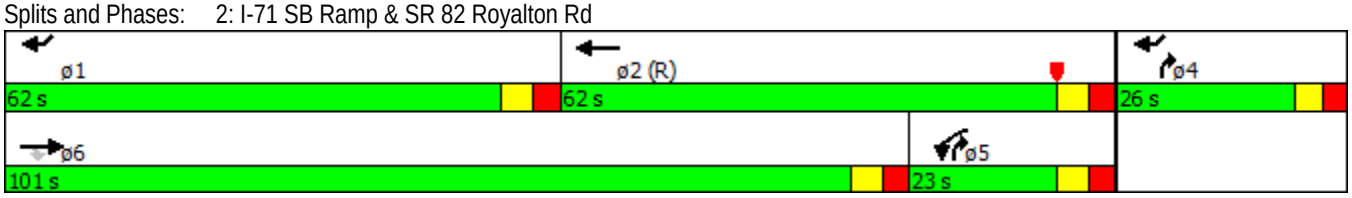
10/7/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø1	ø4
Lane Configurations								
Volume (vph)	2030	450	100	1400	840	1850		
Turn Type	NA	Perm	Prot	NA	pt+ov	custom		
Protected Phases	6		5	2	4 5	1 4	1	4
Permitted Phases	6	6		2		1 4		
Detector Phase	6	6	5	2	4 5	1 4		
Switch Phase								
Minimum Initial (s)	25.0	25.0	10.0	25.0			1.0	7.0
Minimum Split (s)	32.0	32.0	17.0	32.0			20.0	20.0
Total Split (s)	101.0	101.0	23.0	62.0			62.0	26.0
Total Split (%)	67.3%	67.3%	15.3%	41.3%			41%	17%
Yellow Time (s)	3.6	3.6	3.6	3.6			3.6	3.0
All-Red Time (s)	3.0	3.0	3.0	3.0			3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0				
Total Lost Time (s)	6.6	6.6	6.6	6.6				
Lead/Lag	Lead	Lead	Lag	Lag			Lead	
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Max			None	Max
Act Effct Green (s)	94.4	94.4	16.4	55.4	43.0	81.4		
Actuated g/C Ratio	0.63	0.63	0.11	0.37	0.29	0.54		
v/c Ratio	1.33	0.44	1.14	0.88	1.18	0.98		
Control Delay	167.8	0.3	154.2	40.9	139.7	50.4		
Queue Delay	0.0	0.0	0.0	0.0	0.0	40.6		
Total Delay	167.8	0.3	154.2	40.9	139.7	91.0		
LOS	F	A	F	D	F	F		
Approach Delay	137.4			54.3				
Approach LOS	F			D				

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 86 (57%), Referenced to phase 2:WBT, Start of Yellow
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.33
Intersection Signal Delay: 105.5 Intersection LOS: F
Intersection Capacity Utilization Err% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



Timings
3: Howe Road & SR 82 Royalton Rd

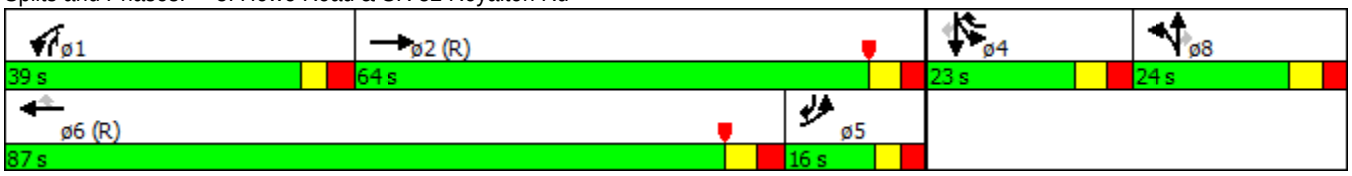
10/7/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	190	1640	930	1930	390	170	100	630	210	150	270
Turn Type	Prot	NA	Prot	NA	pm+ov	Split	NA	pm+ov	Split	NA	pm+ov
Protected Phases	5	2	1	6	4	8	8	1	4	4	5
Permitted Phases					6			8			4
Detector Phase	5	2	1	6	4	8	8	1	4	4	5
Switch Phase											
Minimum Initial (s)	7.0	27.0	10.0	27.0	10.0	10.0	10.0	10.0	10.0	10.0	7.0
Minimum Split (s)	13.0	40.6	16.0	46.6	41.6	20.0	20.0	16.0	41.6	41.6	13.0
Total Split (s)	16.0	64.0	39.0	87.0	23.0	24.0	24.0	39.0	23.0	23.0	16.0
Total Split (%)	10.7%	42.7%	26.0%	58.0%	15.3%	16.0%	16.0%	26.0%	15.3%	15.3%	10.7%
Yellow Time (s)	3.0	3.6	3.0	3.6	3.6	3.6	3.6	3.0	3.6	3.6	3.0
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Total Lost Time (s)	4.0	4.6	4.0	4.6	4.6	5.0	5.0	4.4	5.0	5.0	4.4
Lead/Lag	Lag	Lag	Lead	Lead				Lead			Lag
Lead-Lag Optimize?											
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None	None	None
Act Effct Green (s)	12.0	59.4	35.8	83.2	101.3	18.5	18.5	58.9	17.7	17.7	34.3
Actuated g/C Ratio	0.08	0.40	0.24	0.55	0.68	0.12	0.12	0.39	0.12	0.12	0.23
v/c Ratio	0.79	1.41	1.42	1.03	0.49	0.84	0.49	0.63	0.64	0.82	0.86
Control Delay	71.7	218.2	232.2	56.7	4.7	94.5	69.1	40.1	70.9	92.0	57.1
Queue Delay	0.0	0.0	0.0	26.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Total Delay	71.7	218.2	232.2	83.3	4.7	94.5	69.1	40.1	70.9	92.0	57.3
LOS	E	F	F	F	A	F	E	D	E	F	E
Approach Delay		204.8		117.5			53.5			69.1	
Approach LOS		F		F			D			E	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 28 (19%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.42
Intersection Signal Delay: 130.4 — Intersection LOS: F
Intersection Capacity Utilization 93.2% — ICU Level of Service F
Analysis Period (min) 15

Splits and Phases: 3: Howe Road & SR 82 Royalton Rd



Zone A Totals

Number of Intersections	4
Control Delay / Veh (s/v)	68
Queue Delay / Veh (s/v)	6
Total Delay / Veh (s/v)	74
Total Delay (hr)	450
Stops / Veh	0.51
Stops (#)	11254
Average Speed (mph)	6
Total Travel Time (hr)	537
Distance Traveled (mi)	3111
Fuel Consumed (gal)	543
Fuel Economy (mpg)	5.7
CO Emissions (kg)	37.97
NOx Emissions (kg)	7.39
VOC Emissions (kg)	8.80
Unserved Vehicles (#)	1482
Vehicles in dilemma zone (#)	161
Performance Index	481.2

