# I-71 NB at SR 82 EB
# Interchange Operations Study

December 2015

Prepared for:

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

Prepared by:

Hatch Mott MacDonald

18013 Cleveland Parkway Drive
Suite 200
Cleveland, OH 44135

# Contents



# I. Executive Summary

The Ohio Department of Transportation (ODOT) commissioned Hatch Mott MacDonald (HMM) to conduct an Interchange Operations Study 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 widening the SR 82 EB to I-71 NB entrance ramp allowing an additional SR 82 EB lane to access I-71 NB. The proposed ramp widening will taper back to a single travel lane prior to merging with I-71. This improvement is proposed to specifically address the severe lane imbalance, congestion and rear end crashes on SR 82 EB. The proposed improvement may also have a positive impact on the overall congestion and crash problems in the study area by improving the efficiency of the adjacent I-71 SB and Howe Road signals.

Based on the analyses presented in this report, the Build condition does not degrade or otherwise negatively affect freeway operations on I-71. The Build condition is expected to improve the efficiency of the SR 82 coordinated signal system and thus reduce travel times, fuel consumption, emissions, and crashes. Improving the efficiency of the SR 82 signal system may also help mitigate queues that currently extend onto the I-71 SB mainline during periods of high traffic volumes. Therefore, the Build condition is recommended.

*Figure 1 - 2035 No Build LOS Summary*

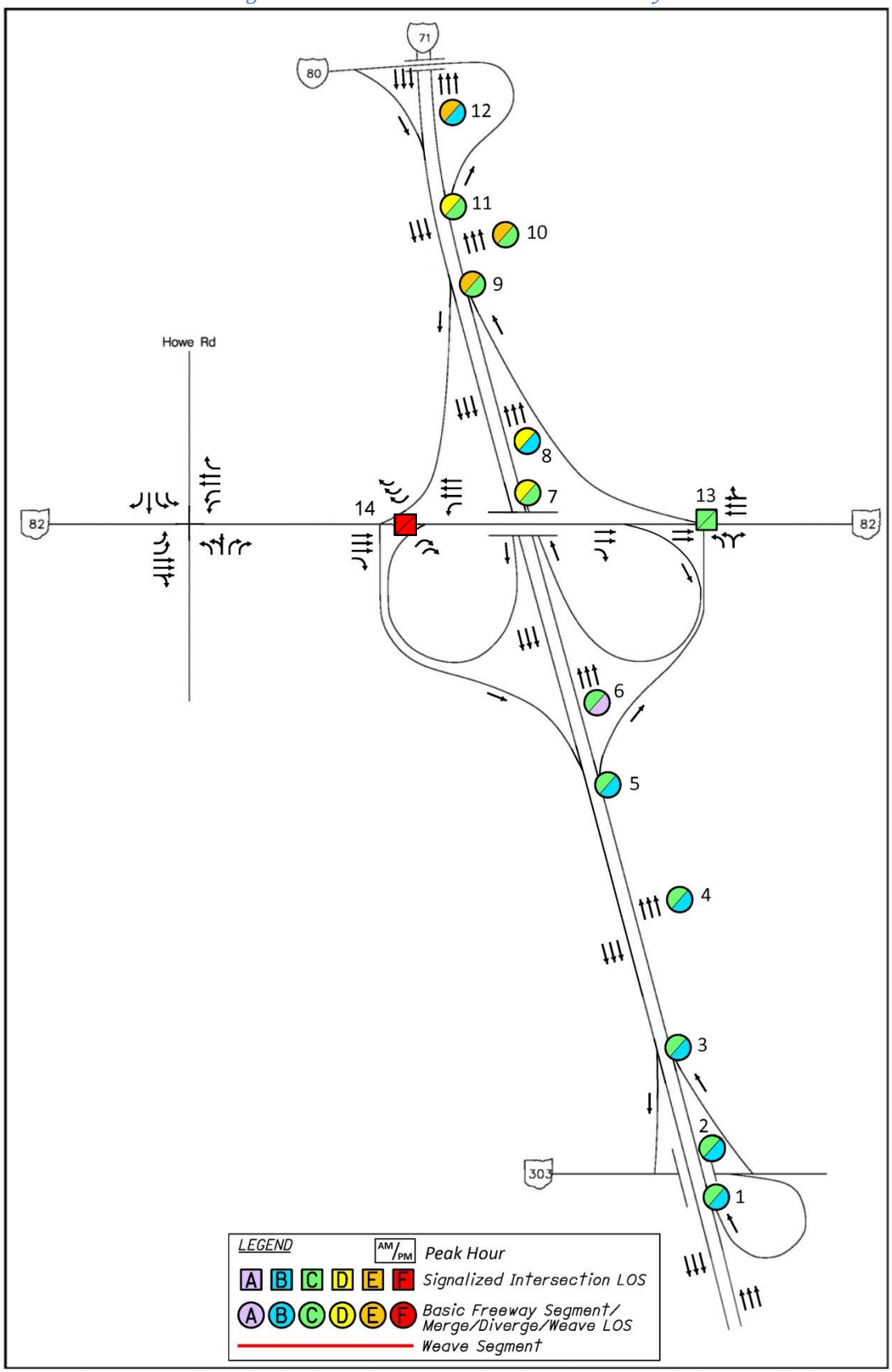
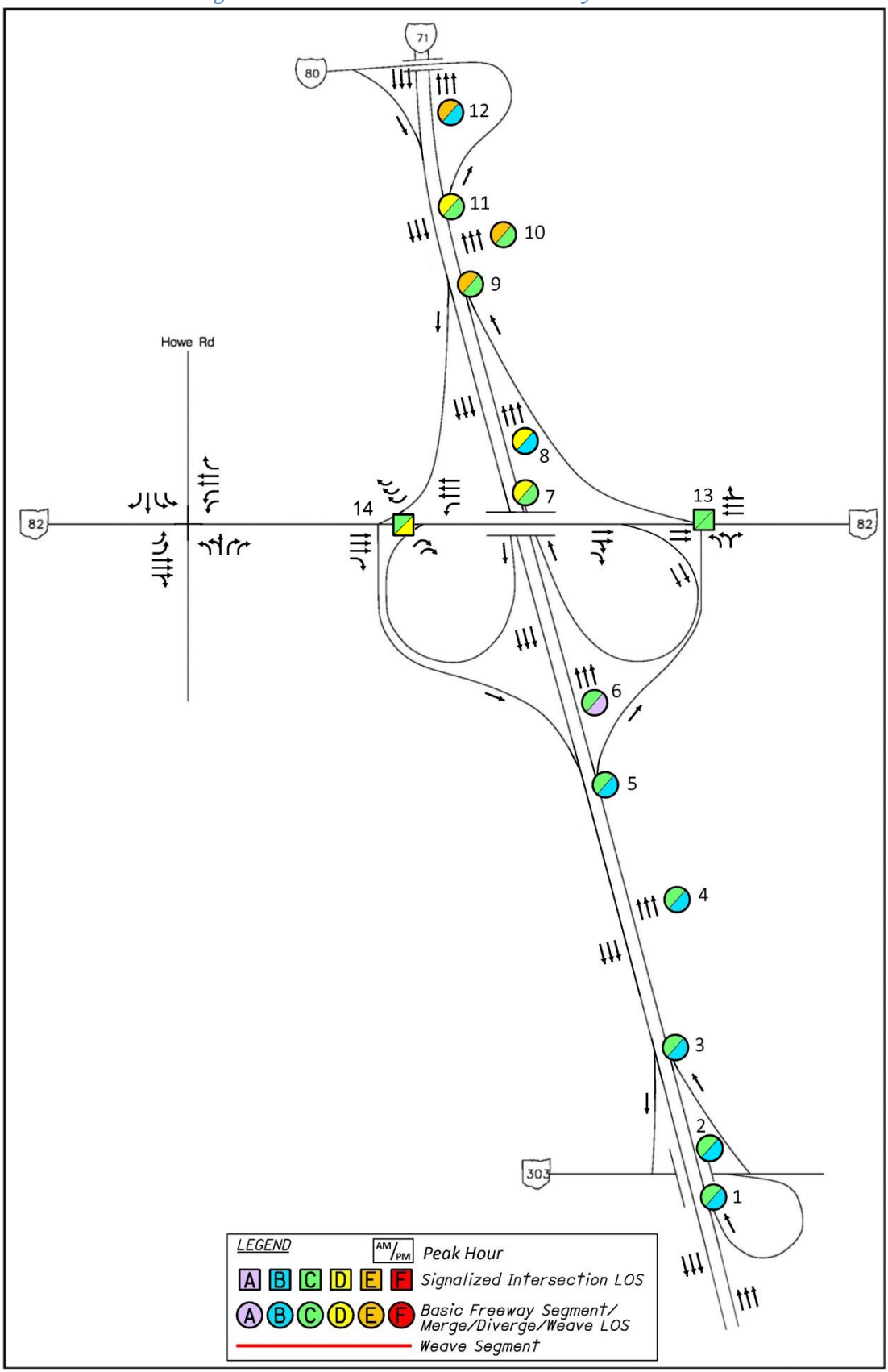


*Figure 2 - 2035 Build LOS Summary*



## II. Background

The Ohio Department of Transportation (ODOT) commissioned Hatch Mott MacDonald (HMM) to conduct an Interchange Operations Study (IOS) of the Interstate 71 (I-71) / SR 82 interchange (CUY-71-2.57) located in the City of Strongsville, Cuyahoga County, Ohio. This IOS expands upon the preparation of the "*I-71 at SR 82 Interchange Operation Analysis*" completed by HMM on April 15, 2013. The study follows IOS procedures and guidance as given by the ODOT Office of Roadway Engineering.

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.
- Signal displays on Howe Road northbound revised to be 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 was provided along with a second left turn lane on 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).

## 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. 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 throughout the SR 82 corridor and the I-71 / SR 82 interchange study area.

## IV. Study Area

The study area consists of I-71 from the SR 303 interchange to the I-80 (Ohio Turnpike) interchange and SR 82 from Howe Road through the I-71 interchange. See Figure 3 & 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. Areas further to the south of SR 82 are largely residential. US 42 is a major north-south arterial located about one mile west of I-71 which is also heavily commercial.

*Table 1 - Functional Classification within Study Area*

| | Functional Class | Legal Speed Limit |
|---|---|---|
| **I-71** | Urban Interstate | 60 |
| **SR 82** | Urban Principal Arterial | 35 |

Current ADT on SR 82 in the project area is approximately 45,000 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**

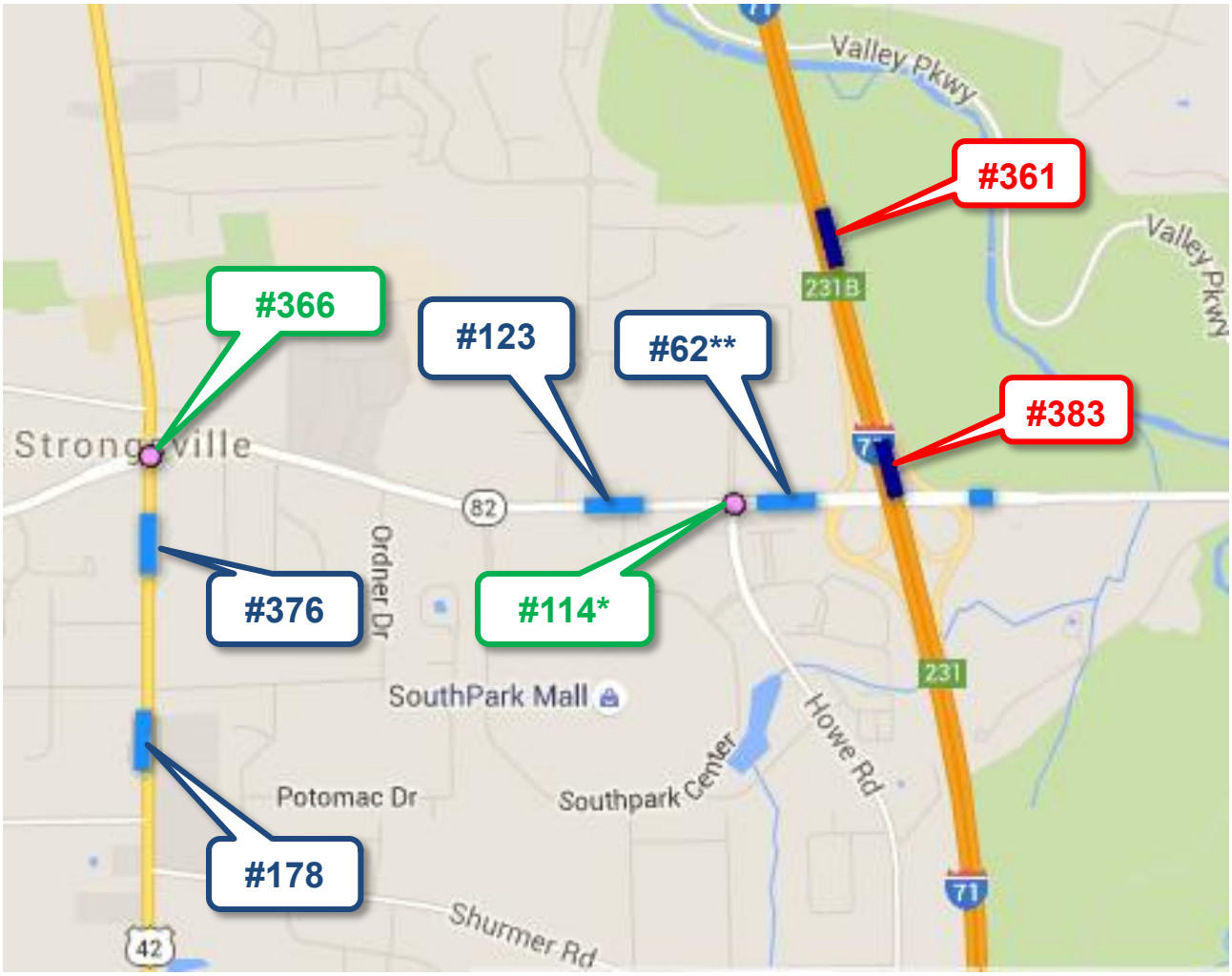
The terrain is relatively flat is this area. I-71 passes under SR 82.

**c. Crash Data**

Based on the Formal Safety Study completed in July of 2012, an analysis of traffic crashes from 2008 – 2010 reveal that 289 crashes occurred on the SR 82 corridor from MP 2.7 to 3.7 with about 25% of all crashes resulting in an injury. 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 on the following page 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)

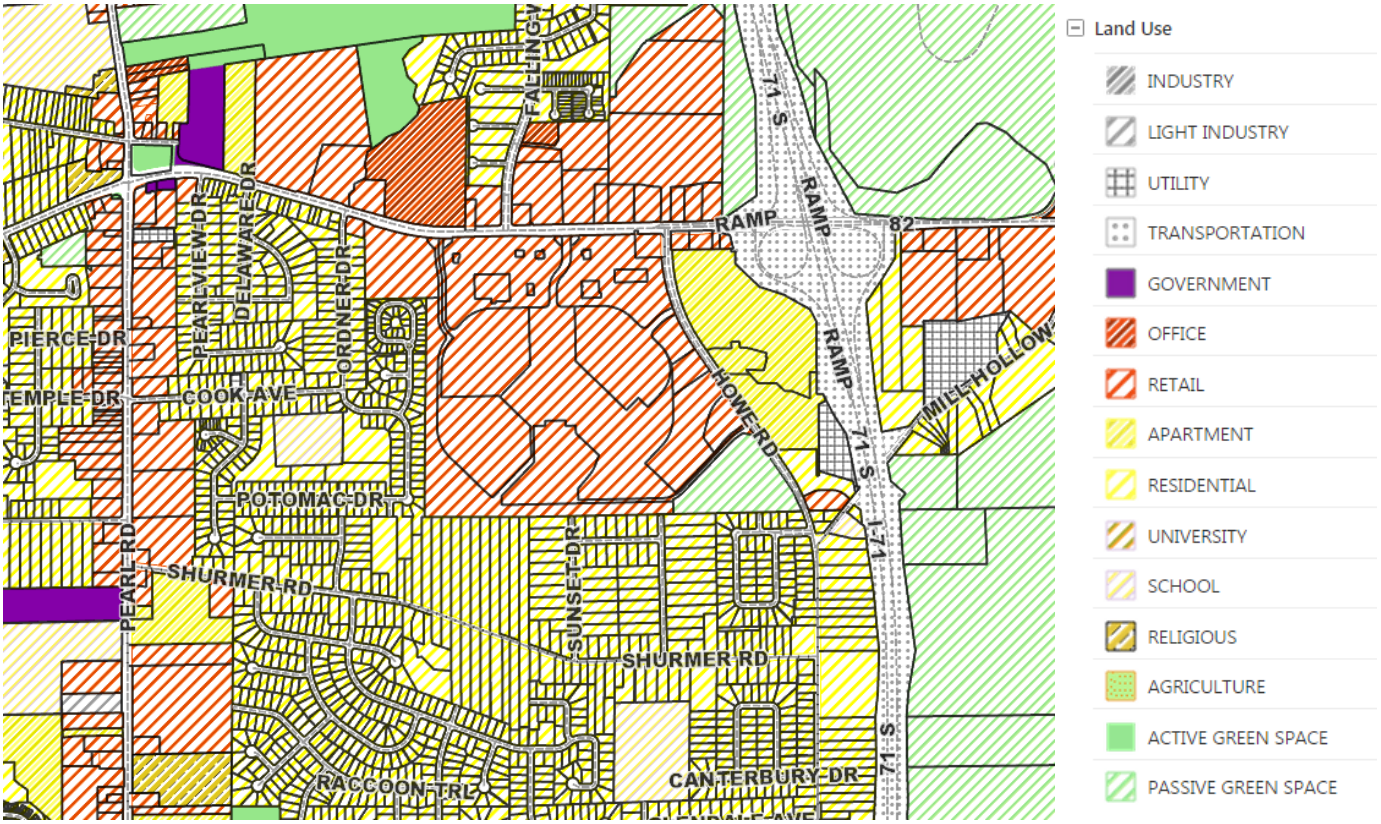
**d. Demographics**

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 IOS 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 improvement as presented in Figure 7. This includes widening the SR 82 EB to I-71 NB loop ramp to two lanes allowing an additional SR 82 EB lane to access I-71 NB by converting the outside through lane to a decision lane.