SR 82 Corridor

2035 Build Condition

AM

Timings
1: I-71 NB Off Ramp

10/8/2015

Lane Group	EBT	EBR	WBT	NBL
Lane Configurations				
Volume (vph)	730	1690	2040	290
Turn Type	NA	Perm	NA	Prot
Protected Phases	2		6	8
Permitted Phases		2		
Detector Phase	2	2	6	8
Switch Phase				
Minimum Initial (s)	32.0	32.0	32.0	10.0
Minimum Split (s)	53.0	53.0	38.0	20.0
Total Split (s)	53.0	53.0	53.0	22.0
Total Split (%)	70.7%	70.7%	70.7%	29.3%
Yellow Time (s)	3.6	3.6	3.6	3.0
All-Red Time (s)	2.2	2.2	2.2	3.0
Lost Time Adjust (s)	-1.4	0.0	-2.0	-1.4
Total Lost Time (s)	4.4	5.8	3.8	4.6
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	None
Act Effct Green (s)	49.7	48.3	50.3	16.3
Actuated g/C Ratio	0.66	0.64	0.67	0.22
v/c Ratio	0.34	0.76	0.66	0.77
Control Delay	7.6	14.2	8.8	31.7
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	7.6	14.2	8.8	31.7
LOS	A	B	A	C
Approach Delay	12.2		8.8	31.7
Approach LOS	B		A	C

Intersection Summary	
Cycle Length: 75	
Actuated Cycle Length: 75	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 75	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.77	
Intersection Signal Delay: 12.9	Intersection LOS: B
Intersection Capacity Utilization 64.0%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 1: I-71 NB Off Ramp

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

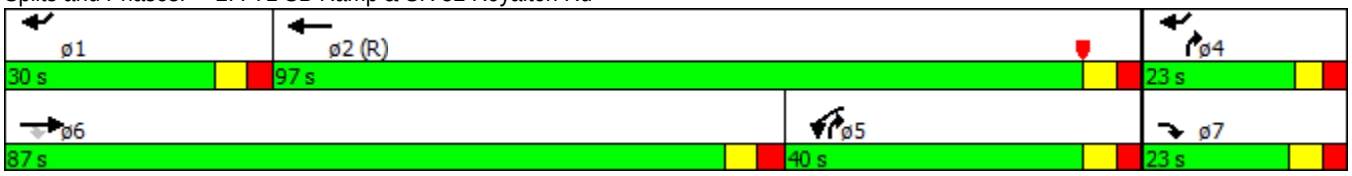
10/8/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR	ø1	ø4
Lane Configurations								
Volume (vph)	2050	280	210	1020	370	680		
Turn Type	NA	custom	Prot	NA	pt+ov	custom		
Protected Phases	6	7	5	2	4 5	1 4	1	4
Permitted Phases	6	6 7		2		1 4		
Detector Phase	6	7	5	2	4 5	1 4		
Switch Phase								
Minimum Initial (s)	25.0	4.0	10.0	25.0			1.0	7.0
Minimum Split (s)	32.0	10.6	17.0	32.0			20.0	20.0
Total Split (s)	87.0	23.0	40.0	97.0			30.0	23.0
Total Split (%)	58.0%	15.3%	26.7%	64.7%			20%	15%
Yellow Time (s)	3.6	3.6	3.6	3.6			3.6	3.0
All-Red Time (s)	3.0	3.0	3.0	3.0			3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0				
Total Lost Time (s)	6.6	6.6	6.6	6.6				
Lead/Lag	Lead		Lag	Lag			Lead	
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Max			None	Max
Act Effct Green (s)	80.4	103.4	33.4	93.7	57.0	43.1		
Actuated g/C Ratio	0.54	0.69	0.22	0.62	0.38	0.29		
v/c Ratio	0.94	0.31	0.71	0.42	0.40	0.71		
Control Delay	26.8	2.5	63.8	15.4	35.4	51.2		
Queue Delay	1.6	0.0	0.0	0.0	0.0	0.3		
Total Delay	28.4	2.5	63.8	15.4	35.4	51.4		
LOS	C	A	E	B	D	D		
Approach Delay	25.0			23.8				
Approach LOS	C			C				

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 24 (16%), Referenced to phase 2:WBT, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 29.3 Intersection LOS: C
Intersection Capacity Utilization Err% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



Timings
3: Howe Road & SR 82 Royalton Rd

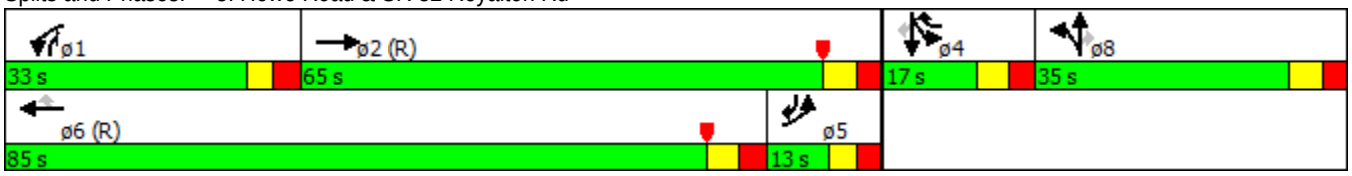
10/8/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	30	1400	110	1540	50	120	30	890	40	10	10
Turn Type	Prot	NA	Prot	NA	pm+ov	Split	NA	pm+ov	Split	NA	pm+ov
Protected Phases	5	2	1	6	4	8	8	1	4	4	5
Permitted Phases					6			8			4
Detector Phase	5	2	1	6	4	8	8	1	4	4	5
Switch Phase											
Minimum Initial (s)	7.0	27.0	10.0	27.0	10.0	10.0	10.0	10.0	10.0	10.0	7.0
Minimum Split (s)	13.0	40.6	16.0	46.6	41.6	20.0	20.0	16.0	41.6	41.6	13.0
Total Split (s)	13.0	65.0	33.0	85.0	17.0	35.0	35.0	33.0	17.0	17.0	13.0
Total Split (%)	8.7%	43.3%	22.0%	56.7%	11.3%	23.3%	23.3%	22.0%	11.3%	11.3%	8.7%
Yellow Time (s)	3.0	3.6	3.0	3.6	3.6	3.6	3.6	3.0	3.6	3.6	3.0
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Total Lost Time (s)	4.0	4.6	4.0	4.6	4.6	5.0	5.0	4.4	5.0	5.0	4.4
Lead/Lag	Lag	Lag	Lead	Lead				Lead			Lag
Lead-Lag Optimize?											
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None	None	None
Act Effct Green (s)	9.0	64.0	39.8	97.4	110.3	16.0	16.0	60.4	11.6	11.6	25.2
Actuated g/C Ratio	0.06	0.43	0.27	0.65	0.74	0.11	0.11	0.40	0.08	0.08	0.17
v/c Ratio	0.19	0.88	0.15	0.78	0.05	0.55	0.55	0.85	0.18	0.18	0.06
Control Delay	65.4	41.5	46.9	17.9	0.6	74.5	74.0	49.0	66.6	68.0	0.3
Queue Delay	0.0	1.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	65.4	42.4	46.9	18.3	0.6	74.5	74.0	49.0	66.6	68.0	0.3
LOS	E	D	D	B	A	E	E	D	E	E	A
Approach Delay		42.9		19.7			53.3			51.9	
Approach LOS		D		B			D			D	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 118 (79%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.88
Intersection Signal Delay: 36.4 — Intersection LOS: D
Intersection Capacity Utilization 79.5% — ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 3: Howe Road & SR 82 Royalton Rd



Zone A Totals

Number of Intersections	4
Control Delay / Veh (s/v)	18
Queue Delay / Veh (s/v)	0
Total Delay / Veh (s/v)	19
Total Delay (hr)	95
Stops / Veh	0.50
Stops (#)	9204
Average Speed (mph)	14
Total Travel Time (hr)	163
Distance Traveled (mi)	2362
Fuel Consumed (gal)	230
Fuel Economy (mpg)	10.3
CO Emissions (kg)	16.06
NOx Emissions (kg)	3.12
VOC Emissions (kg)	3.72
Unserved Vehicles (#)	0
Vehicles in dilemma zone (#)	230
Performance Index	120.7

SR 82 Corridor

2035 Build Condition

PM

Timings
1: I-71 NB Off Ramp

10/8/2015

Lane Group	EBT	EBR	WBT	NBL
Lane Configurations				
Volume (vph)	1690	1180	1600	330
Turn Type	NA	Perm	NA	Prot
Protected Phases	2		6	8
Permitted Phases		2		
Detector Phase	2	2	6	8
Switch Phase				
Minimum Initial (s)	32.0	32.0	32.0	10.0
Minimum Split (s)	53.0	53.0	38.0	20.0
Total Split (s)	54.0	54.0	54.0	21.0
Total Split (%)	72.0%	72.0%	72.0%	28.0%
Yellow Time (s)	3.6	3.6	3.6	3.0
All-Red Time (s)	2.2	2.2	2.2	3.0
Lost Time Adjust (s)	-1.4	0.0	-2.0	-1.4
Total Lost Time (s)	4.4	5.8	3.8	4.6
Lead/Lag				
Lead-Lag Optimize?				
Recall Mode	C-Max	C-Max	C-Max	None
Act Effct Green (s)	49.8	48.4	50.4	16.2
Actuated g/C Ratio	0.66	0.65	0.67	0.22
v/c Ratio	0.79	0.57	0.51	0.86
Control Delay	10.8	1.3	6.8	40.6
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	10.8	1.3	6.8	40.6
LOS	B	A	A	D
Approach Delay	6.9		6.8	40.6
Approach LOS	A		A	D

Intersection Summary

Cycle Length: 75
Actuated Cycle Length: 75
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 10.7 Intersection LOS: B
Intersection Capacity Utilization 69.6% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: I-71 NB Off Ramp

Timings
2: I-71 SB Ramp & SR 82 Royalton Rd

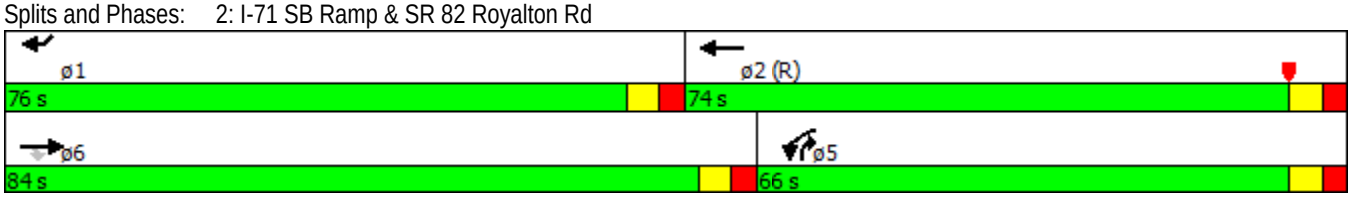
10/8/2015

Lane Group	EBT	EBR	WBL	WBT	NBR2	SWR
Lane Configurations						
Volume (vph)	2030	450	310	1190	840	1240
Turn Type	NA	Perm	Prot	NA	Over	Prot
Protected Phases	6		5	2	5	1
Permitted Phases	6	6		2		1
Detector Phase	6	6	5	2	5	1
Switch Phase						
Minimum Initial (s)	25.0	25.0	10.0	25.0	10.0	1.0
Minimum Split (s)	32.0	32.0	17.0	32.0	17.0	20.0
Total Split (s)	84.0	84.0	66.0	74.0	66.0	76.0
Total Split (%)	56.0%	56.0%	44.0%	49.3%	44.0%	50.7%
Yellow Time (s)	3.6	3.6	3.6	3.6	3.6	3.6
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.6	6.6	6.6	6.6	6.6	6.6
Lead/Lag	Lead	Lead	Lag	Lag	Lag	Lead
Lead-Lag Optimize?						
Recall Mode	None	None	None	C-Max	None	None
Act Effct Green (s)	77.4	77.4	59.4	78.3	59.4	58.5
Actuated g/C Ratio	0.52	0.52	0.40	0.52	0.40	0.39
v/c Ratio	0.94	0.59	0.97	0.53	0.85	0.81
Control Delay	51.8	32.8	72.9	27.3	50.4	45.0
Queue Delay	3.1	0.0	0.0	0.0	0.0	0.4
Total Delay	54.9	32.8	72.9	27.3	50.4	45.4
LOS	D	C	E	C	D	D
Approach Delay	50.9			42.2		
Approach LOS	D			D		

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 56 (37%), Referenced to phase 2:WBT, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.97
Intersection Signal Delay: 47.3 Intersection LOS: D
Intersection Capacity Utilization Err% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