# 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 Southpark Mall entrances to improve turn lane use and efficiency (ex: the SR 82 EB left turn storage capacity at Howe Road was increased by providing a dual turning lane and extending the existing turning lane based on updated traffic count information).
    b. 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.

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 as well as 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 time there is no ramp metering in this area. Ramp metering was tried at this interchange in the past for the SR 82 WB to I-71 NB entrance 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 Road intersection such as a roundabout, continuous flow intersection (CFI), and median U-turns in a safety study dated November 2014. The close proximity 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, ODOT has dismissed this alternative due to high costs, ROW needs, and a lack of support by local municipalities and ODOT.

6. Additional I-71 SB Exit Ramp – As part of the SR 82 interchange, an additional I-71 SB exit ramp tying directly into Howe Road south of SR 82 is being explored in conjunction with this study.

7. Build – The Build condition studied in this report will represent the following proposed conditions:
    a. Widen the SR 82 EB to I-71 NB entrance loop ramp to accommodate two receiving lanes.
    b. Modify SR 82 EB lane configuration by making the outside through lane a decision lane.
    c. Optimize signal timings and coordination parameters.

One of the major identified issues associated with congestion and crashes in the project area is lane imbalance. This is particularly prevalent in the curb lane on SR 82 eastbound and for the northbound right turn movement of Howe Road at SR 82. Both conditions are directly related to the existing access to I-71 NB. Currently, the same SR 82 EB lane is the only lane that accesses both I-71 NB and SB. With only one lane for the heavy SR 82 EB to I-71 NB movement (over 1600 AM peak and 1100 PM peak vehicles), extended queues form in the curb lanes on SR 82 EB and Howe Road NB while the other lanes are under-utilized. During peak periods, the SR 82 EB curb lane queue lengths extend approximately three quarters of a mile to the western mall entrance and Howe Road NB curb lane queue lengths extend over 1000 feet in order to get into the lane that eventually accesses I-71 NB.

The Build condition specifically addresses this lane imbalance with the intent to distribute SR 82 EB traffic across two lanes to access I-71 NB.

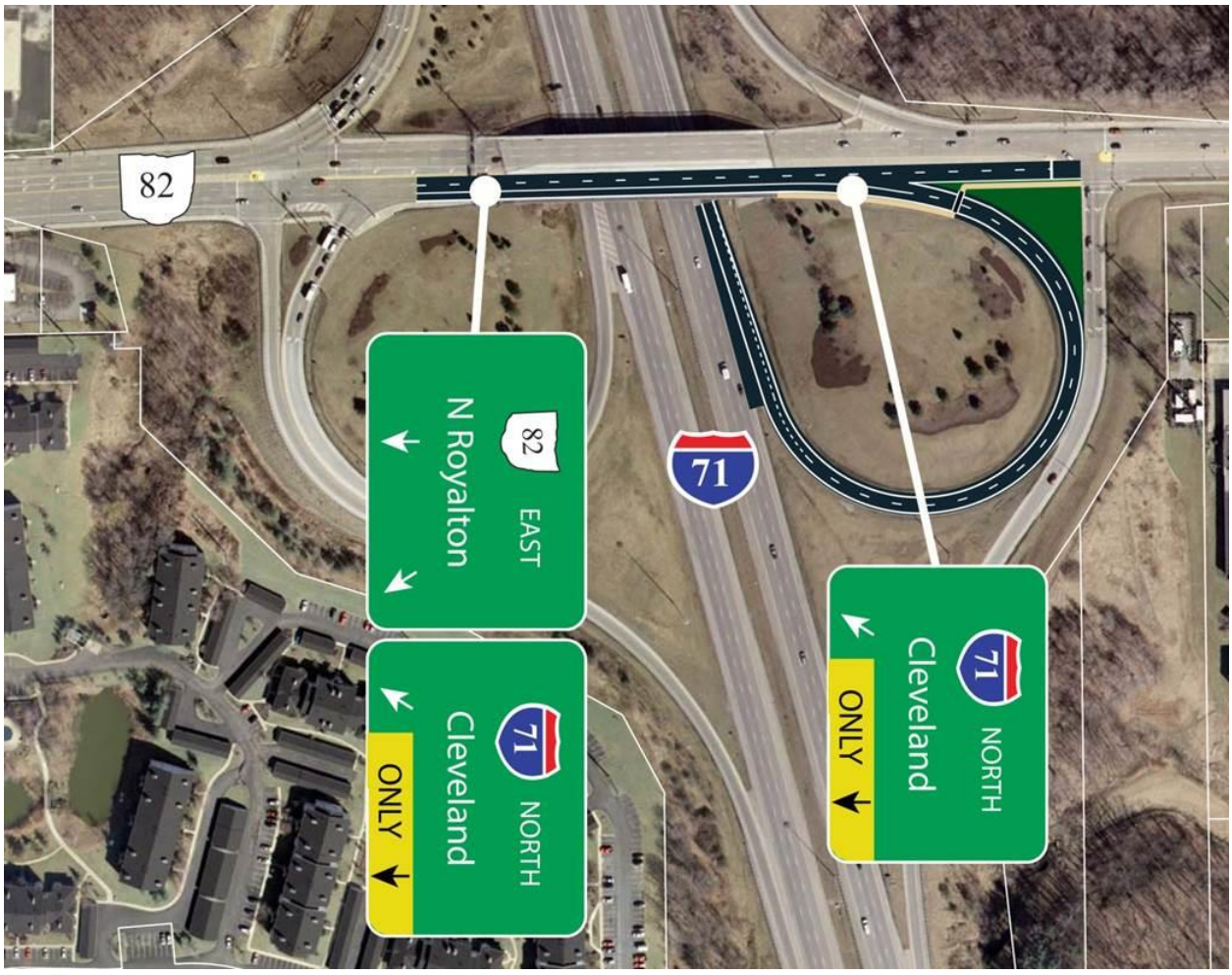
**Build Condition Design Standards**

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

**Build Condition Limits of L/A ROW**

All proposed work for the Build condition is within existing ROW limits.

*Figure 7 - Build Condition*



# 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) No Build and Build conditions. See Appendix B for certified traffic.

# 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 Metropolitan Planning Organization (MPO) boundaries. Full capacity reports are available in Appendix C.

**Intersections**

Traffic analysis was completed for the I-71 intersections with SR 82 during the AM and PM peak hours under the No Build and Build conditions. The intersections were analyzed to determine LOS given existing conditions (No Build) and to appropriately size the intersection given proposed conditions (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. Per ODOT procedures, HMM utilized *Highway Capacity Software* (*HCS) 2010* to analyze the I-71 NB intersection while *Synchro 8* was used for the I-71 SB intersection due to limitations of HCS given the geometrics and signal phasing of the intersection. The change in delay at the I-71 SB intersection was due to a change in lane utilization in the Build Condition.

In addition, the signal was analyzed in *Synchro 8* to measure coordination parameters and the interaction between other signals within the SR 82 closed loop system. Synchro results are shown for the SR 82/I-71 NB intersection as well as the two upstream intersections on SR 82. Note that the volumes are the same in the No Build and Build conditions.

*Figure 8 – Intersection LOS Summary*

AM No Build vs Build

| ID | Location | 2035 No Build | | 2035 Build | |
|---|---|---|---|---|---|
| | | LOS | Delay | LOS | Delay |
| **13** | **SR 82 & I-71 NB** | **C** | **20.0** | **C** | ***20.0*** |
| | EB Approach | B | 13.0 | B | *13.0* |
| | WB Approach | C | 21.8 | C | *21.8* |
| | NB Approach | C | 23.7 | C | *23.7* |
| **14** | **SR 82 & I-71 SB[1]** | **F** | **85.2** | **C** | **33.1** |
| | EB Approach | F | 111.6 | C | 33.3 |
| | WB Approach | C | 29.8 | C | 32.2 |
| | NB Approach | E | 60.1 | C | 32.0 |
| | SB Approach | F | 110.0 | C | 34.6 |

PM No Build vs Build

| ID | Location | 2035 No Build | | 2035 Build | |
|---|---|---|---|---|---|
| | | LOS | Delay | LOS | Delay |
| **13** | **SR 82 & I-71 NB** | **C** | **22.0** | **C** | ***22.0*** |
| | EB Approach | C | 28.0 | C | *28.0* |
| | WB Approach | B | 12.7 | B | *12.7* |
| | NB Approach | C | 31.3 | C | *31.3* |
| **14** | **SR 82 & I-71 SB[1]** | **F** | **104.2** | **D** | **49.0** |
| | EB Approach | F | 145.7 | D | 45.9 |
| | WB Approach | D | 54.9 | D | 52.1 |
| | NB Approach | F | 145.1 | D | 46.2 |
| | SB Approach | E | 70.3 | D | 51.8 |

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

*Figure 9 – SR 82 Coordinated System LOS Summary*

| AM No Build vs Build | | | | | | PM No Build vs Build | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Location | 2035 No Build | | 2035 Build | | ID | Location | 2035 No Build | | 2035 Build | |
| | | LOS | Delay | LOS | Delay | | | LOS | Delay | LOS | Delay |
| **13** | **SR 82 & I-71 NB** | **B** | **17.9** | **B** | **16.4** | **13** | **SR 82 & I-71 NB** | **B** | **16.5** | **C** | **20.5** |
| | EB Approach | A | 4.7 | A | 7.6 | | EB Approach | A | 7.2 | B | 15.5 |
| | WB Approach | B | 11.1 | B | 13.5 | | WB Approach | A | 9.6 | B | 10.4 |
| | NB Approach | E | 61.8 | E | 66.9 | | NB Approach | E | 63.7 | E | 74.4 |
| **14** | **SR 82 & I-71 SB** | **E** | **57.7** | **C** | **24.9** | **14** | **SR 82 & I-71 SB** | **F** | **105.5** | **D** | **50.5** |
| | EB Approach | F | 80.2 | A | 8.0 | | EB Approach | F | 137.4 | A | 8.8 |
| | WB Approach | C | 28.3 | C | 32.3 | | WB Approach | D | 54.3 | D | 54.1 |
| | NB Approach | E | 58.8 | E | 58.8 | | NB Approach | F | 139.7 | F | 139.7 |
| | SB Approach | D | 43.9 | D | 42.8 | | SB Approach | F | 91.0 | E | 65.6 |
| | **SR 82 & Howe** | **F** | **125.4** | **D** | **38.2** | | **SR 82 & Howe** | **F** | **130.4** | **F** | **99.3** |
| | EB Approach | F | 221.4 | D | 35.2 | | EB Approach | F | 204.8 | F | 100.6 |
| | WB Approach | C | 34.4 | C | 28.6 | | WB Approach | F | 117.5 | F | 117.2 |
| | NB Approach | F | 174.2 | E | 62.1 | | NB Approach | D | 53.5 | D | 53.5 |
| | SB Approach | D | 51.9 | D | 51.9 | | SB Approach | E | 69.1 | E | 69.2 |

Delay was reduced more in the Build condition for the intersections upstream of the SR 82/I-71 NB intersection. This is a direct effect of the expected lane balancing on SR 82 EB given the Build condition.

**Freeway Section Analysis**

HMM analyzed freeway segments on I-71 NB following ODOT methodology using *HCS 2010*. Segments were analyzed between interchanges and within interchanges between merge and diverge points. A summary is below. Note that no changes to the I-71 Mainline are proposed for the Build condition. Certified traffic volumes for each I-71 analysis point remained the same between the No Build and Build conditions.

- In the AM, the NB section of I-71 from SR 82 to I-80 is LOS E for the No Build & Build conditions.
- In the AM, the NB section of I-71 at I-80 is LOS E for No Build & Build conditions.
- The proposed Build condition does not degrade freeway segment operations.

*Figure 10 – Freeway Segment LOS Summary*

AM No Build vs Build

| ID | I-71 Northbound Segment | Lanes | 2035 No Build LOS | 2035 No Build Density | 2035 Build LOS | 2035 Build Density |
|---|---|---|---|---|---|---|
| 2 | @ SR 303 | 3 | C | 20.1 | *C* | *20.1* |
| 4 | SR 303 to SR 82 | 3 | C | 21.8 | *C* | *21.8* |
| 6 | @ SR 82 EB | 3 | C | 19.5 | *C* | *19.5* |
| 8 | @ SR 82 WB | 3 | D | 30.5 | *D* | *30.5* |
| 10 | SR 82 to I-80 | 3 | **E** | 41.8 | ***E*** | *41.8* |
| 12 | @ I-80 | 3 | **E** | 36.9 | ***E*** | *36.9* |

PM No Build vs Build

| ID | I-71 Northbound Segment | Lanes | 2035 No Build LOS | 2035 No Build Density | 2035 Build LOS | 2035 Build Density |
|---|---|---|---|---|---|---|
| 2 | @ SR 303 | 3 | B | 11.2 | *B* | *11.2* |
| 4 | SR 303 to SR 82 | 3 | B | 13.1 | *B* | *13.1* |
| 6 | @ SR 82 EB | 3 | A | 10.2 | *A* | *10.2* |
| 8 | @ SR 82 WB | 3 | B | 16.8 | *B* | *16.8* |
| 10 | SR 82 to I-80 | 3 | C | 19.0 | *C* | *19.0* |
| 12 | @ I-80 | 3 | B | 16.9 | *B* | *16.9* |

**Merge / Diverge Analysis**

HMM analyzed the LOS at merge and diverge points along I-71 NB within the project area following ODOT methodology using *HCS 2010*. Note that although the SR 82 EB to I-71 NB entrance ramp is widened in the Build condition, the forecasted traffic volume at the merge point after the ramp has been reduced back to a single lane remains the same. All other merge and diverge analysis points also remain the same between the No Build and Build conditions.

- In the AM, the SR 82 WB entrance ramp to I-71 NB operates with a merge LOS E for the No Build and Build conditions.
- The proposed Build condition does not degrade freeway operations for merge and diverge points.

*Figure 11 – Merge/Diverge LOS Summary*

AM No Build vs Build

| ID | I-71 NB | 2035 No Build | | 2035 Build | |
|---|---|---|---|---|---|
| | | LOS | Density | LOS | Density |
| | **@ SR 303** | | | | |
| 1 | Merge 1 | C | 22.0 | *C* | *22.0* |
| 3 | Merge 2 | C | 21.5 | *C* | *21.5* |
| | **@ SR 82** | | | | |
| 5 | Diverge | C | 24.7 | *C* | *24.7* |
| 7 | Merge 1 | D | 32.8 | *D* | *32.8* |
| 9 | Merge 2 | **E** | 36.5 | ***E*** | *36.5* |
| | **@ I-80** | | | | |
| 11 | Diverge | D | 34.6 | *D* | *34.6* |

PM No Build vs Build

| ID | I-71 NB | 2035 No Build | | 2035 Build | |
|---|---|---|---|---|---|
| | | LOS | Density | LOS | Density |
| | **@ SR 303** | | | | |
| 1 | Merge 1 | B | 12.4 | *B* | *12.4* |
| 3 | Merge 2 | B | 13.7 | *B* | *13.7* |
| | **@ SR 82** | | | | |
| 5 | Diverge | B | 16.4 | *B* | *16.4* |
| 7 | Merge 1 | C | 20.3 | *C* | *20.3* |
| 9 | Merge 2 | C | 20.2 | *C* | *20.2* |
| | **@ I-80** | | | | |
| 11 | Diverge | C | 21.3 | *C* | *21.3* |

**Constrained Analysis**
Constrained analysis is not required as the Build condition does not cause freeway degradation as defined in the ODOT IMS Traffic Academy Manual.

## X. Cost Estimate

The cost estimate for the Build condition, completed by EMH&T as part of PID 99435, is approximately $857,000. A breakdown by group is provided below. A detailed cost estimate is provided in Appendix D.

*Table 2 - Build Condition Cost Estimate*

| Group | Cost |
|---|---|
| Roadway | $ 205,000 |
| Erosion Control | $ 45,500 |
| Drainage | $ 35,500 |
| Pavement | $ 359,500 |
| Lighting | $ 24,500 |
| Traffic Control | $ 36,000 |
| Maintenance of Traffic | $ 86,000 |
| Incidentals | $ 41,500 |
| ***Subtotal*** | ***$ 833,500*** |
| ***Inflation (2016)*** | ***2.8 %*** |
| ***Total*** | ***$ 857,000*** |

This improvement is funded by a 90% federal share through the ODOT Highway Safety Improvement Program and a 10% local match by the City of Strongsville.

# VIII. Environmental Overview

Environmental Documentation was completed by ODOT District 12 with an Environmental Document Approval date of 8/14/2015. All proposed work will be in the public right of way. The only utility impacted by the Build condition is an electrical service cable owned by ODOT.

# IX. Conclusion and Recommendations

The I-71 / SR 82 interchange is heavily congested due to 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 and have for several consecutive years.

The Build Condition reduces queues on SR 82 EB by distributing traffic desiring to access I-71 NB over two lanes as opposed to one lane. By improving the lane utilization to a more balanced condition, the Build condition will allow the SR 82 coordinated signal system to operate more efficiently. Improving the existing lane imbalance on SR 82 EB is also expected to help reduce crashes. Specifically, rear end crashes are expected to decrease as a result of the reduced queue lengths in the SR 82 EB curb lane.

The Build Condition does not degrade freeway operations. All intersections, freeway segments, merge and diverge locations operate with equal or improved LOS between the No Build and Build conditions. The Build Condition is expected to improve traffic operations along the SR 82 corridor and at the I-71 / SR 82 interchange. The presented Build condition provides an adequate traffic solution and is recommended to be carried forward.

# 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.

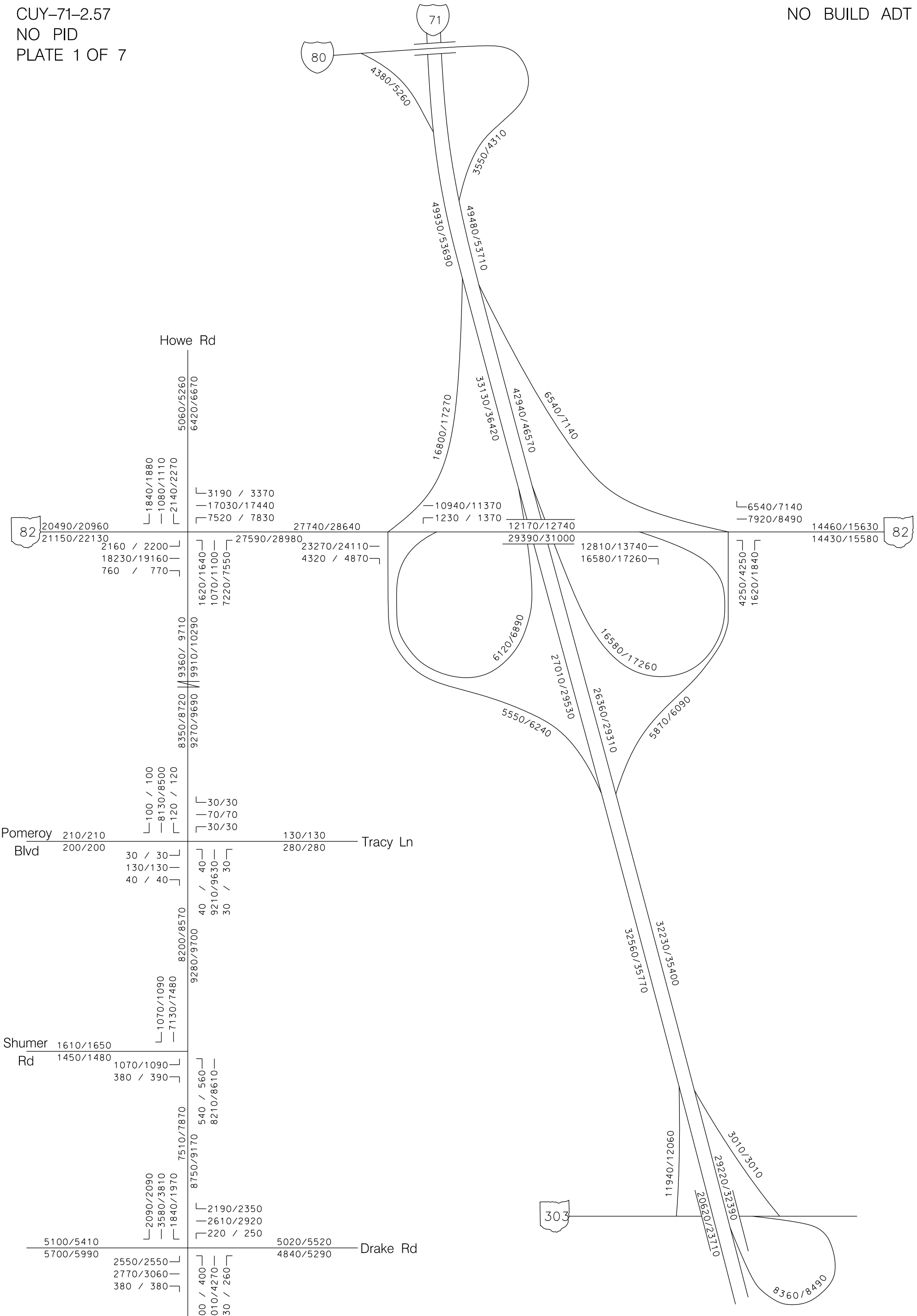
In reply to a request received May 24, 2013, plates are attached showing 2015/2035 ADT, A.M. DHV, and P.M. DHV turning movement forecasts for the no build and build scenarios. K & D factors can be calculated as needed. Truck factors are shown on a separate plate.

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

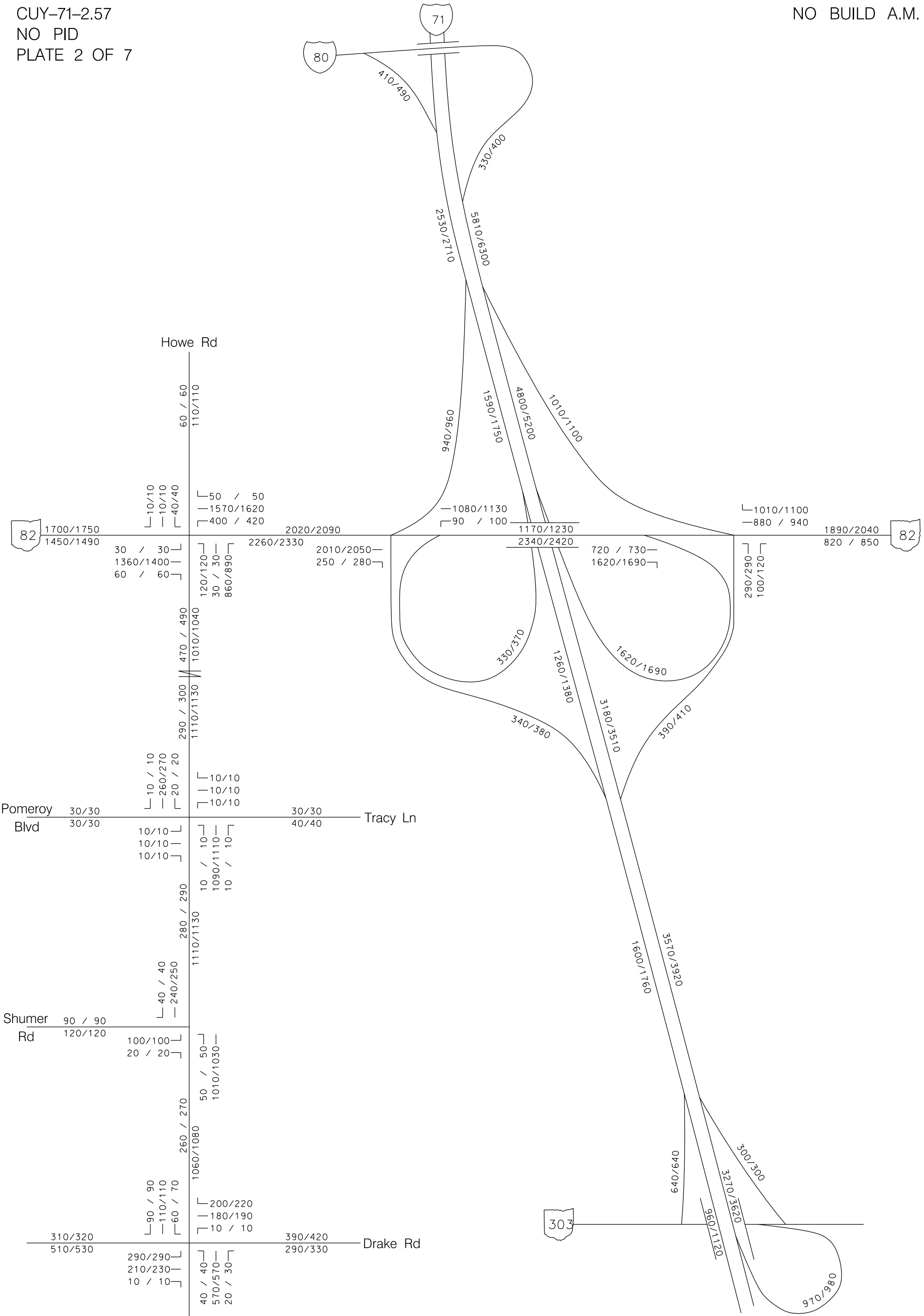
NO BUILD ADT




| | |
|---|---|
| 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

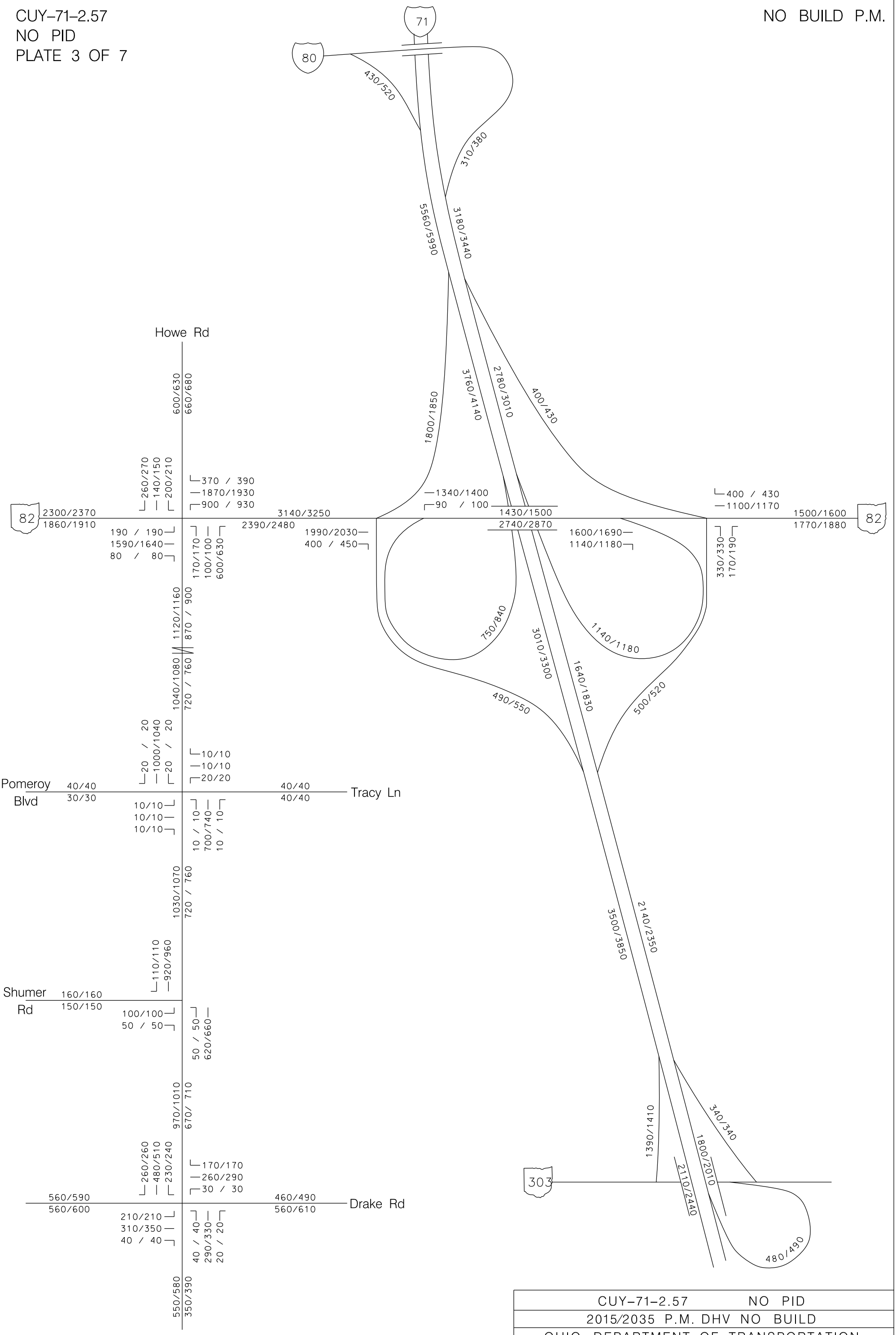
NO BUILD A.M.