Timings
3: Howe Road & SR 82 Royalton Rd

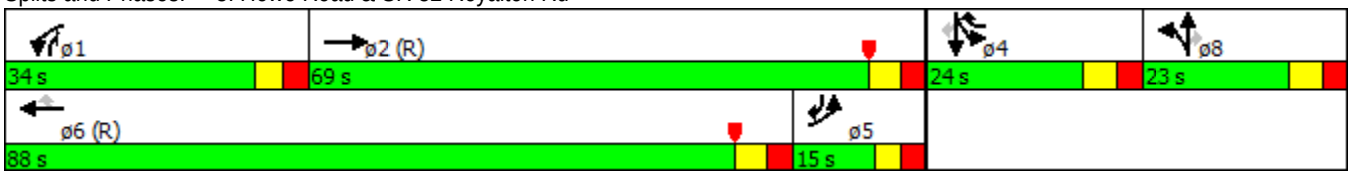
10/8/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations											
Volume (vph)	190	1640	210	1830	390	170	100	630	210	150	270
Turn Type	Prot	NA	Prot	NA	pm+ov	Split	NA	pm+ov	Split	NA	pm+ov
Protected Phases	5	2	1	6	4	8	8	1	4	4	5
Permitted Phases					6			8			4
Detector Phase	5	2	1	6	4	8	8	1	4	4	5
Switch Phase											
Minimum Initial (s)	7.0	27.0	10.0	27.0	10.0	10.0	10.0	10.0	10.0	10.0	7.0
Minimum Split (s)	13.0	40.6	16.0	46.6	41.6	20.0	20.0	16.0	41.6	41.6	13.0
Total Split (s)	15.0	69.0	34.0	88.0	24.0	23.0	23.0	34.0	24.0	24.0	15.0
Total Split (%)	10.0%	46.0%	22.7%	58.7%	16.0%	15.3%	15.3%	22.7%	16.0%	16.0%	10.0%
Yellow Time (s)	3.0	3.6	3.0	3.6	3.6	3.6	3.6	3.0	3.6	3.6	3.0
All-Red Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Total Lost Time (s)	4.0	4.6	4.0	4.6	4.6	5.0	5.0	4.4	5.0	5.0	4.4
Lead/Lag	Lag	Lag	Lead	Lead				Lead			Lag
Lead-Lag Optimize?											
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None	None	None
Act Effct Green (s)	11.0	69.5	25.7	84.2	103.0	17.8	17.8	48.1	18.4	18.4	34.0
Actuated g/C Ratio	0.07	0.46	0.17	0.56	0.69	0.12	0.12	0.32	0.12	0.12	0.23
v/c Ratio	0.87	0.98	0.45	0.97	0.49	0.87	0.51	0.78	0.62	0.78	0.86
Control Delay	79.2	39.4	57.2	36.6	3.2	100.6	70.8	52.3	69.1	86.8	57.7
Queue Delay	0.0	0.0	0.0	6.0	0.0	0.0	0.0	2.5	0.0	0.0	0.2
Total Delay	79.2	39.4	57.2	42.6	3.2	100.6	70.8	54.8	69.1	86.8	58.0
LOS	E	D	E	D	A	F	E	D	E	F	E
Approach Delay		43.0		35.9			65.1			67.7	
Approach LOS		D		D			E			E	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 150
Offset: 16 (11%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.98
Intersection Signal Delay: 46.3 — Intersection LOS: D
Intersection Capacity Utilization 89.7% — ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 3: Howe Road & SR 82 Royalton Rd



Zone A Totals

Number of Intersections	4
Control Delay / Veh (s/v)	25
Queue Delay / Veh (s/v)	1
Total Delay / Veh (s/v)	26
Total Delay (hr)	153
Stops / Veh	0.55
Stops (#)	11603
Average Speed (mph)	12
Total Travel Time (hr)	233
Distance Traveled (mi)	2831
Fuel Consumed (gal)	313
Fuel Economy (mpg)	9.0
CO Emissions (kg)	21.89
NOx Emissions (kg)	4.26
VOC Emissions (kg)	5.07
Unserved Vehicles (#)	0
Vehicles in dilemma zone (#)	317
Performance Index	184.7

Freeway Segments

2035 No Build Condition

AM

No Build | 01

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ I-80*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*2220*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*799*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*12.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 03

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM Lanes 1+2*

Site Information

Highway/Direction of Travel	*SB*
From/To	*I-80 to SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*1565*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*845*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*13.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 03

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM Lane 3*

Site Information

Highway/Direction of Travel	*SB*
From/To	*I-80 to SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*2290*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1236*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*19.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 05

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*1750*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*630*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*9.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 07

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/4/2015*
Analysis Time Period	*AM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 EB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*1380*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*499*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*7.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 09

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*SR 82 to SR 303*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*1760*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*637*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*9.8*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 303*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*1120*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*405*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*6.2*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

Freeway Segments

2035 No Build Condition

PM

No Build | 01

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ I-80*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*5470*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1969*	pc/h/ln
S	*60.4*	mph
D = v_p / S	*32.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 03

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM - Lane 1 + 2*

Site Information

Highway/Direction of Travel	*SB*
From/To	*I-80 to SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*3720*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2008*	pc/h/ln
S	*59.8*	mph
D = v_p / S	*33.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 03

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM - Lane 3*

Site Information

Highway/Direction of Travel	*SB*
From/To	*I-80 to SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*4540*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2451*	pc/h/ln
S	*49.3*	mph
D = v_p / S	*49.7*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 10-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 05

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*4140*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1490*	pc/h/ln
S	*64.9*	mph
D = v_p / S	*23.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 07

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/4/2015*
Analysis Time Period	*PM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 EB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*3300*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1194*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*18.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

No Build | 09

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*SR 82 to SR 303*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*3850*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1393*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*21.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM No Build*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 303*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*2440*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*883*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*13.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

Freeway Segment

2035 Build Condition

AM

Build | 05

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*AM Build ALT 1 & 2*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*2030*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*731*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*11.2*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/4/2015*
Analysis Time Period	*AM Build ALT 1*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 EB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*1660*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*600*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*9.2*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

Freeway Segment

2035 Build Condition

PM

Build | 05

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/2/2015*
Analysis Time Period	*PM Build ALT 1 & 2*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 WB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*4750*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1710*	pc/h/ln
S	*63.6*	mph
D = v_p / S	*26.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

Build | 07

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*SJT*
Agency or Company	*Hatch Mott MacDonald*
Date Performed	*6/4/2015*
Analysis Time Period	*PM Build ALT 1*

Site Information

Highway/Direction of Travel	*SB*
From/To	*@ SR 82 EB*
Jurisdiction	
Analysis Year	*2035*

Project Description *I-71 / SR 82 IMS*

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

Flow Inputs

Volume, V	*3910*	veh/h	Peak-Hour Factor, PHF	*0.94*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1414*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*21.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

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

Glossary

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

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

Freeway Merges / Diverges

2035 No Build Condition

AM

No Build | 02

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	I-80
Date Performed	6/04/2015	Jurisdiction	
Analysis Time Period	AM	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 680	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2220	
	Ramp Volume, V_R: 490	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 40.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2220	0.94	Level	3	0	0.985	1.00	2397
Ramp	490	0.94	Level	6	0	0.971	1.00	537
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 0.597 using Equation (Exhibit 13-6)

V_{12} = 1430 pc/h

V_3 or V_{av34} 967 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 1430 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2934	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1967	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 16.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.294 (Exibit 13-11)

S_R = 58.2 mph (Exhibit 13-11)

S_0 = 63.3 mph (Exhibit 13-11)

S = 59.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 WB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	AM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	450
Freeway Volume, V_F	2710
Ramp Volume, V_R	960
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{down} = 1500 ft
V_D = 370 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2710	0.94	Level	3	0	0.985	1.00	2926
Ramp	960	0.94	Level	2	0	0.990	1.00	1031
UpStream								
DownStream	370	0.94	Level	3	0	0.985	1.00	400

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = 592.06 (Equation 13-12 or 13-13)
P_{FD} = 0.639 using Equation (Exhibit 13-7)
V_{12} = 2243 pc/h
V_3 or V_{av34} 683 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2926	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	1895	Exhibit 13-8	7050	No
V_R	1031	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2243	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 19.5 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.326 (Exhibit 13-12)
S_R = 57.5 mph (Exhibit 13-12)
S_0 = 71.3 mph (Exhibit 13-12)
S = 60.2 mph (Exhibit 13-13)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 EB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	AM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{up} = 1500 ft
V_u = 960 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	1750
Ramp Volume, V_R	370
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1750	0.94	Level	3	0	0.985	1.00	1890
Ramp	370	0.94	Level	3	0	0.985	1.00	400
UpStream	960	0.94	Level	2	0	0.990	1.00	1031
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.694 using Equation (Exhibit 13-7)
V_{12} = 1435 pc/h
V_3 or V_{av34} 455 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1890	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	1490	Exhibit 13-8	7050	No
V_R	400	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1435	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 13.4 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.269 (Exhibit 13-12)
S_R = 58.8 mph (Exhibit 13-12)
S_0 = 71.3 mph (Exhibit 13-12)
S = 61.4 mph (Exhibit 13-13)

No Build | 08

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJB	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82
Date Performed	4/10/2013	Jurisdiction	
Analysis Time Period	AM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{up} = 2000 ft
V_u = 370 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	750
Deceleration Lane Length L_D	
Freeway Volume, V_F	1380
Ramp Volume, V_R	380
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1380	0.94	Level	4	0	0.980	1.00	1497
Ramp	380	0.94	Level	4	0	0.980	1.00	412
UpStream	370	0.94	Level	3	0	0.985	1.00	400
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = 954.53 (Equation 13-6 or 13-7)
P_{FM} = 0.599 using Equation (Exhibit 13-6)
V_{12} = 896 pc/h
V_3 or V_{av34} 601 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No
If Yes, V_{12a} = 896 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1909	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1308	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 10.8 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.260 (Exibit 13-11)
S_R = 59.0 mph (Exhibit 13-11)
S_0 = 64.6 mph (Exhibit 13-11)
S = 60.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R = mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 303
Date Performed	6/5/2015	Jurisdiction	
Analysis Time Period	AM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	1760
Ramp Volume, V_R	640
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1760	0.94	Level	4	0	0.980	1.00	1910
Ramp	640	0.94	Level	4	0	0.980	1.00	694
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.680 using Equation (Exhibit 13-7)
V_{12} = 1521 pc/h
V_3 or V_{av34} 389 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1910	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	1216	Exhibit 13-8	7050	No
V_R	694	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1521	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 14.2 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.295 (Exhibit 13-12)
S_R = 58.2 mph (Exhibit 13-12)
S_0 = 71.3 mph (Exhibit 13-12)
S = 60.5 mph (Exhibit 13-13)

Freeway Merges / Diverges

2035 No Build Condition

PM

No Build | 02

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	I-80
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	PM	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	680
Deceleration Lane Length L_D	
Freeway Volume, V_F	5470
Ramp Volume, V_R	520
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	40.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	5470	0.94	Level	3	0	0.985	1.00	5906
Ramp	520	0.94	Level	6	0	0.971	1.00	570
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 0.597 using Equation (Exhibit 13-6)
V_{12} = 3523 pc/h
V_3 or V_{av34} 2383 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No
If Yes,V_{12a} = 3523 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6476	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4093	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 32.9 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.500 (Exibit 13-11)
S_R = 53.5 mph (Exhibit 13-11)
S_0 = 58.0 mph (Exhibit 13-11)
S = 55.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R = mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

No Build | 04

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 WB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	PM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	450
Freeway Volume, V_F	5990
Ramp Volume, V_R	1850
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{down} = 1500 ft
V_D = 840 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	5990	0.94	Level	3	0	0.985	1.00	6468
Ramp	1850	0.94	Level	2	0	0.990	1.00	1988
UpStream								
DownStream	840	0.94	Level	3	0	0.985	1.00	907

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = 4345.11 (Equation 13-12 or 13-13)
P_{FD} = 0.555 using Equation (Exhibit 13-7)
V_{12} = 4475 pc/h
V_3 or V_{av34} 1993 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6468	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	4480	Exhibit 13-8	7050	No
V_R	1988	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4475	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 38.7 (pc/mi/ln)
LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.412 (Exhibit 13-12)
S_R = 55.5 mph (Exhibit 13-12)
S_0 = 67.4 mph (Exhibit 13-12)
S = 58.7 mph (Exhibit 13-13)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 EB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	PM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{up} = 1500 ft
V_u = 1850 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	4140
Ramp Volume, V_R	840
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	4140	0.94	Level	3	0	0.985	1.00	4470
Ramp	840	0.94	Level	3	0	0.985	1.00	907
UpStream	1850	0.94	Level	2	0	0.990	1.00	1988
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.607 using Equation (Exhibit 13-7)
V_{12} = 3068 pc/h
V_3 or V_{av34} 1402 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4470	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3563	Exhibit 13-8	7050	No
V_R	907	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3068	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 27.5 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.315 (Exhibit 13-12)
S_R = 57.8 mph (Exhibit 13-12)
S_0 = 69.7 mph (Exhibit 13-12)
S = 61.1 mph (Exhibit 13-13)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJB	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82
Date Performed	4/10/2013	Jurisdiction	
Analysis Time Period	PM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 2000 ft

V_u = 840 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	750
Deceleration Lane Length L_D	
Freeway Volume, V_F	3300
Ramp Volume, V_R	550
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3300	0.94	Level	4	0	0.980	1.00	3581
Ramp	550	0.94	Level	4	0	0.980	1.00	597
UpStream	840	0.94	Level	3	0	0.985	1.00	907
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = 1440.09 (Equation 13-6 or 13-7)

P_{FM} = 0.599 using Equation (Exhibit 13-6)

V_{12} = 2143 pc/h

V_3 or V_{av34} 1438 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes, V_{12a} = 2143 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4178	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2740	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 21.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.306 (Exibit 13-11)

S_R = 58.0 mph (Exhibit 13-11)

S_0 = 61.6 mph (Exhibit 13-11)

S = 59.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 303
Date Performed	6/5/2015	Jurisdiction	
Analysis Time Period	PM No Build	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	3850
Ramp Volume, V_R	1410
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3850	0.94	Level	4	0	0.980	1.00	4178
Ramp	1410	0.94	Level	4	0	0.980	1.00	1530
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.585 using Equation (Exhibit 13-7)
V_{12} = 3080 pc/h
V_3 or V_{av34} 1098 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4178	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2648	Exhibit 13-8	7050	No
V_R	1530	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3080	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 27.6 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.371 (Exhibit 13-12)
S_R = 56.5 mph (Exhibit 13-12)
S_0 = 70.9 mph (Exhibit 13-12)
S = 59.7 mph (Exhibit 13-13)

Freeway Merges / Diverges

2035 Build Condition

AM

Build | 04

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 WB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	AM Build ALT 1 & 2	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	450
Freeway Volume, V_F	2710
Ramp Volume, V_R	680
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{down} = 1500 ft
V_D = 370 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2710	0.94	Level	3	0	0.985	1.00	2926
Ramp	680	0.94	Level	2	0	0.990	1.00	731
UpStream								
DownStream	370	0.94	Level	3	0	0.985	1.00	400