| | |
|---|---|
| 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

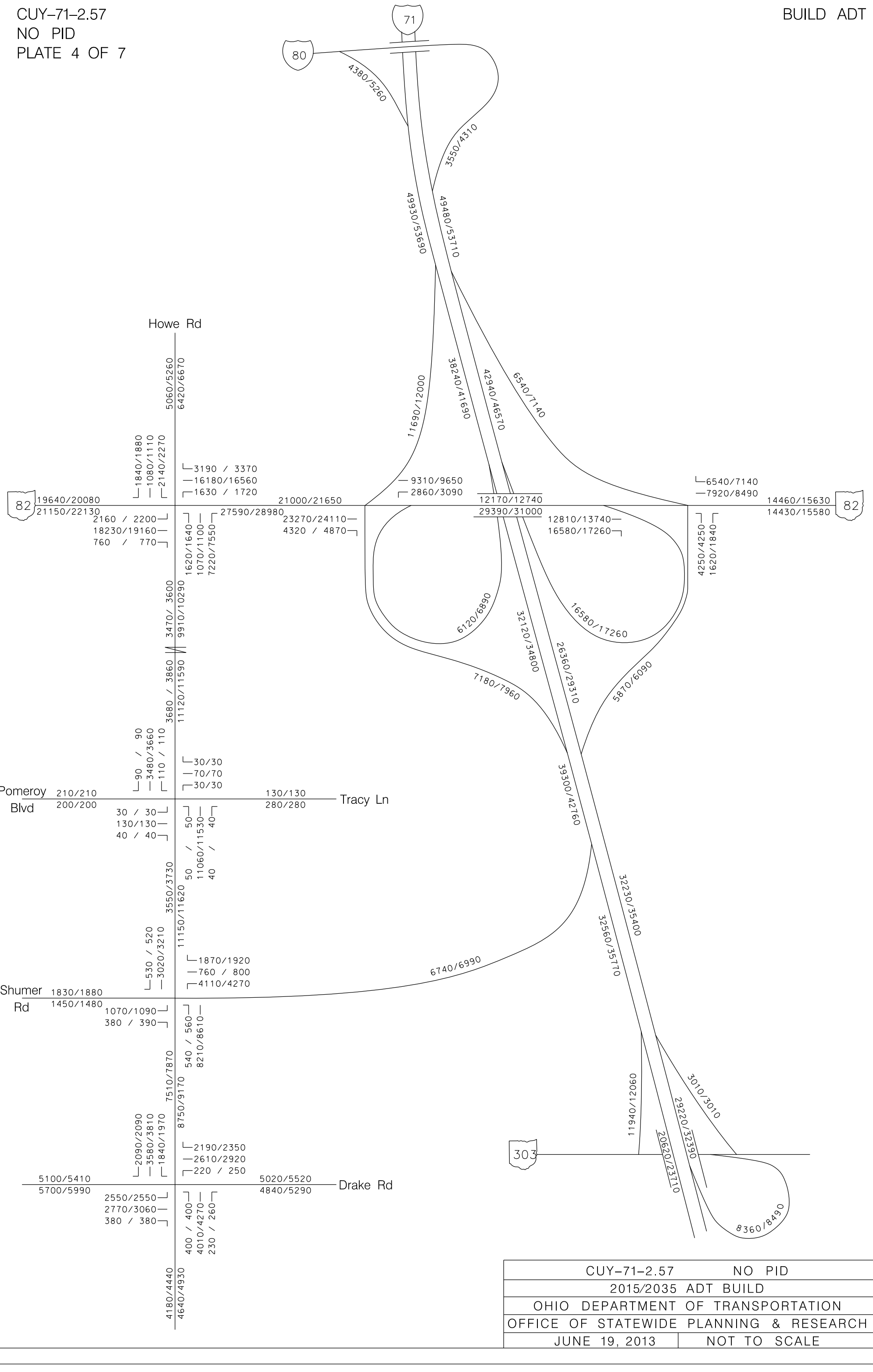
NO BUILD P.M.




| | |
|---|---|
| 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

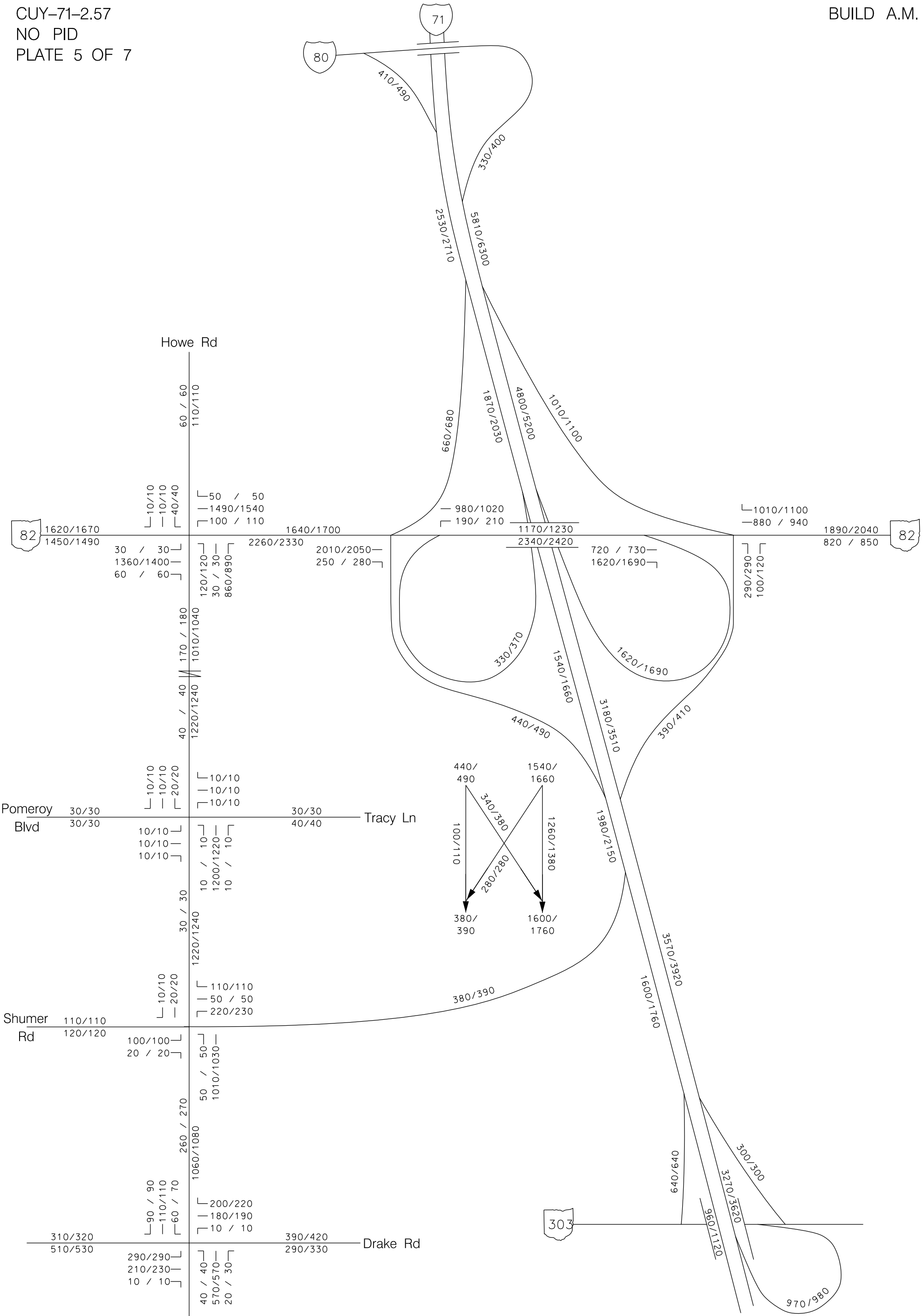
BUILD ADT




| | |
|---|---|
| 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

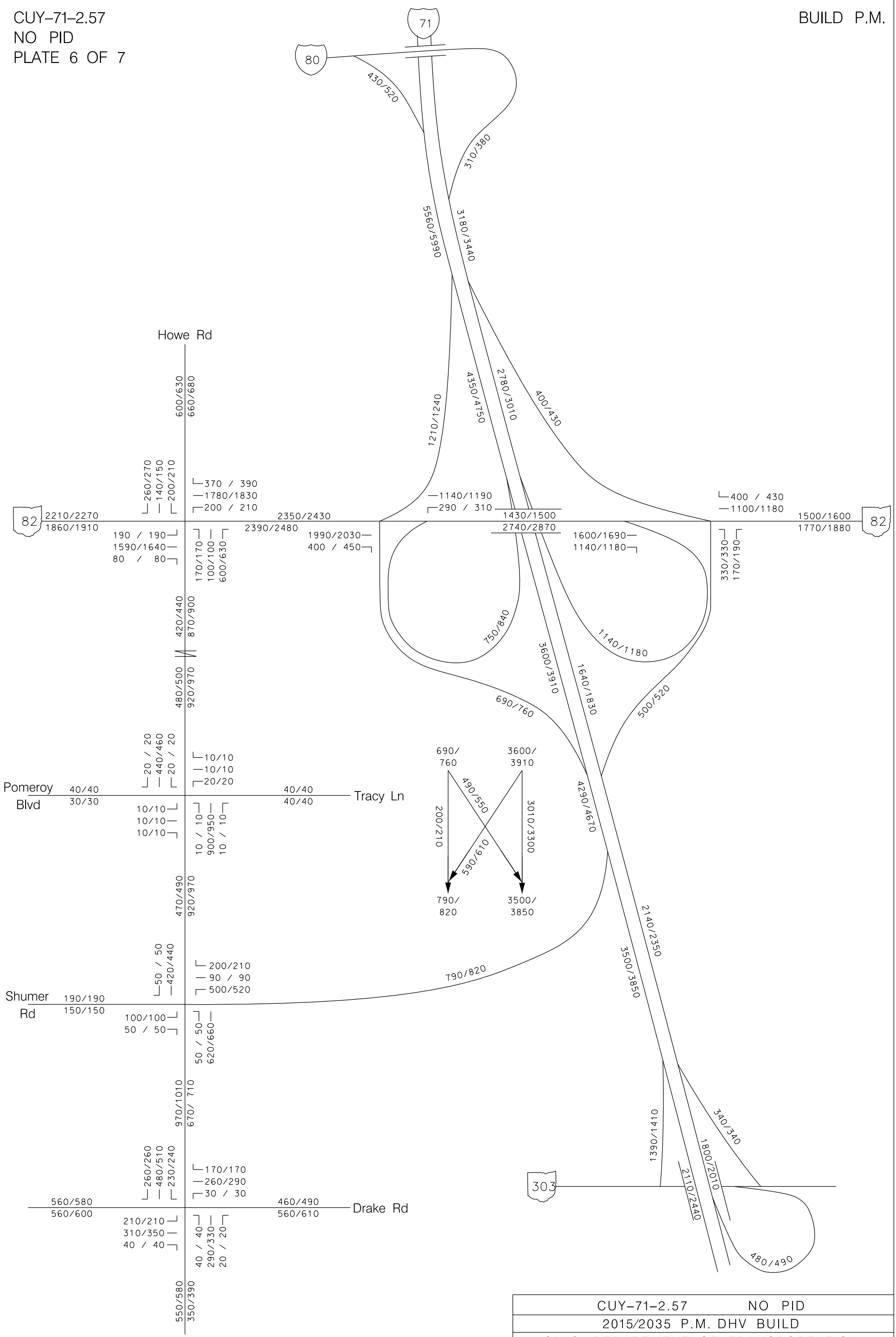
BUILD A.M.




| | |
|---|---|
| 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 |

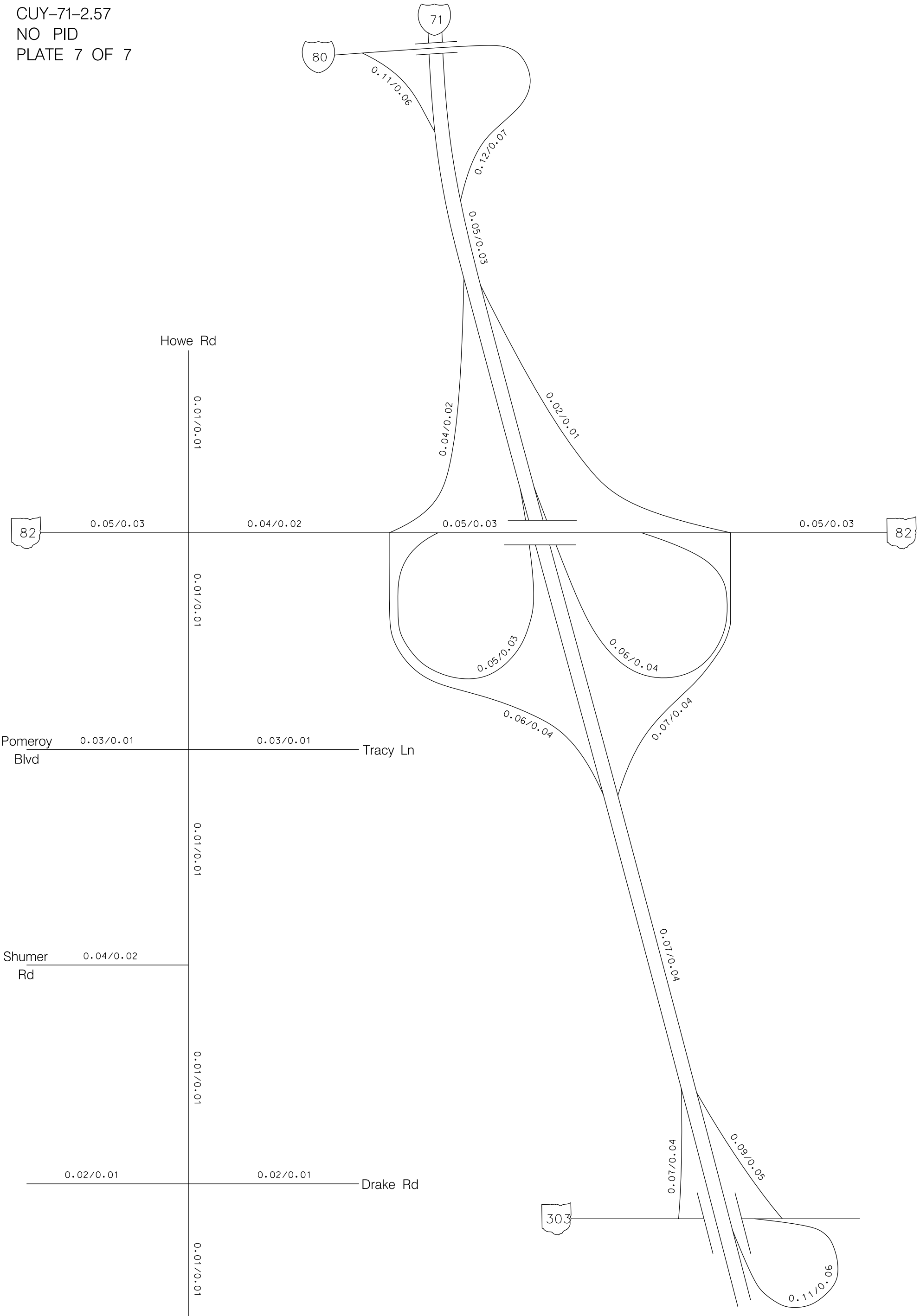
CUY–71–2.57
NO PID
PLATE 6 OF 7

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

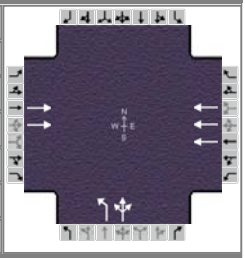
# 2035 AM

Hatch Mott MacDonald

# HCS 2010 Signalized Intersection Results Summary

**AM | 13**

| General Information | | | | Intersection Information | |
|---|---|---|---|---|---|
| Agency | Hatch Mott MacDonald | | | Duration, h | 0.25 |
| Analyst | SJT | Analysis Date | Oct 20, 2015 | Area Type | Other |
| Jurisdiction | Strongsville | Time Period | AM | PHF | 0.92 |
| Intersection | SR 82 @ I-71 NB | Analysis Year | 2035 | Analysis Period | 1> 7:00 |
| File Name | 13_SR82 & I-71 NB 2035 AM.xus | | | | |
| Project Description | I-71 / SR 82 IMS | | | | |



| Demand Information | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approach Movement | L | T | R | L | T | R | L | T | R | L | T | R |
| Demand (*v*), veh/h | | 730 | | | 2040 | | 290 | 0 | 120 | | | |

| Signal Information | | | |
|---|---|---|---|
| Cycle, s | 80.0 | 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 | 40.0 | 29.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5 | 6 | 7 | 8 |
| Yellow | 4.0 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |
| Red | 1.5 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |

| Timer Results | EBL | EBT | WBL | WBT | NBL | NBT | SBL | SBT |
|---|---|---|---|---|---|---|---|---|
| Assigned Phase | | 2 | | 6 | | 8 | | |
| Case Number | | 8.0 | | 8.0 | | 10.0 | | |
| Phase Duration, s | | 45.5 | | 45.5 | | 34.5 | | |
| Change Period, ($Y+R_c$), s | | 5.5 | | 5.5 | | 5.5 | | |
| Max Allow Headway (*MAH*), s | | 3.0 | | 3.0 | | 3.3 | | |
| Queue Clearance Time ($g_s$), s | | 13.7 | | 33.6 | | 14.6 | | |
| Green Extension Time ($g_e$), s | | 11.7 | | 4.7 | | 0.9 | | |
| Phase Call Probability | | 1.00 | | 1.00 | | 1.00 | | |
| Max Out Probability | | 0.21 | | 0.80 | | 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 | | 2 | | | 6 | | 3 | 8 | 18 | | | |
| Adjusted Flow Rate (*v*), veh/h | | 793 | | | 2217 | | 158 | 158 | | | | |
| Adjusted Saturation Flow Rate (*s*), veh/h/ln | | 1756 | | | 1675 | | 1740 | 1740 | | | | |
| Queue Service Time ($g_s$), s | | 11.7 | | | 31.6 | | 5.1 | 5.1 | | | | |
| Cycle Queue Clearance Time ($g_c$), s | | 11.7 | | | 31.6 | | 5.1 | 5.1 | | | | |
| Green Ratio (*g/C*) | | 0.50 | | | 0.50 | | 0.36 | 0.36 | | | | |
| Capacity (*c*), veh/h | | 1756 | | | 2512 | | 631 | 631 | | | | |
| Volume-to-Capacity Ratio (*X*) | | 0.452 | | | 0.883 | | 0.250 | 0.250 | | | | |
| Available Capacity ($c_a$), veh/h | | 1756 | | | 2512 | | 631 | 631 | | | | |
| Back of Queue (*Q*), veh/ln (50th percentile) | | 4.1 | | | 11.5 | | 1.9 | 1.9 | | | | |
| Queue Storage Ratio (*RQ*) (50th percentile) | | 0.00 | | | 0.00 | | 0.20 | 0.20 | | | | |
| Uniform Delay ($d_1$), s/veh | | 12.9 | | | 17.9 | | 17.9 | 17.9 | | | | |
| Incremental Delay ($d_2$), s/veh | | 0.1 | | | 3.9 | | 0.1 | 0.1 | | | | |
| Initial Queue Delay ($d_3$), s/veh | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | | |
| Control Delay (*d*), s/veh | | 13.0 | | | 21.8 | | 18.0 | 18.0 | | | | |
| Level of Service (LOS) | | B | | | C | | B | B | | | | |
| Approach Delay, s/veh / LOS | 13.0 | B | | 21.8 | C | | 23.7 | C | | 0.0 | | |
| Intersection Delay, s/veh / LOS | 20.0 | | | | | | C | | | | | |

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

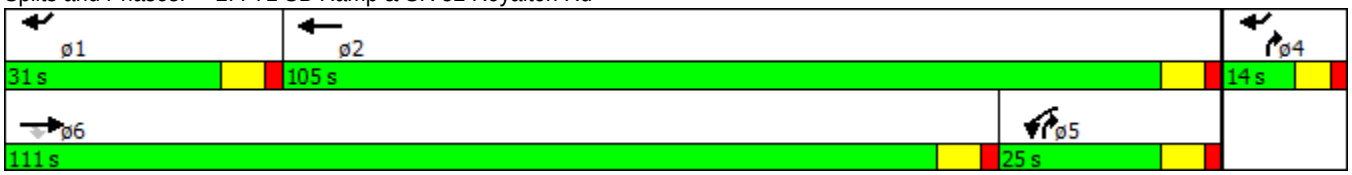
# Timings
## 2: I-71 SB Ramp & SR 82 Royalton Rd

12/11/2015

| 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



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

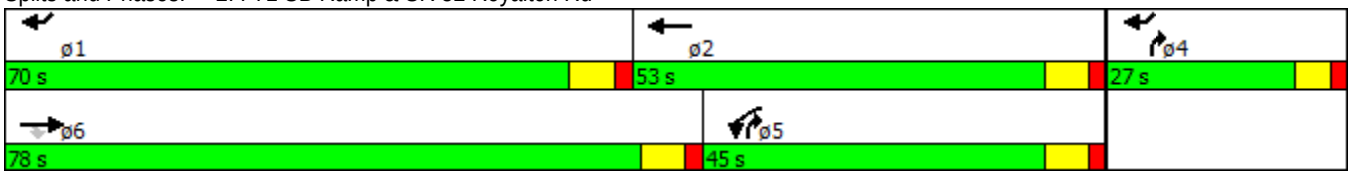
12/11/2015

| 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) | 78.0 | 78.0 | 45.0 | 53.0 | | | 70.0 | 27.0 |
| Total Split (%) | 52.0% | 52.0% | 30.0% | 35.3% | | | 47% | 18% |
| 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) | 71.1 | 71.1 | 22.1 | 65.5 | 50.1 | 54.8 | | |
| Actuated g/C Ratio | 0.53 | 0.53 | 0.16 | 0.49 | 0.37 | 0.41 | | |
| v/c Ratio | 0.93 | 0.33 | 0.75 | 0.54 | 0.40 | 0.68 | | |
| Control Delay | 37.2 | 2.8 | 70.1 | 25.9 | 32.0 | 34.6 | | |
| Queue Delay | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| Total Delay | 37.5 | 2.8 | 70.1 | 25.9 | 32.0 | 34.6 | | |
| LOS | D | A | E | C | C | C | | |
| Approach Delay | 33.3 | | | 32.2 | | | | |
| Approach LOS | C | | | C | | | | |

### Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 134.3
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.93
Intersection Signal Delay: 33.1 — 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



# Intersections

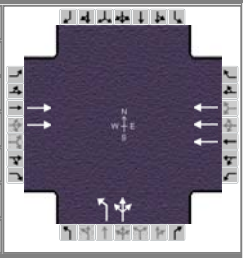
# 2035 PM

Hatch Mott MacDonald

# HCS 2010 Signalized Intersection Results Summary

PM | 13

| General Information | | | | Intersection Information | |
|---|---|---|---|---|---|
| Agency | Hatch Mott MacDonald | | | Duration, h | 0.25 |
| Analyst | SJT | Analysis Date | Oct 20, 2015 | Area Type | Other |
| Jurisdiction | Strongsville | Time Period | PM | PHF | 0.92 |
| Intersection | SR 82 @ I-71 NB | Analysis Year | 2035 | Analysis Period | 1> 7:00 |
| File Name | 13_SR82 & I-71 NB 2035 PM.xus | | | | |
| Project Description | I-71 / SR 82 IMS | | | | |



| Demand Information | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approach Movement | L | T | R | L | T | R | L | T | R | L | T | R |
| Demand (*v*), veh/h | | 1690 | | | 1600 | | 330 | 0 | 190 | | | |

| Signal Information | | | |
|---|---|---|---|
| Cycle, s | 80.0 | 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 | 44.0 | 25.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5 | 6 | 7 | 8 |
| Yellow | 4.0 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |
| Red | 1.5 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | | | | |

| Timer Results | EBL | EBT | WBL | WBT | NBL | NBT | SBL | SBT |
|---|---|---|---|---|---|---|---|---|
| Assigned Phase | | 2 | | 6 | | 8 | | |
| Case Number | | 8.0 | | 8.0 | | 10.0 | | |
| Phase Duration, s | | 49.5 | | 49.5 | | 30.5 | | |
| Change Period, ($Y+R_c$), s | | 5.5 | | 5.5 | | 5.5 | | |
| Max Allow Headway (*MAH*), s | | 3.0 | | 3.0 | | 3.3 | | |
| Queue Clearance Time ($g_s$), s | | 41.5 | | 21.1 | | 20.0 | | |
| Green Extension Time ($g_e$), s | | 2.2 | | 13.7 | | 0.7 | | |
| Phase Call Probability | | 1.00 | | 1.00 | | 1.00 | | |
| Max Out Probability | | 1.00 | | 0.43 | | 0.41 | | |

| Movement Group Results | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approach Movement | L | T | R | L | T | R | L | T | R | L | T | R |
| Assigned Movement | | 2 | | | 6 | | 3 | 8 | 18 | | | |
| Adjusted Flow Rate (*v*), veh/h | | 1837 | | | 1739 | | 179 | 179 | | | | |
| Adjusted Saturation Flow Rate (*s*), veh/h/ln | | 1756 | | | 1675 | | 1740 | 1740 | | | | |
| Queue Service Time ($g_s$), s | | 39.5 | | | 19.1 | | 6.3 | 6.3 | | | | |
| Cycle Queue Clearance Time ($g_c$), s | | 39.5 | | | 19.1 | | 6.3 | 6.3 | | | | |
| Green Ratio (*g/C*) | | 0.55 | | | 0.55 | | 0.31 | 0.31 | | | | |
| Capacity (*c*), veh/h | | 1932 | | | 2764 | | 544 | 544 | | | | |
| Volume-to-Capacity Ratio (*X*) | | 0.951 | | | 0.629 | | 0.330 | 0.330 | | | | |
| Available Capacity ($c_a$), veh/h | | 1932 | | | 2764 | | 544 | 544 | | | | |
| Back of Queue (*Q*), veh/ln (50th percentile) | | 16.2 | | | 6.2 | | 2.5 | 2.5 | | | | |
| Queue Storage Ratio (*RQ*) (50th percentile) | | 0.00 | | | 0.00 | | 0.25 | 0.25 | | | | |
| Uniform Delay ($d_1$), s/veh | | 17.0 | | | 12.4 | | 21.1 | 21.1 | | | | |
| Incremental Delay ($d_2$), s/veh | | 11.0 | | | 0.4 | | 0.1 | 0.1 | | | | |
| Initial Queue Delay ($d_3$), s/veh | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | | |
| Control Delay (*d*), s/veh | | 28.0 | | | 12.7 | | 21.2 | 21.2 | | | | |
| Level of Service (LOS) | | C | | | B | | C | C | | | | |
| Approach Delay, s/veh / LOS | 28.0 | C | | 12.7 | B | | 31.3 | C | | 0.0 | | |
| Intersection Delay, s/veh / LOS | 22.0 | | | | | | C | | | | | |

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

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

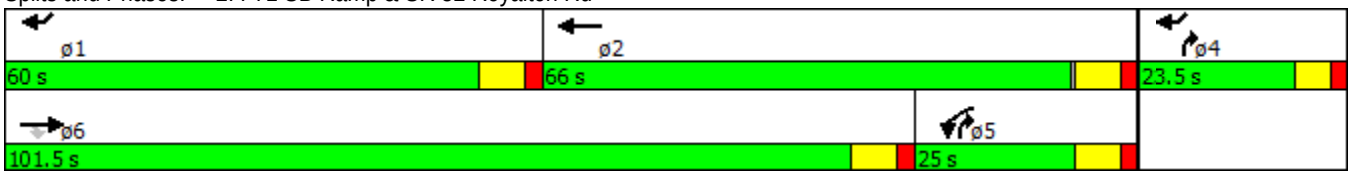
12/11/2015

| 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



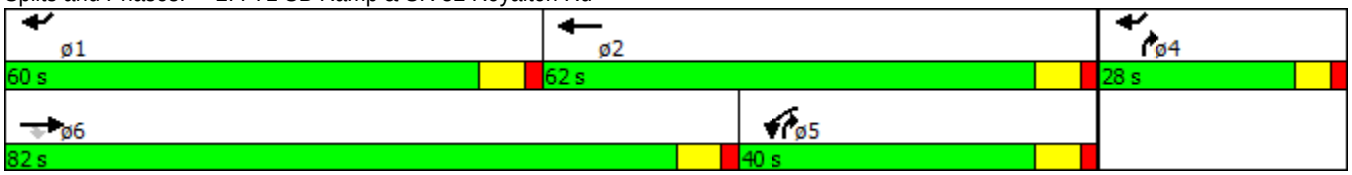
# Timings
## 2: I-71 SB Ramp & SR 82 Royalton Rd

12/11/2015

| 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) | 82.0 | 82.0 | 40.0 | 62.0 | | | 60.0 | 28.0 |
| Total Split (%) | 54.7% | 54.7% | 26.7% | 41.3% | | | 40% | 19% |
| 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) | 75.0 | 75.0 | 33.0 | 55.0 | 62.0 | 81.0 | | |
| Actuated g/C Ratio | 0.50 | 0.50 | 0.22 | 0.37 | 0.41 | 0.54 | | |
| v/c Ratio | 0.97 | 0.49 | 0.56 | 0.88 | 0.82 | 0.99 | | |
| Control Delay | 49.1 | 3.3 | 58.6 | 51.2 | 46.2 | 51.8 | | |
| Queue Delay | 6.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| Total Delay | 55.4 | 3.3 | 58.6 | 51.2 | 46.2 | 51.8 | | |
| LOS | E | A | E | D | D | D | | |
| Approach Delay | 45.9 | | | 52.1 | | | | |
| Approach LOS | D | | | D | | | | |

| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.99 | |
| Intersection Signal Delay: 49.0 | 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



# SR 82 Corridor

Hatch Mott MacDonald

# No Build

# 2035 AM

Hatch Mott MacDonald

| 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 | |

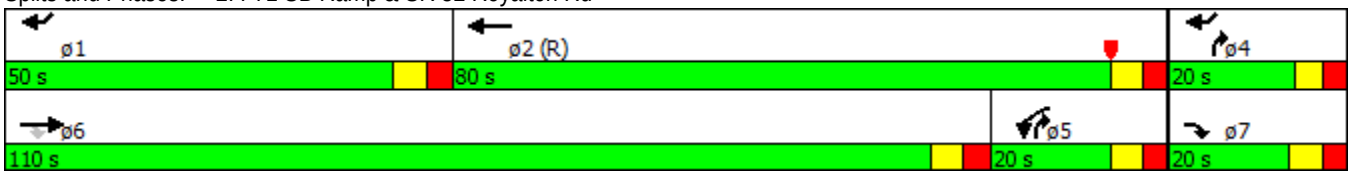
Splits and Phases: 1: I-71 NB Off Ramp

| 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

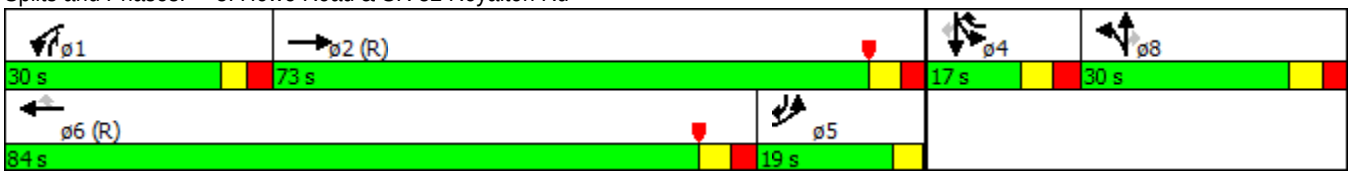


| Lane Group | EBL | EBT | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Volume (vph) | 30 | 1400 | 420 | 1620 | 50 | 120 | 30 | 890 | 40 | 10 | 10 |
| Turn Type | Prot | NA | Prot | NA | pm+ov | 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



# No Build

# 2035 PM

Hatch Mott MacDonald

| 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 | |

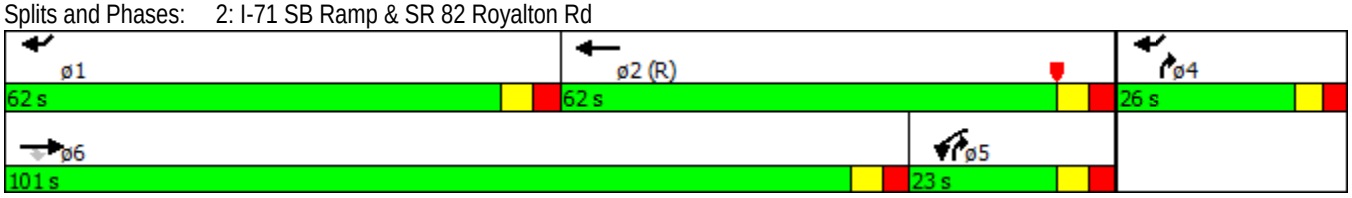
Splits and Phases: 1: I-71 NB Off Ramp

| 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

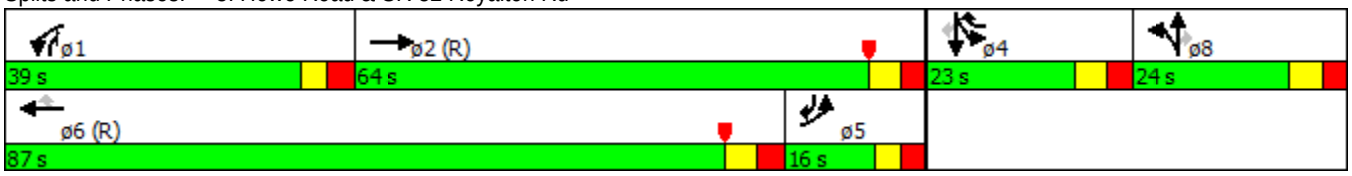


| Lane Group | EBL | EBT | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Volume (vph) | 190 | 1640 | 930 | 1930 | 390 | 170 | 100 | 630 | 210 | 150 | 270 |
| Turn Type | Prot | NA | Prot | NA | pm+ov | 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



# Build

# 2035 AM

Hatch Mott MacDonald

| Lane Group | EBT | EBR | WBT | NBL2 | NBL |
|---|---|---|---|---|---|
| Lane Configurations | | | | | |
| Traffic Volume (vph) | 730 | 1690 | 940 | 290 | 0 |
| Future Volume (vph) | 730 | 1690 | 940 | 290 | 0 |
| Turn Type | NA | Free | NA | Prot | Perm |
| Protected Phases | 2 | | 6 | 8 | |
| Permitted Phases | | Free | | | 8 |
| Detector Phase | 2 | | 6 | 8 | 8 |
| Switch Phase | | | | | |
| Minimum Initial (s) | 32.0 | | 32.0 | 10.0 | 10.0 |
| Minimum Split (s) | 53.0 | | 38.0 | 20.0 | 20.0 |
| Total Split (s) | 102.0 | | 102.0 | 48.0 | 48.0 |
| Total Split (%) | 68.0% | | 68.0% | 32.0% | 32.0% |
| Yellow Time (s) | 3.6 | | 3.6 | 3.0 | 3.0 |
| All-Red Time (s) | 2.2 | | 2.2 | 3.0 | 3.0 |
| Lost Time Adjust (s) | -1.4 | | -2.0 | -1.4 | 0.0 |
| Total Lost Time (s) | 4.4 | | 3.8 | 4.6 | 6.0 |
| Lead/Lag | | | | | |
| Lead-Lag Optimize? | | | | | |
| Recall Mode | C-Max | | C-Max | None | None |
| Act Effct Green (s) | 107.2 | 150.0 | 107.8 | 33.8 | 32.4 |
| Actuated g/C Ratio | 0.71 | 1.00 | 0.72 | 0.23 | 0.22 |
| v/c Ratio | 0.75 | 0.65 | 1.03dr | 0.82 | 0.77 |
| Control Delay | 8.7 | 5.7 | 13.5 | 72.1 | 61.2 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 8.7 | 5.7 | 13.5 | 72.1 | 61.2 |
| LOS | A | A | B | E | E |
| Approach Delay | 7.6 | | 13.5 | | 66.9 |
| Approach LOS | A | | B | | E |

| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 95 (63%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow | |
| Natural Cycle: 75 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.82 | |
| Intersection Signal Delay: 16.4 | Intersection LOS: B |
| Intersection Capacity Utilization 62.9% | ICU Level of Service B |
| Analysis Period (min) 15 | |

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

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

| Lane Group | EBT | EBR | WBL | WBT | NBR2 | SWR | ø1 | ø4 |
|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | |
| Traffic Volume (vph) | 2050 | 280 | 100 | 1130 | 370 | 960 | | |
| Future 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 | 78.9 | 34.0 | 57.9 | | |
| Actuated g/C Ratio | 0.69 | 0.82 | 0.09 | 0.53 | 0.23 | 0.39 | | |
| v/c Ratio | 0.73 | 0.27 | 0.85 | 0.55 | 0.67 | 0.74 | | |
| Control Delay | 8.8 | 1.7 | 100.2 | 26.1 | 58.8 | 42.6 | | |
| Queue Delay | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | | |
| Total Delay | 9.0 | 1.7 | 100.2 | 26.1 | 58.8 | 42.8 | | |
| LOS | A | A | F | C | E | D | | |
| Approach Delay | 8.0 | | | 32.3 | | | | |
| Approach LOS | A | | | C | | | | |

| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 149 (99%), Referenced to phase 2:WBT, Start of Yellow | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.85 | |
| Intersection Signal Delay: 24.9 | 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

| Lane Group | EBL | EBT | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 30 | 1400 | 420 | 1620 | 50 | 120 | 30 | 890 | 40 | 10 | 10 |
| Future 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 | 68.5 | 35.4 | 92.7 | 105.6 | 15.9 | 15.9 | 55.9 | 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 | 0.83 | 0.64 | 0.86 | 0.06 | 0.55 | 0.55 | 0.92 | 0.18 | 0.18 | 0.05 |
| Control Delay | 55.1 | 34.7 | 50.5 | 23.5 | 0.9 | 74.6 | 74.2 | 59.5 | 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 | 55.1 | 34.7 | 50.5 | 23.5 | 0.9 | 74.6 | 74.2 | 59.5 | 66.6 | 68.0 | 0.2 |
| LOS | E | C | D | C | A | E | E | E | E | E | A |
| Approach Delay | | 35.2 | | 28.6 | | | 62.1 | | | 51.9 | |
| Approach LOS | | D | | C | | | E | | | D | |

| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 114 (76%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow | |
| Natural Cycle: 150 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.92 | |
| Intersection Signal Delay: 38.2 | 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

# Build

# 2035 PM

Hatch Mott MacDonald

| Lane Group | EBT | EBR | WBT | NBL2 | NBL |
|---|---|---|---|---|---|
| Lane Configurations | | | | | |
| Traffic Volume (vph) | 1690 | 1180 | 1180 | 330 | 0 |
| Future Volume (vph) | 1690 | 1180 | 1180 | 330 | 0 |
| Turn Type | NA | Free | NA | Prot | Perm |
| Protected Phases | 2 | | 6 | 8 | |
| Permitted Phases | | Free | | | 8 |
| Detector Phase | 2 | | 6 | 8 | 8 |
| Switch Phase | | | | | |
| Minimum Initial (s) | 32.0 | | 32.0 | 10.0 | 10.0 |
| Minimum Split (s) | 53.0 | | 38.0 | 20.0 | 20.0 |
| Total Split (s) | 107.0 | | 107.0 | 43.0 | 43.0 |
| Total Split (%) | 71.3% | | 71.3% | 28.7% | 28.7% |
| Yellow Time (s) | 3.6 | | 3.6 | 3.0 | 3.0 |
| All-Red Time (s) | 2.2 | | 2.2 | 3.0 | 3.0 |
| Lost Time Adjust (s) | -1.4 | | -2.0 | -1.4 | 0.0 |
| Total Lost Time (s) | 4.4 | | 3.8 | 4.6 | 6.0 |
| Lead/Lag | | | | | |
| Lead-Lag Optimize? | | | | | |
| Recall Mode | C-Max | | C-Max | None | None |
| Act Effct Green (s) | 107.0 | 150.0 | 107.6 | 34.0 | 32.6 |
| Actuated g/C Ratio | 0.71 | 1.00 | 0.72 | 0.23 | 0.22 |
| v/c Ratio | 0.92 | 0.67 | 0.50 | 0.87 | 0.83 |
| Control Delay | 18.0 | 9.5 | 10.4 | 78.0 | 70.4 |
| Queue Delay | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 18.2 | 9.5 | 10.4 | 78.0 | 70.4 |
| LOS | B | A | B | E | E |
| Approach Delay | 15.5 | | 10.4 | | 74.4 |
| Approach LOS | B | | B | | E |

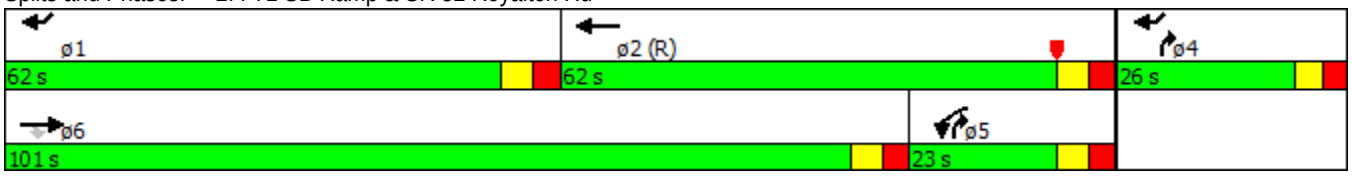
| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 127 (85%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.92 | |
| Intersection Signal Delay: 20.5 | Intersection LOS: C |
| Intersection Capacity Utilization 82.9% | ICU Level of Service E |
| Analysis Period (min) 15 | |

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

| Lane Group | EBT | EBR | WBL | WBT | NBR2 | SWR | ø1 | ø4 |
|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | |
| Traffic Volume (vph) | 2030 | 450 | 100 | 1400 | 840 | 1850 | | |
| Future 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 | 55.8 | 43.0 | 81.0 | | |
| Actuated g/C Ratio | 0.63 | 0.63 | 0.11 | 0.37 | 0.29 | 0.54 | | |
| v/c Ratio | 0.77 | 0.44 | 1.14 | 0.87 | 1.18 | 0.87 | | |
| Control Delay | 9.8 | 0.3 | 153.8 | 40.8 | 139.7 | 35.7 | | |
| Queue Delay | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 29.9 | | |
| Total Delay | 10.6 | 0.3 | 153.8 | 40.8 | 139.7 | 65.6 | | |
| LOS | B | A | F | D | F | E | | |
| Approach Delay | 8.8 | | | 54.1 | | | | |
| Approach LOS | A | | | D | | | | |

| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 74 (49%), Referenced to phase 2:WBT, Start of Yellow | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 1.18 | |
| Intersection Signal Delay: 50.5 | Intersection LOS: D |
| Intersection Capacity Utilization Err% | ICU Level of Service H |
| Analysis Period (min) 15 | |

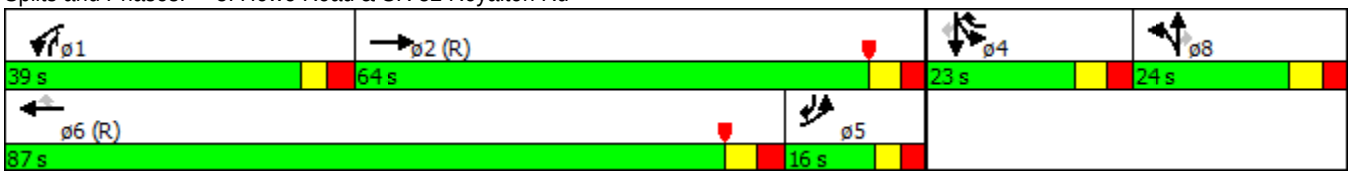
Splits and Phases: 2: I-71 SB Ramp & SR 82 Royalton Rd



| Lane Group | EBL | EBT | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | |
| Traffic Volume (vph) | 190 | 1640 | 930 | 1930 | 390 | 170 | 100 | 630 | 210 | 150 | 270 |
| Future 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 | 1.15 | 1.42 | 1.03 | 0.49 | 0.84 | 0.49 | 0.63 | 0.64 | 0.82 | 0.86 |
| Control Delay | 70.7 | 103.6 | 233.8 | 55.3 | 5.5 | 94.5 | 69.1 | 40.1 | 71.0 | 92.0 | 57.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 26.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| Total Delay | 70.7 | 103.6 | 233.8 | 81.9 | 5.5 | 94.5 | 69.1 | 40.1 | 71.0 | 92.0 | 57.4 |
| LOS | E | F | F | F | A | F | E | D | E | F | E |
| Approach Delay | | 100.6 | | 117.4 | | | 53.5 | | | 69.2 | |
| Approach LOS | | F | | F | | | D | | | E | |

| Intersection Summary | |
|---|---|
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 6 (4%), 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: 99.3 | 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



# Freeway Segments

# 2035 AM

Hatch Mott MacDonald

**AM | 02**

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *AM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *3620* | 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 $f_p$) | *1309* | pc/h/ln |
| S | *65.0* | mph |
| D = $v_p$ / S | *20.1* | pc/mi/ln |
| LOS | *C* | |

## Design (N)

Design (N)

| | |
|---|---|
| Design LOS | |
| $v_p$ = (V or DDHV) / (PHF x N x $f_{HV}$ x $f_p$) | pc/h/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 | |

AM | 04

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *AM* |

## Site Information

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

Project Description *I-71 / SR 82 IMS*

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

## Flow Inputs

| | | | | |
|---|---|---|---|---|
| Volume, V | *3920* | 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 $f_p$) | *1418* | 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 | |

**AM | 06**

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *AM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *3510* | 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 | *mi* |
| | | | Up/Down % | |

## Calculate Flow Adjustments

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

## 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 $f_p$) | *1270* | pc/h/ln |
| S | *65.0* | mph |
| D = $v_p$ / S | *19.5* | pc/mi/ln |
| LOS | *C* | |

## Design (N)

Design (N)

| | |
|---|---|
| Design LOS | |
| $v_p$ = (V or DDHV) / (PHF x N x $f_{HV}$ x $f_p$) | pc/h/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 | |

**AM | 08**

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *AM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *5200* | 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 $f_p$) | *1881* | pc/h/ln |
| S | *61.7* | mph |
| D = $v_p$ / S | *30.5* | pc/mi/ln |
| LOS | *D* | |

## Design (N)

Design (N)

| | |
|---|---|
| Design LOS | |
| $v_p$ = (V or DDHV) / (PHF x N x $f_{HV}$ x $f_p$) | pc/h/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 | |

**AM | 10**

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *AM* |

## Site Information

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

Project Description *I-71 / SR 82 IMS*

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

## Flow Inputs

| | | | | |
|---|---|---|---|---|
| Volume, V | *6300* | 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 $f_p$) | *2268* | pc/h/ln |
| S | *54.3* | mph |
| D = $v_p$ / S | *41.8* | pc/mi/ln |
| LOS | *E* | |

## Design (N)

Design (N)

| | |
|---|---|
| Design LOS | |
| $v_p$ = (V or DDHV) / (PHF x N x $f_{HV}$ x $f_p$) | pc/h/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 | |

AM | 12

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *AM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *5900* | 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 | *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 $f_p$) | *2124* | pc/h/ln |
| S | *57.6* | mph |
| D = $v_p$ / S | *36.9* | pc/mi/ln |
| LOS | *E* | |

## Design (N)

Design (N)

| | |
|---|---|
| Design LOS | |
| $v_p$ = (V or DDHV) / (PHF x N x $f_{HV}$ x $f_p$) | pc/h/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 PM

Hatch Mott MacDonald

PM | 02

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *PM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *2010* | 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 | *mi* |
| | | | Up/Down % | |

## Calculate Flow Adjustments

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

## 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 $f_p$) | *727* | 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 | |

PM | 04

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *PM* |

## Site Information

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

Project Description *I-71 / SR 82 IMS*

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

## Flow Inputs

| | | | | |
|---|---|---|---|---|
| Volume, V | *2350* | 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 | *mi* |
| | | | Up/Down % | |

## Calculate Flow Adjustments

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

## 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 $f_p$) | *850* | pc/h/ln |
| S | *65.0* | mph |
| D = $v_p$ / S | *13.1* | 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 | |

PM | 06

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *PM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *1830* | 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 | *mi* |
| | | | Up/Down % | |

## Calculate Flow Adjustments

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

## 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 $f_p$) | *662* | pc/h/ln |
| S | *65.0* | mph |
| D = $v_p$ / S | *10.2* | 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 | |

PM | 08

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *PM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *3010* | 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 | *mi* |
| | | | Up/Down % | |

## Calculate Flow Adjustments

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

## 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 $f_p$) | *1089* | pc/h/ln |
| S | *65.0* | mph |
| D = $v_p$ / S | *16.8* | 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 | |

PM | 10

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *PM* |

## Site Information

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

Project Description *I-71 / SR 82 IMS*

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

## Flow Inputs

| | | | | |
|---|---|---|---|---|
| Volume, V | *3440* | 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 $f_p$) | *1238* | 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 | |

PM | 12

# BASIC FREEWAY SEGMENTS WORKSHEET

## General Information

| | |
|---|---|
| Analyst | *SJT* |
| Agency or Company | *Hatch Mott MacDonald* |
| Date Performed | *5/27/2015* |
| Analysis Time Period | *PM* |

## Site Information

| | |
|---|---|
| Highway/Direction of Travel | *NB* |
| 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 | *3060* | 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 $f_p$) | *1101* | pc/h/ln |
| S | *65.0* | mph |
| D = $v_p$ / S | *16.9* | pc/mi/ln |
| LOS | *B* | |

## Design (N)

Design (N)

| | |
|---|---|
| Design LOS | |
| $v_p$ = (V or DDHV) / (PHF x N x $f_{HV}$ x $f_p$) | pc/h/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 | |

# Freeway Merges / Diverges

# 2035 AM

Hatch Mott MacDonald

AM | 01

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 303 EB |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | AM | 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, $L_A$ | 750 |
| Deceleration Lane Length $L_D$ | |
| Freeway Volume, $V_F$ | 2640 |
| Ramp Volume, $V_R$ | 980 |
| Freeway Free-Flow Speed, $S_{FF}$ | 65.0 |
| Ramp Free-Flow Speed, $S_{FR}$ | 40.0 |

Downstream Adj Ramp
☑ Yes ☑ On
☐ No ☐ Off
$L_{down}$ = 1500 ft
$V_D$ = 300 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 | 2640 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 2865 |
| Ramp | 980 | 0.94 | Level | 6 | 0 | 0.971 | 1.00 | 1074 |
| UpStream | | | | | | | | |
| DownStream | 300 | 0.94 | Level | 5 | 0 | 0.976 | 1.00 | 327 |

## Merge Areas

### Estimation of $v_{12}$

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

$L_{EQ}$ = (Equation 13-6 or 13-7)
$P_{FM}$ = 0.599 using Equation (Exhibit 13-6)
$V_{12}$ = 1715 pc/h
$V_3$ or $V_{av34}$ 1150 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,$V_{12a}$ = 1715 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 3939 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 2789 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 22.0 (pc/mi/ln)
LOS = C (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.324 (Exibit 13-11)
$S_R$= 57.5 mph (Exhibit 13-11)
$S_0$= 62.7 mph (Exhibit 13-11)
S = 58.9 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)



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# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 303 WB |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | AM | Analysis Year | 2035 |

Project Description I-71 / SR 82 IMS

## Inputs

**Upstream Adj Ramp**

☑ Yes ☑ On

☐ No ☐ Off

$L_{up}$ = 1500 ft

$V_u$ = 980 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, $V_F$ | 3620 |
| Ramp Volume, $V_R$ | 300 |
| 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 | 3620 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 3928 |
| Ramp | 300 | 0.94 | Level | 5 | 0 | 0.976 | 1.00 | 327 |
| UpStream | 980 | 0.94 | Level | 6 | 0 | 0.971 | 1.00 | 1074 |
| DownStream | | | | | | | | |

## Merge Areas

### Estimation of $v_{12}$

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

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

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

$V_{12}$ = 2351 pc/h

$V_3$ or $V_{av34}$ 1577 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, $V_{12a}$ = 2351 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 4255 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 2678 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 21.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.303 (Exibit 13-11)

$S_R$ = 58.0 mph (Exhibit 13-11)

$S_0$ = 61.1 mph (Exhibit 13-11)

S = 59.1 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)



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AM | 05

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 82 |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | AM | 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 $L_D$ | 460 |
| Freeway Volume, $V_F$ | 3920 |
| Ramp Volume, $V_R$ | 410 |
| Freeway Free-Flow Speed, $S_{FF}$ | 65.0 |
| Ramp Free-Flow Speed, $S_{FR}$ | 50.0 |

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; $L_{down}$ = 1800 ft; $V_D$ = 1690 veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | %Truck | %Rv | $f_{HV}$ | $f_p$ | $v = V/PHF \times f_{HV} \times f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3920 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 4254 |
| Ramp | 410 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 445 |
| UpStream | | | | | | | | |
| DownStream | 1690 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1834 |

## Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM} )$ (Equation 13-6 or 13-7)

$L_{EQ}$ =

$P_{FM}$ = 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 $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$ (Equation 13-12 or 13-13)

$L_{EQ}$ =

$P_{FD}$ = 0.633 using Equation (Exhibit 13-7)

$V_{12}$ = 2857 pc/h

$V_3$ or $V_{av34}$ 1397 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? |
|---|---|---|---|---|
| $V_F$ | 4254 | Exhibit 13-8 | 7050 | No |
| $V_{FO} = V_F - V_R$ | 3809 | Exhibit 13-8 | 7050 | No |
| $V_R$ | 445 | Exhibit 13-10 | 2100 | No |

### Flow Entering Diverge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{12}$ | 2857 | Exhibit 13-8 | 4400:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 24.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

### Speed Determination

$D_s$ = 0.273 (Exhibit 13-12)

$S_R$ = 58.7 mph (Exhibit 13-12)

$S_0$ = 69.8 mph (Exhibit 13-12)

S = 61.9 mph (Exhibit 13-13)



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**AM | 07**

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 82 EB |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | AM | 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, $L_A$ | 600 |
| Deceleration Lane Length $L_D$ | |
| Freeway Volume, $V_F$ | 3510 |
| Ramp Volume, $V_R$ | 1690 |
| Freeway Free-Flow Speed, $S_{FF}$ | 65.0 |
| Ramp Free-Flow Speed, $S_{FR}$ | 40.0 |

Downstream Adj Ramp
☑ Yes ☑ On
☐ No ☐ Off
$L_{down}$ = 1400 ft
$V_D$ = 1100 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 | 3510 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 3809 |
| Ramp | 1690 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1834 |
| UpStream | | | | | | | | |
| DownStream | 1100 | 0.94 | Level | 1 | 0 | 0.995 | 1.00 | 1176 |

## Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM} )$
$L_{EQ}$ = (Equation 13-6 or 13-7)
$P_{FM}$ = 0.594 using Equation (Exhibit 13-6)
$V_{12}$ = 2264 pc/h
$V_3$ or $V_{av34}$ 1545 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,$V_{12a}$ = 2264 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 5643 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 4098 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$
$D_R$ = 32.8 (pc/mi/ln)
LOS = D (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.508 (Exibit 13-11)
$S_R$= 53.3 mph (Exhibit 13-11)
$S_0$= 61.2 mph (Exhibit 13-11)
S = 55.3 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)



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AM | 09

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 82 WB |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | AM | Analysis Year | 2035 |

Project Description I-71 / SR 82 IMS

## Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off

$L_{up}$ = 1400 ft

$V_u$ = 1690 veh/h

| | |
|---|---|
| Freeway Number of Lanes, N | 3 |
| Ramp Number of Lanes, N | 1 |
| Acceleration Lane Length, $L_A$ | 600 |
| Deceleration Lane Length $L_D$ | |
| Freeway Volume, $V_F$ | 5200 |
| Ramp Volume, $V_R$ | 1100 |
| 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 | 5200 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 5643 |
| Ramp | 1100 | 0.94 | Level | 1 | 0 | 0.995 | 1.00 | 1176 |
| UpStream | 1690 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1834 |
| DownStream | | | | | | | | |

## Merge Areas

### Estimation of $v_{12}$

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

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

$P_{FM}$ = 0.594 using Equation (Exhibit 13-6)

$V_{12}$ = 3354 pc/h

$V_3$ or $V_{av34}$ 2289 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, $V_{12a}$ = 3354 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 6819 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 4530 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 36.5 (pc/mi/ln)

LOS = E (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.623 (Exibit 13-11)

$S_R$= 50.7 mph (Exhibit 13-11)

$S_0$= 58.6 mph (Exhibit 13-11)

S = 53.1 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)



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**AM | 11**

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | I-80 |
| Date Performed | 5/27/2015 | 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, $L_A$: | $L_{down}$ = ft |
| $V_u$ = veh/h | Deceleration Lane Length $L_D$: 550 | $V_D$ = veh/h |
| | Freeway Volume, $V_F$: 6300 | |
| | Ramp Volume, $V_R$: 400 | |
| | Freeway Free-Flow Speed, $S_{FF}$: 65.0 | |
| | Ramp Free-Flow Speed, $S_{FR}$: 50.0 | |

## 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 | 6300 | 0.94 | Level | 3 | 0 | 0.985 | 1.00 | 6803 |
| Ramp | 400 | 0.94 | Level | 7 | 0 | 0.966 | 1.00 | 440 |
| 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)

$P_{FD}$ = 0.570 using Equation (Exhibit 13-7)

$V_{12}$ = 4065 pc/h

$V_3$ or $V_{av34}$ 2738 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,$V_{12a}$ = 4103 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_F$ | 6803 | Exhibit 13-8 | 7050 | No |
| $V_{FO} = V_F - V_R$ | 6363 | Exhibit 13-8 | 7050 | No |
| $V_R$ | 440 | Exhibit 13-10 | 2100 | No |

### Flow Entering Diverge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{12}$ | 4065 | Exhibit 13-8 | 4400:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 34.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

### Speed Determination

$D_s$ = 0.273 (Exhibit 13-12)

$S_R$= 58.7 mph (Exhibit 13-12)

$S_0$= 64.7 mph (Exhibit 13-12)

S = 61.0 mph (Exhibit 13-13)

# Freeway Merges / Diverges

## 2035 PM

Hatch Mott MacDonald

**PM | 01**

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 303 EB |
| Date Performed | 5/27/2015 | 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, $L_A$ | 750 |
| Deceleration Lane Length $L_D$ | |
| Freeway Volume, $V_F$ | 1520 |
| Ramp Volume, $V_R$ | 490 |
| Freeway Free-Flow Speed, $S_{FF}$ | 65.0 |
| Ramp Free-Flow Speed, $S_{FR}$ | 40.0 |

**Downstream Adj Ramp**

☑ Yes ☑ On

☐ No ☐ Off

$L_{down}$ = 1500 ft

$V_D$ = 340 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 | 1520 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1649 |
| Ramp | 490 | 0.94 | Level | 6 | 0 | 0.971 | 1.00 | 537 |
| UpStream | | | | | | | | |
| DownStream | 340 | 0.94 | Level | 5 | 0 | 0.976 | 1.00 | 371 |

## Merge Areas

### Estimation of $v_{12}$

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

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

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

$V_{12}$ = 987 pc/h

$V_3$ or $V_{av34}$ 662 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? |
|---|---|---|---|---|
| $V_{FO}$ | 2186 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 1524 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 12.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.279 (Exibit 13-11)

$S_R$= 58.6 mph (Exhibit 13-11)

$S_0$= 64.4 mph (Exhibit 13-11)

S = 60.2 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)

PM | 03

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 303 WB |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | PM | Analysis Year | 2035 |

Project Description I-71 / SR 82 IMS

## Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off

$L_{up}$ = 1500 ft

$V_u$ = 490 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, $V_F$ | 2010 |
| Ramp Volume, $V_R$ | 340 |
| 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 | 2010 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 2181 |
| Ramp | 340 | 0.94 | Level | 5 | 0 | 0.976 | 1.00 | 371 |
| UpStream | 490 | 0.94 | Level | 6 | 0 | 0.971 | 1.00 | 537 |
| DownStream | | | | | | | | |

## Merge Areas

### Estimation of $v_{12}$

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

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

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

$V_{12}$ = 1305 pc/h

$V_3$ or $V_{av34}$ 876 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, $V_{12a}$ = 1305 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 2552 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 1676 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 13.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.267 (Exibit 13-11)

$S_R$ = 58.9 mph (Exhibit 13-11)

$S_0$ = 63.6 mph (Exhibit 13-11)

S = 60.4 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)

PM | 05

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 82 |
| Date Performed | 5/27/2015 | 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, $L_A$ | |
| Deceleration Lane Length $L_D$ | 460 |
| Freeway Volume, $V_F$ | 2350 |
| Ramp Volume, $V_R$ | 520 |
| Freeway Free-Flow Speed, $S_{FF}$ | 65.0 |
| Ramp Free-Flow Speed, $S_{FR}$ | 50.0 |

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off

$L_{down}$ = 1800 ft

$V_D$ = 1180 veh/h

## Conversion to pc/h Under Base Conditions

| | V (Veh/hr) | PHF | Terrain | %Truck | %Rv | $f_{HV}$ | $f_p$ | v = V/PHF x $f_{HV}$ x $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2350 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 2550 |
| Ramp | 520 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 564 |
| UpStream | | | | | | | | |
| DownStream | 1180 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1280 |

## 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)

$P_{FD}$ = 0.670 using Equation (Exhibit 13-7)

$V_{12}$ = 1895 pc/h

$V_3$ or $V_{av34}$ 655 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? |
|---|---|---|---|---|
| $V_F$ | 2550 | Exhibit 13-8 | 7050 | No |
| $V_{FO} = V_F - V_R$ | 1986 | Exhibit 13-8 | 7050 | No |
| $V_R$ | 564 | Exhibit 13-10 | 2100 | No |

### Flow Entering Diverge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{12}$ | 1895 | Exhibit 13-8 | 4400:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 16.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

### Speed Determination

$D_s$ = 0.284 (Exhibit 13-12)

$S_R$= 58.5 mph (Exhibit 13-12)

$S_0$= 71.3 mph (Exhibit 13-12)

S = 61.3 mph (Exhibit 13-13)



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PM | 07

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 82 EB |
| Date Performed | 5/27/2015 | 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, $L_A$ | 600 |
| Deceleration Lane Length $L_D$ | |
| Freeway Volume, $V_F$ | 1830 |
| Ramp Volume, $V_R$ | 1180 |
| Freeway Free-Flow Speed, $S_{FF}$ | 65.0 |
| Ramp Free-Flow Speed, $S_{FR}$ | 40.0 |

Downstream Adj Ramp
☑ Yes ☑ On
☐ No ☐ Off
$L_{down}$ = 1400 ft
$V_D$ = 430 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 | 1830 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1986 |
| Ramp | 1180 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1280 |
| UpStream | | | | | | | | |
| DownStream | 430 | 0.94 | Level | 1 | 0 | 0.995 | 1.00 | 460 |

## Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM} )$
$L_{EQ}$ = (Equation 13-6 or 13-7)
$P_{FM}$ = 0.594 using Equation (Exhibit 13-6)
$V_{12}$ = 1180 pc/h
$V_3$ or $V_{av34}$ 806 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,$V_{12a}$ = 1180 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 3266 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 2460 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$
$D_R$ = 20.3 (pc/mi/ln)
LOS = C (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.319 (Exibit 13-11)
$S_R$= 57.7 mph (Exhibit 13-11)
$S_0$= 63.9 mph (Exhibit 13-11)
S = 59.1 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)

PM | 09

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | SR 82 WB |
| Date Performed | 5/27/2015 | Jurisdiction | |
| Analysis Time Period | PM | Analysis Year | 2035 |

Project Description I-71 / SR 82 IMS

## Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off

$L_{up}$ = 1400 ft

$V_u$ = 1180 veh/h

| | |
|---|---|
| Freeway Number of Lanes, N | 3 |
| Ramp Number of Lanes, N | 1 |
| Acceleration Lane Length, $L_A$ | 600 |
| Deceleration Lane Length $L_D$ | |
| Freeway Volume, $V_F$ | 3010 |
| Ramp Volume, $V_R$ | 430 |
| 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 | 3010 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 3266 |
| Ramp | 430 | 0.94 | Level | 1 | 0 | 0.995 | 1.00 | 460 |
| UpStream | 1180 | 0.94 | Level | 4 | 0 | 0.980 | 1.00 | 1280 |
| DownStream | | | | | | | | |

## Merge Areas

### Estimation of $v_{12}$

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

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

$P_{FM}$ = 0.594 using Equation (Exhibit 13-6)

$V_{12}$ = 1941 pc/h

$V_3$ or $V_{av34}$ 1325 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, $V_{12a}$ = 1941 pc/h (Equation 13-16, 13-18, or 13-19)

### Capacity Checks

| | Actual | Capacity | | LOS F? |
|---|---|---|---|---|
| $V_{FO}$ | 3726 | Exhibit 13-8 | | No |

### Flow Entering Merge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{R12}$ | 2401 | Exhibit 13-8 | 4600:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 20.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

### Speed Determination

$M_S$ = 0.304 (Exibit 13-11)

$S_R$ = 58.0 mph (Exhibit 13-11)

$S_0$ = 62.0 mph (Exhibit 13-11)

S = 59.4 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)

PM | 11

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst | SJT | Freeway/Dir of Travel | I-71 NB |
| Agency or Company | Hatch Mott MacDonald | Junction | I-80 |
| Date Performed | 5/27/2015 | 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, $L_A$ | |
| Deceleration Lane Length $L_D$ | 550 |
| Freeway Volume, $V_F$ | 3440 |
| 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 | 3440 | 0.94 | Level | 3 | 0 | 0.985 | 1.00 | 3714 |
| Ramp | 380 | 0.94 | Level | 7 | 0 | 0.966 | 1.00 | 418 |
| 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)

$P_{FD}$ = 0.648 using Equation (Exhibit 13-7)