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = 508.71 (Equation 13-12 or 13-13)
P_{FD} = 0.653 using Equation (Exhibit 13-7)
V_{12} = 2165 pc/h
V_3 or V_{av34} 761 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2926	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2195	Exhibit 13-8	7050	No
V_R	731	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2165	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 18.8 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.299 (Exhibit 13-12)
S_R = 58.1 mph (Exhibit 13-12)
S_0 = 71.3 mph (Exhibit 13-12)
S = 61.1 mph (Exhibit 13-13)

Build | 06

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 EB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	AM Build ALT 1 & 2	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp: ☑ Yes ☐ No ☐ On ☑ Off; L_{up} = 1500 ft; V_u = 680 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	2030
Ramp Volume, V_R	370
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2030	0.94	Level	3	0	0.985	1.00	2192
Ramp	370	0.94	Level	3	0	0.985	1.00	400
UpStream	680	0.94	Level	2	0	0.990	1.00	731
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R = mph (Exhibit 13-11)

S_0 = mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 0.687 using Equation (Exhibit 13-7)

V_{12} = 1631 pc/h

V_3 or V_{av34} 561 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2192	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	1792	Exhibit 13-8	7050	No
V_R	400	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1631	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 15.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.269 (Exhibit 13-12)

S_R = 58.8 mph (Exhibit 13-12)

S_0 = 71.3 mph (Exhibit 13-12)

S = 61.6 mph (Exhibit 13-13)

Freeway Merges / Diverges

2035 Build Condition

PM

Build | 04

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 WB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	PM Build ALT 1 & 2	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	450
Freeway Volume, V_F	5990
Ramp Volume, V_R	1240
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{down} = 1500 ft
V_D = 840 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	5990	0.94	Level	3	0	0.985	1.00	6468
Ramp	1240	0.94	Level	2	0	0.990	1.00	1332
UpStream								
DownStream	840	0.94	Level	3	0	0.985	1.00	907

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = 2011.96 (Equation 13-12 or 13-13)
P_{FD} = 0.555 using Equation (Exhibit 13-7)
V_{12} = 4183 pc/h
V_3 or V_{av34} 2285 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6468	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	5136	Exhibit 13-8	7050	No
V_R	1332	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4183	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 36.2 (pc/mi/ln)
LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.353 (Exhibit 13-12)
S_R = 56.9 mph (Exhibit 13-12)
S_0 = 66.3 mph (Exhibit 13-12)
S = 59.9 mph (Exhibit 13-13)

Build | 06

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	SJT	Freeway/Dir of Travel	I-71 SB
Agency or Company	Hatch Mott MacDonald	Junction	SR 82 EB
Date Performed	6/4/2015	Jurisdiction	
Analysis Time Period	PM Build ALT 1 & 2	Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 1500 ft; V_u = 1240 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	4750
Ramp Volume, V_R	840
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	50.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	4750	0.94	Level	3	0	0.985	1.00	5129
Ramp	840	0.94	Level	3	0	0.985	1.00	907
UpStream	1240	0.94	Level	2	0	0.990	1.00	1332
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R = mph (Exhibit 13-11)

S_0 = mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 0.590 using Equation (Exhibit 13-7)

V_{12} = 3398 pc/h

V_3 or V_{av34} 1731 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5129	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	4222	Exhibit 13-8	7050	No
V_R	907	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3398	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 30.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.315 (Exhibit 13-12)

S_R = 57.8 mph (Exhibit 13-12)

S_0 = 68.5 mph (Exhibit 13-12)

S = 61.0 mph (Exhibit 13-13)

Freeway Weave

2035 Build Condition

AM

Build | 08A

FREEWAY WEAVING WORKSHEET

General Information

Analyst	SJT
Agency/Company	Hatch Mott MacDonald
Date Performed	6/23/2015
Analysis Time Period	AM Build ALT 3

Site Information

Freeway/Dir of Travel	I-71 SB
Weaving Segment Location	SR 82 Entrance to Howe Exit
Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1900ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	50
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1380	0.94	4	0	1.5	1.2	0.980	1.00	1497
V_{RF}	380	0.94	4	0	1.5	1.2	0.980	1.00	412
V_{FR}	280	0.94	2	0	1.5	1.2	0.990	1.00	301
V_{RR}	110	0.94	2	0	1.5	1.2	0.990	1.00	118
V_{NW}	1615							V =	2283
V_W	713								
VR	0.306								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	713 lc/h
Interchange density, ID	0.5 int/mi	Weaving lane changes, LC_W	1058 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	592 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1650 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	153

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

Weaving segment flow rate, v	2283 veh/h	Weaving intensity factor, W	0.202
Weaving segment capacity, c_w	7683 veh/h	Weaving segment speed, S	58.6 mph
Weaving segment v/c ratio	0.297	Average weaving speed, S_W	62.5 mph
Weaving segment density, D	9.9 pc/mi/ln	Average non-weaving speed, S_{NW}	57.1 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	5651 ft

Notes

a. 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".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

Freeway Weave

2035 Build Condition

PM

Build | 08A

FREEWAY WEAVING WORKSHEET

General Information

Analyst	SJT
Agency/Company	Hatch Mott MacDonald
Date Performed	6/23/2015
Analysis Time Period	PM Build ALT 3

Site Information

Freeway/Dir of Travel	I-71 SB
Weaving Segment Location	SR 82 Entrance to Howe Exit
Analysis Year	2035

Project Description I-71 / SR 82 IMS

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	50
Weaving segment length, L_S	1900ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3300	0.94	4	0	1.5	1.2	0.980	1.00	3581
V_{RF}	550	0.94	4	0	1.5	1.2	0.980	1.00	597
V_{FR}	610	0.94	2	0	1.5	1.2	0.990	1.00	655
V_{RR}	210	0.94	2	0	1.5	1.2	0.990	1.00	226
V_{NW}	3807							V =	4960
V_W	1252								
VR	0.247								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1252 lc/h
Interchange density, ID	0.5 int/mi	Weaving lane changes, LC_W	1597 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1044 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2641 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	362

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

Weaving segment flow rate, v	4960 veh/h	Weaving intensity factor, W	0.293
Weaving segment capacity, c_w	8278 veh/h	Weaving segment speed, S	52.4 mph
Weaving segment v/c ratio	0.599	Average weaving speed, S_W	61.6 mph
Weaving segment density, D	24.1 pc/mi/ln	Average non-weaving speed, S_{NW}	49.9 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5027 ft

Notes

a. 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".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

Appendix D

Turn Lane Calculations

STORAGE LENGTH CALCULATION WORKSHEET - SIGNALIZED INTERSECTION

From the ODOT Location & Design Manual (Vol. 1) - Sections 401-9E and 401-10E [Oct 2004]

Date Competed:	10/6/2015		
Completed by:	SJT	Checked by:	SJB
Project:	I-71 / SR82 IJS		
Intersection:	SR 82 @ I-71 SB	Cycle Length Known:	Yes
Approaches Analyzed:	1	Cycle Length (sec):	150
		Signal Phases:	
		Cycles / Hr	24

Approach:	Street Name:	Design Speed:		Notes:
Eastbound			mph	
Westbound	SR 82	35	mph	Build 2035 PM Build Volumes
Northbound			mph	
Southbound			mph	