$V_{12}$ = 2554 pc/h

$V_3$ or $V_{av34}$ 1160 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? |
|---|---|---|---|---|
| $V_F$ | 3714 | Exhibit 13-8 | 7050 | No |
| $V_{FO} = V_F - V_R$ | 3296 | Exhibit 13-8 | 7050 | No |
| $V_R$ | 418 | Exhibit 13-10 | 2100 | No |

### Flow Entering Diverge Influence Area

| | Actual | Max Desirable | | Violation? |
|---|---|---|---|---|
| $V_{12}$ | 2554 | Exhibit 13-8 | 4400:All | No |

### Level of Service Determination (if not F)

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

$D_R$ = 21.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

### Speed Determination

$D_s$ = 0.271 (Exhibit 13-12)

$S_R$= 58.8 mph (Exhibit 13-12)

$S_0$= 70.7 mph (Exhibit 13-12)

S = 62.0 mph (Exhibit 13-13)



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# Appendix D

# Cost Estimate

# Estimate CUY-82-3.54

Estimated Cost:$833,485.10

Contingency:  2.80%

**Estimated Total: $856,822.68**

*STAGE 3 ESTIMATE*

Base Date: 09/17/15

Spec Year: 13

Unit System: E

Work Type: ASPHALT

Highway Type: 448 ON 304

Urban/Rural Type: URBAN CLASS

Season: SUMMER

County:  CUYAHOGA

Midpoint of Latitude:  411845

Midpoint of Longitude:  0814835

District: 12

Federal/State Project Number: E150253/527095

*Prepared by Dan Reinke*
*Checked by Ed Kagel*

| Line # | Item Number / Description / *Supplemental Description* | Quantity | Units | Unit Price | Extension |
|---|---|---|---|---|---|
| **Group 0100: ROADWAY** | | | | | |
| 0001 | 201E11000<br>CLEARING AND GRUBBING | 1.000 | LS | $10,000.00000 | $10,000.00 |
| 0002 | 202E23000<br>PAVEMENT REMOVED | 3,891.000 | SY | $11.80248 | $45,923.45 |
| 0003 | 202E30000<br>WALK REMOVED | 1,957.000 | SF | $1.65955 | $3,247.74 |
| 0004 | 202E30500<br>CONCRETE MEDIAN REMOVED | 220.000 | FT | $10.88808 | $2,395.38 |
| 0005 | 202E30600<br>CONCRETE MEDIAN REMOVED | 20.000 | SY | $29.88857 | $597.77 |
| 0006 | 202E32000<br>CURB REMOVED | 493.000 | FT | $3.67812 | $1,813.31 |
| 0007 | 202E38000<br>GUARDRAIL REMOVED | 170.000 | FT | $2.39120 | $406.50 |
| 0008 | 202E98100<br>REMOVAL MISC.:<br>*CATCH BASIN CASTING AND GRATE REMOVED AND STORED* | 1.000 | EACH | $3,000.00000 | $3,000.00 |
| 0009 | 204E10000<br>SUBGRADE COMPACTION | 6,310.000 | SY | $1.66745 | $10,521.61 |
| 0010 | 204E45000<br>PROOF ROLLING | 4.000 | HOUR | $195.58211 | $782.33 |
| 0011 | 203E10000<br>EXCAVATION | 3,666.000 | CY | $12.69058 | $46,523.67 |
| 0012 | 203E20000<br>EMBANKMENT | 36.000 | CY | $27.71233 | $997.64 |
| 0013 | 606E15050<br>GUARDRAIL, TYPE MGS | 325.000 | FT | $16.18728 | $5,260.87 |
| 0014 | 606E26000<br>ANCHOR ASSEMBLY, TYPE B | 1.000 | EACH | $1,505.66298 | $1,505.66 |
| 0015 | 606E26550<br>ANCHOR ASSEMBLY, MGS TYPE T | 1.000 | EACH | $774.62623 | $774.63 |
| 0016 | 606E60028<br>IMPACT ATTENUATOR, TYPE 2 (BIDIRECTIONAL)<br>*, 25MPH, 28"* | 2.000 | EACH | $17,132.13740 | $34,264.27 |
| 0017 | 608E10000<br>4" CONCRETE WALK | 1,603.000 | SF | $5.69782 | $9,133.61 |
| 0018 | 608E52000<br>CURB RAMP | 314.000 | SF | $13.54756 | $4,253.93 |
| 0019 | 622E10060<br>CONCRETE BARRIER, SINGLE SLOPE, TYPE B | 240.000 | FT | $61.27924 | $14,707.02 |
| 0020 | 622E24840<br>CONCRETE BARRIER END SECTION, TYPE B | 2.000 | EACH | $4,471.75630 | $8,943.51 |

Total for Group 0100:$205,052.90

## Group 0200: EROSION CONTROL

| | | | | | |
|---|---|---|---|---|---|
| 0021 | 601E21050<br>TIED CONCRETE BLOCK MAT, TYPE 1 | 2.000 | SY | $177.17301 | $354.35 |
| 0022 | 601E21060<br>TIED CONCRETE BLOCK MAT, TYPE 2 | 5.000 | SY | $150.00000 | $750.00 |
| 0023 | 659E00100<br>SOIL ANALYSIS TEST | 2.000 | EACH | $64.93874 | $129.88 |
| 0024 | 659E00300<br>TOPSOIL | 635.000 | CY | $21.19174 | $13,456.75 |
| 0025 | 659E10000<br>SEEDING AND MULCHING | 5,104.000 | SY | $0.96420 | $4,921.28 |
| 0026 | 659E14000 | 255.000 | SY | $0.70310 | $179.29 |

| Line # | Item Number | Description / *Supplemental Description* | Quantity | Units | Unit Price | Extension |
|---|---|---|---|---|---|---|
| | | REPAIR SEEDING AND MULCHING | | | | |
| 0027 | 659E15000 | INTER-SEEDING | 255.000 | SY | $0.29026 | $74.02 |
| 0028 | 659E20000 | COMMERCIAL FERTILIZER | 1.150 | TON | $937.00000 | $1,077.55 |
| 0029 | 659E31000 | LIME | 1.050 | ACRE | $122.00000 | $128.10 |
| 0030 | 659E35000 | WATER | 29.000 | MGAL | $1.08640 | $31.51 |
| 0031 | 659E40000 | MOWING | 11.000 | MSF | $1.84347 | $20.28 |
| 0032 | 670E00700 | DITCH EROSION PROTECTION | 952.000 | SY | $1.82739 | $1,739.68 |
| 0033 | 832E15000 | STORM WATER POLLUTION PREVENTION PLAN | 1.000 | LS | $2,500.00000 | $2,500.00 |
| 0034 | 832E30000 | EROSION CONTROL | 20,394.000 | EACH | $1.00000 | $20,394.00 |

Total for Group 0200:$45,756.69

## Group 0300: DRAINAGE

| | | | | | | |
|---|---|---|---|---|---|---|
| 0035 | 605E11110 | 6" SHALLOW PIPE UNDERDRAINS WITH FABRIC WRAP | 1,293.000 | FT | $11.09101 | $14,340.68 |
| 0036 | 605E13410 | 6" UNCLASSIFIED PIPE UNDERDRAINS WITH FABRIC WRAP | 35.000 | FT | $20.00000 | $700.00 |
| 0037 | 605E14020 | 6" BASE PIPE UNDERDRAINS WITH FABRIC WRAP | 1,345.000 | FT | $13.48606 | $18,138.75 |
| 0038 | 611E00510 | 6" CONDUIT, TYPE F FOR UNDERDRAIN OUTLETS | 84.000 | FT | $16.66513 | $1,399.87 |
| 0039 | 611E99710 | PRECAST REINFORCED CONCRETE OUTLET | 2.000 | EACH | $220.21585 | $440.43 |
| 0040 | 611E98651 | CATCH BASIN FRAME AND GRATE, AS PER PLAN | 1.000 | EACH | $600.00000 | $600.00 |

Total for Group 0300:$35,619.73

## Group 0400: PAVEMENT

| | | | | | | |
|---|---|---|---|---|---|---|
| 0041 | 302E46000 | ASPHALT CONCRETE BASE, PG64-22 | 1,542.000 | CY | $130.77235 | $201,650.96 |
| 0042 | 304E20000 | AGGREGATE BASE | 1,052.000 | CY | $49.67938 | $52,262.71 |
| 0043 | 407E14000 | TACK COAT FOR INTERMEDIATE COURSE | 239.000 | GAL | $3.43646 | $821.31 |
| 0044 | 441E50101 | ASPHALT CONCRETE SURFACE COURSE, TYPE 1, (448), AS PER PLAN *, (PG64-22)* | 249.000 | CY | $190.00000 | $47,310.00 |
| 0045 | 441E50300 | ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, (448) | 291.000 | CY | $168.35237 | $48,990.54 |
| 0046 | 609E12000 | COMBINATION CURB AND GUTTER, TYPE 2 | 153.000 | FT | $28.47955 | $4,357.37 |
| 0047 | 609E16000 | CURB, TYPE 2-B | 217.000 | FT | $14.30588 | $3,104.38 |
| 0048 | 609E72000 | CONCRETE MEDIAN | 7.000 | SY | $135.36414 | $947.55 |

Total for Group 0400:$359,444.82

## Group 0700: LIGHTING

| Line # | Item Number / Description / *Supplemental Description* | Quantity | Units | Unit Price | Extension |
|---|---|---|---|---|---|
| 0049 | 625E00480<br>CONNECTION, UNFUSED PERMANENT | 3.000 | EACH | $89.07792 | $267.23 |
| 0050 | 625E23200<br>NO. 4 AWG 5000 VOLT DISTRIBUTION CABLE | 2,037.000 | FT | $2.64357 | $5,384.95 |
| 0051 | 625E25500<br>CONDUIT, 3", 725.04 | 639.000 | FT | $15.94876 | $10,191.26 |
| 0052 | 625E29000<br>TRENCH | 639.000 | FT | $6.05661 | $3,870.17 |
| 0053 | 625E30700<br>PULL BOX, 725.08, 18" | 4.000 | EACH | $630.73427 | $2,522.94 |
| 0054 | 625E31510<br>PULL BOX REMOVED | 6.000 | EACH | $122.52870 | $735.17 |
| 0055 | 625E36000<br>PLASTIC CAUTION TAPE | 639.000 | FT | $0.32924 | $210.38 |
| 0056 | 625E75500<br>LIGHT POLE FOUNDATION REMOVED | 1.000 | EACH | $323.99742 | $324.00 |
| 0057 | 625E75550<br>DISTRIBUTION CABLE REMOVED | 1,047.000 | FT | $0.41313 | $432.55 |
| 0058 | 625E75800<br>DISCONNECT CIRCUIT | 3.000 | EACH | $147.17833 | $441.53 |

Total for Group 0700:$24,380.18

## Group 1100: TRAFFIC CONTROL

| | | | | | |
|---|---|---|---|---|---|
| 0059 | 620E00500<br>DELINEATOR, POST MOUNTED | 42.000 | EACH | $39.55324 | $1,661.24 |
| 0060 | 620E31200<br>REMOVAL OF DELINEATOR | 45.000 | EACH | $2.43463 | $109.56 |
| 0061 | 621E00100<br>RPM<br>*, (WHITE/RED), (YELLOW/RED)* | 31.000 | EACH | $65.22324 | $2,021.92 |
| 0062 | 630E03100<br>GROUND MOUNTED SUPPORT, NO. 3 POST | 99.000 | FT | $7.88772 | $780.88 |
| 0063 | 630E80100<br>SIGN, FLAT SHEET | 49.000 | SF | $15.88906 | $778.56 |
| 0064 | 630E80400<br>SIGN, PERMANENT OVERLAY | 29.000 | SF | $20.73823 | $601.41 |
| 0065 | 630E84900<br>REMOVAL OF GROUND MOUNTED SIGN AND DISPOSAL | 3.000 | EACH | $15.67638 | $47.03 |
| 0066 | 630E86002<br>REMOVAL OF GROUND MOUNTED POST SUPPORT AND DISPOSAL | 3.000 | EACH | $19.11292 | $57.34 |
| 0067 | 646E10010<br>EDGE LINE, 6" | 0.540 | MILE | $8,763.73031 | $4,732.41 |
| 0068 | 646E10110<br>LANE LINE, 6" | 0.300 | MILE | $15,000.00000 | $4,500.00 |
| 0069 | 646E10300<br>CHANNELIZING LINE, 8" | 1,441.000 | FT | $1.45592 | $2,097.98 |
| 0070 | 646E10500<br>CROSSWALK LINE | 72.000 | FT | $5.45239 | $392.57 |
| 0071 | 646E10600<br>TRANSVERSE/DIAGONAL LINE<br>*, (WHITE)* | 59.000 | FT | $6.11262 | $360.64 |
| 0072 | 646E20300<br>LANE ARROW | 10.000 | EACH | $140.00154 | $1,400.02 |
| 0073 | 646E20350<br>LANE REDUCTION ARROW | 2.000 | EACH | $260.00000 | $520.00 |
| 0074 | 646E20504<br>DOTTED LINE, 6" | 400.000 | FT | $8.00000 | $3,200.00 |
| 0075 | 646E50000 | 3.000 | EACH | $200.00000 | $600.00 |

| Line # | Item Number | Description / *Supplemental Description* | Quantity | Units | Unit Price | Extension |
|---|---|---|---|---|---|---|
| | | REMOVAL OF PAVEMENT MARKING | | | | |
| 0076 | 630E97700 | SIGNING, MISC.:<br>*SOLAR POWERED RECTANGULAR RAPID FLASHING BEACON (RRFB) SIGN ASSEMBLY* | 2.000 | EACH | $6,000.00000 | $12,000.00 |

Total for Group 1100:$35,861.56

## Group 2100: MAINTENANCE OF TRAFFIC

| | | | | | | |
|---|---|---|---|---|---|---|
| 0077 | 614E11110 | LAW ENFORCEMENT OFFICER WITH PATROL CAR FOR ASSISTANCE | 50.000 | HOUR | $61.36704 | $3,068.35 |
| 0078 | 614E12336 | WORK ZONE IMPACT ATTENUATOR (UNIDIRECTIONAL) | 4.000 | EACH | $2,187.11571 | $8,748.46 |
| 0079 | 614E13300 | BARRIER REFLECTOR, TYPE B | 74.000 | EACH | $6.16128 | $455.93 |
| 0080 | 614E13350 | OBJECT MARKER, ONE WAY | 74.000 | EACH | $11.62547 | $860.28 |
| 0081 | 614E22100 | WORK ZONE EDGE LINE, CLASS I, 642 PAINT | 1.830 | MILE | $1,336.02782 | $2,444.93 |
| 0082 | 614E23200 | WORK ZONE CHANNELIZING LINE, CLASS I, 642 PAINT | 780.000 | FT | $0.61211 | $477.45 |
| 0083 | 614E25200 | WORK ZONE TRANSVERSE/DIAGONAL LINE, CLASS I, 642 PAINT | 66.000 | FT | $2.50000 | $165.00 |
| 0084 | 615E10000 | ROADS FOR MAINTAINING TRAFFIC | 1.000 | LS | $2,200.00000 | $2,200.00 |
| 0085 | 615E20000 | PAVEMENT FOR MAINTAINING TRAFFIC, CLASS A | 344.000 | SY | $59.61958 | $20,509.14 |
| 0086 | 622E41000 | PORTABLE BARRIER, 32" | 3,670.000 | FT | $12.33814 | $45,280.97 |
| 0087 | 622E41050 | PORTABLE BARRIER, "Y" CONNECTOR | 1.000 | EACH | $1,670.82777 | $1,670.83 |

Total for Group 2100:$85,881.34

## Group 2300: INCIDENTALS

| | | | | | | |
|---|---|---|---|---|---|---|
| 0088 | 619E16010 | FIELD OFFICE, TYPE B | 6.000 | MNTH | $1,197.97980 | $7,187.88 |
| 0089 | 623E10000 | CONSTRUCTION LAYOUT STAKES AND SURVEYING | 1.000 | LS | $5,300.00000 | $5,300.00 |
| 0090 | 624E10000 | MOBILIZATION | 1.000 | LS | $20,000.00000 | $20,000.00 |
| 0091 | 614E11001 | MAINTAINING TRAFFIC, AS PER PLAN | 1.000 | LS | $9,000.00000 | $9,000.00 |

Total for Group 2300:$41,487.88