	EB			WB - SR 82			NB			SB		
	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt
Volume:				310	1190	0						
Demand:				high		low						
# Lanes:				1	3							
Avg Veh/Cycle:	0	0	0	13	50	0	0	0	0	0	0	0
Condition:				A		A						
Thru Backup:					517							
L&D Length (ft)[1]:				525		#N/A						
95% Queue (ft)[2]:				350								

	WB Lt	WB Rt
Recommended Turn Length (ft)[1]:		

[1] *includes 50 ft taper* [2] *from SimTraffic* *[created by Hatch Mott MacDonald]* *rev. 4/22/2013*

Justification for Turn Lane Length Recommendations

Eastbound

Left: n/a Right: n/a

Westbound

Left: n/a Right: n/a

- existing WB LT lane = 300 ft w/ taper
- available length from stop bar to longitudinal joint between structures over I-71 = 300 ft

Northbound

Left: n/a Right: n/a

Southbound

Left: n/a Right: n/a

STORAGE LENGTH CALCULATION WORKSHEET - SIGNALIZED INTERSECTION

From the ODOT Location & Design Manual (Vol. 1) - Sections 401-9E and 401-10E [Oct 2004]

Hatch Mott MacDonald

Date Competed:	10/6/2015		
Completed by:	SJT	Checked by:	SJB
Project:	I-71 / SR82 IJS		
Intersection:	Howe @ Pomeroy/Tracy	Cycle Length Known:	Yes
Approaches Analyzed:	4	Cycle Length (sec):	110
		Signal Phases:	
		Cycles / Hr	33

Approach:	Street Name:	Design Speed:		Notes:
Eastbound	Pomeroy	25	mph	Build ALT 1, 2, 3 & 4
Westbound	Tracy	25	mph	2035 PM Build volumes used for EB, WB, & SB
Northbound	Howe	35	mph	2035 AM Build volumes used for NB
Southbound	Howe	35	mph	

	EB - Pomeroy			WB - Tracy			NB - Howe			SB - Howe		
	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt
Volume:	10	10	10	20	10	10	10	1210	10	20	590	20
Demand:	high		high	high		high	low		low	low		low
# Lanes:	1	1			1		1	2		1	1	
Avg Veh/Cycle:	1	1	1	1	1	1	1	37	1	1	18	1
Condition:	A		A	A		A	A		A	A		A
Thru Backup:		50			50			#N/A			625	
L&D Length (ft)[1]:	100		100	100		100	100		100	100		100
95% Queue (ft)[2]:												

	EB Lt	EB Rt	WB Lt	WB Rt	NB Lt	NB Rt	SB Lt	SB Rt
Recommended Turn Length (ft)[1]:					**150**		**150**	

[1] *includes 50 ft taper* [2] *from SimTraffic* *[created by Hatch Mott MacDonald]* *rev. 4/22/2013*

Justification for Turn Lane Length Recommendations

Eastbound

Left: n/a Right: n/a

Westbound

Left: n/a Right: n/a

Northbound

Left: 150 Right: n/a

thru backup = 1200 feet over 2 lanes = 600' per lane

lack of turning traffic, multiple drives, and presence of TWLTL dictate a left turn lane close to the L&D calculated value

Southbound

Left: 150 Right: n/a

lack of turning traffic a nd presence of TWLTL dictates a left turn lane close to the L&D calculated value

STORAGE LENGTH CALCULATION WORKSHEET - SIGNALIZED INTERSECTION

From the ODOT Location & Design Manual (Vol. 1) - Sections 401-9E and 401-10E [Oct 2004]

Hatch Mott MacDonald

Date Competed:	10/6/2015		
Completed by:	SJT	Checked by:	SJB
Project:	I-71 / SR82 IJS		
Intersection:	Howe @ Shurmer	Cycle Length Known:	Yes
Approaches Analyzed:	4	Cycle Length (sec):	110
		Signal Phases:	
		Cycles / Hr	33

Approach:	Street Name:	Design Speed:		Notes:
Eastbound	Shurmer	25	mph	
Westbound	I-71	35	mph	2035 PM Build Volumes
Northbound	Howe	35	mph	
Southbound	Howe	35	mph	

	EB - Shurmer			WB - I-71			NB - Howe			SB - Howe		
	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt	Lt	Thru	Rt
Volume:	100	0	50	520	90	210	50	660	0	0	440	50
Demand:	high		high	high		high	low		low	low		high
# Lanes:	1	1		1	1	1	1	2			1	1
Avg Veh/Cycle:	4	0	2	16	3	7	2	20	0	0	14	2
Condition:	A		A	A		A	A		A	A		A
Thru Backup:	#N/A			150			337.5			500		
L&D Length (ft)[1]:	225		150	600		325	150		#N/A	#N/A		150
95% Queue (ft)[2]:												

	EB Lt	EB Rt	WB Lt	WB Rt	NB Lt	NB Rt	SB Lt	SB Rt
Recommended Turn Length (ft)[1]:	**225**	**-**	**600**	**350**	**150**	**-**		**-**

[1] *includes 50 ft taper* [2] *from SimTraffic* *[created by Hatch Mott MacDonald]* *rev. 4/22/2013*

Justification for Turn Lane Length Recommendations

Eastbound

Left: 225 Right: -

Westbound

Left: 600 Right: 350

form both left and right lanes at 600' from intersection

Northbound

Left: 150 Right: -

use L&D turn lane calculation due to low left turn volumes and to limit ROW impacts

Southbound

Left: n/a Right: -

right turn lane will form from thru lane

Appendix E

Cost Estimate

Summary of I71_SR82 Interchange Improvements Probable Costs Build Condition		
Section	**Cost**	
Howe Road Off Ramp and Intersection Improvements	$	4,700,000
Howe Road Widening (5 lanes) North of Shurmer	$	3,000,000
Total	***$***	***7,700,000***

I71_SR82 Interchange Modification - Howe Road Off Ramp and Shurmer Intersection
Preliminary Estimate of Probable Costs

Items	Unit	Unit Cost $ (2015)	Quantity	Total $
General Construction Costs				
Primary Cost Drivers				
Roadway				
Clearing and Grubbing	Acre	$2,200	1	$2,200
Trees Removed	Acre	$2,750	1	$2,750
Pavement Removed	Sq Yd	$8	4,533	$36,267
Drive Removed	Sq Yd	$7	975	$6,825
Walk Removed	Sq Ft	$2	12,600	$25,200
Excavation	Cu Yd	$8	1,500	$12,000
Embankment	Cu Yd	$9	3,056	$27,500
Guardrail	Ft	$14	1,650	$23,100
Curb	Ft	$17	2,100	$35,700
Concrete Walk (6' wide)	Sq Ft	$6	12,600	$75,600
Erosion Control				
Seeding & Mulching	Sq Yd	$3	13,644	$40,933
Erosion Control	Lump	$10,000	1	$10,000
Topsoil	Cu Yd	$15	156	$2,340
Drainage				
Type B Conduit	Ft	$150	1,410	$211,500
Catch Basins	Each	$1,500	7	$10,500
Manhole	Each	$3,000	4	$10,500
Underdrains	Ft	$10	4,220	$42,200
Pavement				
Asphalt Pavement Ramps (3" Item 448, 9" Item 301, 6" Agg Base, Subgrade)	Sq Yd	$45	7,408	$333,350
Asphalt Pavement Roads (3" Item 448, 4" Item 301, 6" Agg Base, Subgrade)	Sq Yd	$45	5,133	$231,000
Drive Aprons (Concrete)	Sq Yd	$55	975	$53,625
Lighting				
Light Towers (Partial Interchange, every 500')	Each	$40,000	4	$160,000
Traffic Control				
Signage	Mile	$200,000	0.60	$120,100
Edge Line	Mile	$5,000	1.20	$6,000
Lane Line	Mile	$3,000	0.53	$1,600
Center Line	Mile	$6,000	0.60	$3,600
Traffic Signals				
Traffic Signal - Howe/Shurmer/Ramp (Standard Urban Traffic Intersection)	Each	$140,000	1	$140,000
Noise Wall				
Noise Wall (assumed 16ft high)	Ft	$500	720	$360,000
Primary Cost Drivers Subtotal				***$1,985,000***
Maintenance of Traffic (MOT) (3%)				$60,000
Construction Layout Stakes (0.75%)				$15,000
Field Office, Type B	Month	$1,600	18	$29,000
Mobilization				$100,000
Contingencies (35%)				$695,000
Summary of Probable Total Construction Costs 2015				***$2,884,000***
Probable Total Construction Costs Including 15.5% Inflation for Oct 2019				***$3,331,020***
Right of Way				
Right of Way Acquisition (Permanent)				$400,000
Property Rights Acquisition (Limited Access Restriction)	Parcel	$15,000	28	$420,000
Engineering Costs (15% of Construction)				$433,000
Construction Services (3% of Construction)				$87,000
Summary of Probable Total Project Costs 2015				***$4,700,000***

I71_SR82 Interchange Modification - Howe Road Widening North of Shurmer
Preliminary Estimate of Probable Costs

Items	Unit	Unit Cost $ (2015)	Quantity	Total $
General Construction Costs				
Primary Cost Drivers				
Roadway				
Clearing and Grubbing	Acre	$2,200	1	$2,200
Trees Removed	Acre	$2,750	1	$2,750
Pavement Removed	Sq Yd	$8	4,400	$35,200
Drive Removed	Sq Yd	$7	1,425	$9,975
Walk Removed	Sq Ft	$2	19,800	$39,600
Excavation	Cu Yd	$8	500	$4,000
Embankment	Cu Yd	$8	500	$4,000
Curb	Ft	$17	3,300	$56,100
Concrete Walk (6' wide)	Sq Ft	$6	19,800	$118,800
Erosion Control				
Seeding & Mulching	Sq Yd	$3	2,933	$8,800
Erosion Control	Lump	$10,000	1	$10,000
Topsoil	Cu Yd	$15	244	$3,660
Drainage				
Type B Conduit	Ft	$150	1,950	$292,500
Catch Basins	Each	$1,500	11	$16,500
Manhole	Each	$3,000	6	$18,000
Underdrains	Ft	$10	3,300	$33,000
Pavement				
Asphalt Pavement Roads (3" Item 448, 4" Item 301, 6" Agg Base, Subgrade)	Sq Yd	$45	11,000	$495,000
Drive Aprons (Concrete)	Sq Yd	$55	1,425	$78,375
Traffic Control				
Signage	Mile	$200,000	0.31	$62,000
Edge Line	Mile	$5,000	0.63	$3,150
Lane Line	Mile	$3,000	0.63	$1,890
Center Line	Mile	$6,000	0.31	$1,860
Traffic Signals				
Traffic Signal - Howe/Tracy-Pomeroy (Standard Urban Traffic Intersection)	Each	$140,000	1.00	$140,000
Primary Cost Drivers Subtotal				***$1,438,000***
Maintenance of Traffic (MOT) (3%)				$44,000
Construction Layout Stakes (0.75%)				$11,000
Field Office, Type B	Month	$1,600	12	$20,000
Mobilization				$40,000
Contingencies (35%)				$504,000
Summary of Probable Total Construction Costs 2015				***$2,057,000***
Probable Total Construction Costs Including 15.5% Inflation for Oct 2019				***$2,375,835***
Right of Way				
Right of Way Acquisition (Permanent)				$220,000
Engineering Costs (15% of Construction)				$309,000
Construction Services (3% of Construction)				$62,000
Summary of Probable Total Project Costs 2015				***$3,000,000***

Right of Way Costs

Total/major take parcel values

	Parcel	Street	Total Square Footage	Total Value	Land Value	Take width	Take length	Take area	land cost	Partial or Total	Cost
1	399-10-009	Howe Rd	349,786	$194,600	$141,400	150	550	82500	$33,360.00	Partial	$33,360.00
2	397-08-001	Howe Rd	33,541	$38,700	$38,700					Total	$38,700.00
3	397-07-003	Shurmer Rd	60,480	$68,900	$68,900					Total	$68,900
4	399-10-008	Howe Rd	67953	$141,400	$42,900					Total	$141,400
											$282,360

Parcels used to obtain average sq ft cost for partial takes

	Parcel	Street	Total Square Footage	Land Value	Avg. Sq Ft Cost
1	399-10-018	Howe Rd	51400	$37,000	0.719844358
2	399-10-014	Howe Rd	39204	$33,200	0.846852362
3	399-10-020	Howe Rd	41817	$34,000	0.813066456
4	399-10-006	Howe Rd	40510	$33,700	0.83189336
5	399-10-005	Howe Rd	59677	$41,400	0.693734605

Avg. Cost 0.781078228 Sq Ft

Increase for land value appriciation, negotiations and acquisition cost. Use **3 Sq Ft**

Total area of partial take

Location	Length	Width	Total Sq Ft Take
Shurmer Rd	350	20	7000
Howe Rd South of Intersection	350	20	7000
Howe Rd North of Intersection	2000	30	60000
Off Ramp along I71	1800	20	36000
			110000

Total partial take costs **$ 330,000**

Total Right of Way costs **$620,000** (400,000 shown with Off Ramp, 220,000 shown on Howe)

FY 2015-2019 Business Plan Inflation Calculator:

Not sure if you have the latest calculator? Click here.

Last Modified: 7/25/2014

Today's Date:
December 28, 2015

Please Enter Values in the Yellow Areas Only:

Estimation Start Date:
Less than or Equal to Today's Date
(mm/dd/yyyy)

12/28/2015
Start Date:

Enter Construction Mid-Point Date:
(cannot exceed 06/01/2025)
(mm/dd/yyyy)

10/1/2019
Construction Mid-Point Date:

Present-Day Estimated Cost:

$1.00
Estimated Dollar Amount:

Estimate Start Date to Construction Mid-Point Date: **46** **Months**

Inflation - Start to Mid-Point of Construction:

	(compounded growth rate)	Inflated Dollar Amount:
Business Plan	**15.5%**	**$1.15**

Estimator's Name:

County - Route - Section:

PID:

Estimator's Notes: