McMILLEN ENGINEERING

CIVIL ENGINEERS • LAND SURVEYORS
115 Wayland Smith Drive • Uniontown • Pennsylvania • 15401
Phone 724-439-8110 Fax 724-439-4733

NEMACOLIN WOODLANDS RESORT CASINO

TRAFFIC IMPACT STUDY

Wharton Township, Fayette County, Pennsylvania

December 2005

Prepared for:
NWL COMPANY
1001 LaFayette Drive
Farmington, PA 15445

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REFERENCE MATERIAL

1. Highway Capacity Software (HCS) Release 4.Id – University of Florida.

2. Chapter 201 Engineering and Traffic Studies, Title 67 of the Pennsylvania Vehicle Code, Transportation, Pennsylvania Department of Transportation, December 1993.

3. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 1997.

4. A Policy on geometric Design of Highways and Streets, 1990, American Association of State highway and Transportation Officials.

5. ITE Trip Generation Manual 7th Edition.

6. PennDOT Publication 282.

APPENDICES

1. Traffic Count Data
2. Capacity Analysis (2006 Base Conditions)
3. Capacity Analysis (2006 Developed Conditions)
4. Capacity Analysis (2016 Base Conditions)
5. Capacity Analysis (2016 Developed Conditions)
6. Peak Hour Factor Calculations
7. Queue Analysis
8. Signal Warrant Analysis

ABSTRACT

On behalf of NWL Company, McMillen Engineering has performed a traffic impact study for the proposed Casino at Nemacolin Woodlands Resort.. The project includes the converting the existing Woodlands Outdoor World into a Class 3 (resort) casino with 500 slot machines. Intersection analysis was performed for the main intersections along the Route 40 corridor from SR 381 to Dinner Bell Road. The project is located in Wharton Township, Fayette County, Pennsylvania.

The objective of this study is to analyze the impact of building conversion on the existing Route 40 Corridor. Base traffic data was compiled from counts conducted by McMillen Engineering during the weekday of August 12 – 13, 2005. This data was used to determine the capacity of the existing roads/ intersections and formed the basis for the recommended improvements.

Traffic analysis has been performed for weekday peak PM and Saturday peak hour traffic volumes for the opening day (2006) and future (2016) design years. All intersections shall operate at an adequate level of service to accommodate design volumes with the proposed roadway improvements. Recommended improvements resulting from the traffic impact study are as follows.

1. **Route 40 / Casino Main Driveway**
   - Install medium volume signalized driveway with left turn lanes for both Route 40 approaches.

I. INTRODUCTION

On behalf of NWL Company, McMillen Engineering performed a traffic impact study for the proposed casino at Nemacolin Woodlands Resort. The project includes converting the existing Woodlands World into a Class 3 resort casino with 500 slot machines. Intersection analysis was performed for the main intersections along the Route 40 Corridor from SR 381 to Dinner Bell Road. The project is located in Wharton Township, Fayette County, Pennsylvania. The general influence area is based on a 30-mile radius from the site which contains five county areas of population outlined in Table 1.

The objective of this study is to analyze the impact of proposed development on the existing Route 40 corridor. This study has been conducted in accordance with PennDOT Publications 282 and traffic impact study guidelines established by the Institute of Transportation Engineers (ITE).

II. BASE TRAFFIC ANALYSIS

A. Study Area and Site Location

The project site is located in Wharton Township, Fayette County, Pennsylvania. The project site is described in Section II. B below. The project scope includes the analysis of the SR 0040 corridor from SR 381 to SR 2011 (Dinner Bell Road). The site is shown on the site location map (Figure 1). The study area for the analysis is shown on Figure 2.

The study area includes the existing seven (7) major intersections of SR 0040 and the proposed driveways at the site.

The existing intersections analyzed for this traffic impact study is as follows:

- Route 40/SR 381 S
- Route 40/SR 381 N
- Route 40/Hawes Road
- Route 40/Secondary Driveway
- Route 40/Casino (main) Driveway and Marker Road
- Route 40/Smith School Road
- Route 40/SR 2011 (Dinner Bell Road)

B. Proposed Development

Proposed development consists of converting the existing 54,000 square-foot Outdoor Store Retail Facility into a 500 slot machine casino. The facility shall be governed by the Pennsylvania Gaming Control Board regulations currently under development. The development components of the proposed development are outlined in Table 2.

TABLE 1 AREA POPULATION DATA	
City / County	2000 Census*
Uniontown	12,422
Fayette	148,644
Westmoreland	369,993
Washington	202,897
Greene	40,672
Somerset	80,023

*2000 census population (critical) used in traffic distribution calculations.

TABLE 2 DEVELOPMENT COMPONENTS TRAFFIC IMPACT STUDY		
ITE Number	**Development Component**	**Description**
473	Casino	500 slots
815	Outdoor Store	54,000 sf

TABLE 3

PROJECTED TRIP GENERATION

NEMACOLIN WOODLANDS RESORT CASINO

Wharton Township, Fayette County, Pennsylvania

Prepared by: McMillen Engineering Inc.

PROJECTED VEHICLE TRIP GENERATION (1)

				Weekday Peak PM Hour (3)			Saturday Peak Hour (4)		
Development Component	Size	ITE Code (5)	Average Weekday Daily Traffic (2)	Enter	Exit	Total	Enter	Exit	Total
Casino	500 slots	473		155	140	295	170	150	320
Outdoor Store	54,000sf	815	3000	148	147	295	208	201	409

(1) Trip generation rates based on Institute of Transportation Engineers, Trip Generation Manual 7th edition and Information provided by PADOT 12-0.

(2) Average weekday daily traffic volumes projected to be generated during a typical weekday (total trips entering and exiting)

(3) Trips shown for weekday PM peak hour of generator. The projected trips are applied to the peak hour of adjacent street traffic.

(4) Trips shown for saturday peak hour of generator. The projected trips are applied to the peak hour of adjacent street traffic.

(5) ITE land use code from Institute of Transportation Engineers, Trip Generation Manual 7th edition

C. Traffic Analysis

SPC has projected traffic growth of 1% based upon projected growth of adjacent developments for the surrounding areas. Base trip data was compiled by McMillen Engineering on August 12 – 13, 2005. Manual counters were utilized to obtain movement counts along the SR 0040 corridor See Appendix 1 for traffic count data. Computer analysis was performed utilizing the HCS Release 4.1d. The scenarios analyzed in the study are as follows:

1 2006 Weekday Peak PM Hour Base Conditions
2 2006 Saturday Peak Hour Base Conditions
3 2006 Weekday Peak PM with Development Conditions
4 2006 Saturday Peak Hour with Development Conditions
5 2016 Weekday Peak PM Hour Base Conditions
6 2016 Saturday Peak Hour Base Conditions
7 2016 Weekday Peak PM Hour with Development Conditions
8 2016 Saturday Peak Hour with Development Conditions

The analysis considers the Weekday PM Peak and the Saturday Peak hour traffic volumes, turning movement data collection, projections of the future development, intersection capacity analysis and left-turn warrant evaluation and safety considerations. Based upon these parameters, findings of the analysis are listed in the following section.

Figures 4 and 5A-B outline the transportation plan and the distribution of the generated traffic.

D. Traffic Impact Study Findings

The following approach levels of service (LOS) were observed for each study intersection.

1. **SR 0040 /SR 0381 S**
LOS E- Weekday PM peak hour 2006 conditions without development
LOS E- Weekday PM peak hour 2006 conditions with development
LOS D- Saturday peak hour 2006 conditions without development
LOS C- Saturday peak hour 2006 conditions with development
LOS F- Weekday PM peak hour 2016 conditions without development
LOS F- Weekday PM peak hour 2016 conditions with development
LOS E- Saturday peak hour 2016 conditions without development
LOS E- Saturday peak hour 2016 conditions with development

2. **SR 0040 / SR 0381 N**
LOS D- Weekday PM peak hour 2006 conditions without development
LOS D- Weekday PM peak hour 2006 conditions with development
LOS E- Saturday peak hour 2006 conditions without development
LOS D- Saturday peak hour 2006 conditions with development
LOS E- Weekday PM peak hour 2016 conditions without development
LOS E- Weekday PM peak hour 2016 conditions with development
LOS F- Saturday peak hour 2016 conditions without development
LOS E- Saturday peak hour 2016 conditions with development

3. **SR 0040 / Hawes Road**
   LOS C- Weekday PM peak hour 2006 conditions without development
   LOS C- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS D- Weekday PM peak hour 2016 conditions without development
   LOS D- Weekday PM peak hour 2016 conditions with development
   LOS C- Saturday peak hour 2016 conditions without development
   LOS C- Saturday peak hour 2016 conditions with development

4. **SR 0040 / Secondary Driveway**
   LOS -- Weekday PM peak hour 2006 conditions without development
   LOS C- Weekday PM peak hour 2006 conditions with development
   LOS -- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS -- Weekday PM peak hour 2016 conditions without development
   LOS C- Weekday PM peak hour 2016 conditions with development
   LOS -- Saturday peak hour 2016 conditions without development
   LOS C- Saturday peak hour 2016 conditions with development

5. **SR 0040 / Casino (main) Driveway and Marker Road**
   LOS B- Weekday PM peak hour 2006 conditions without development
   LOS B- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS B- Saturday peak hour 2006 conditions with development
   LOS C- Weekday PM peak hour 2016 conditions without development
   LOS B- Weekday PM peak hour 2016 conditions with development
   LOS C- Saturday peak hour 2016 conditions without development
   LOS B- Saturday peak hour 2016 conditions with development

6. **SR 0040 / Smith School House Road**
   LOS C- Weekday PM peak hour 2006 conditions without development
   LOS C- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS C- Weekday PM peak hour 2016 conditions without development
   LOS C- Weekday PM peak hour 2016 conditions with development
   LOS C- Saturday peak hour 2016 conditions without development
   LOS C- Saturday peak hour 2016 conditions with development

7. **SR 0040 / SR 2011 (Dinner Bell Road)**
   LOS D- Weekday PM peak hour 2006 conditions without development
   LOS D- Weekday PM peak hour 2006 conditions with development
   LOS C- Saturday peak hour 2006 conditions without development
   LOS C- Saturday peak hour 2006 conditions with development
   LOS E- Weekday PM peak hour 2016 conditions without development
   LOS E- Weekday PM peak hour 2016 conditions with development
   LOS D- Saturday peak hour 2016 conditions without development
   LOS D- Saturday peak hour 2016 conditions with development

III. EXISTING TRANSPORTATION SYSTEM

A. Traffic Impact Study Area

The study area considers the SR 0040 Corridor between SR 0381 and SR 2011. It encompasses seven (7) existing un-signalized intersections and one proposed signalized intersection.

B. Existing Road Network

SR 0040 runs east and west with the majority of the traffic from the adjacent developments traveling the corridor. Local roads will have minimal trips and minimal affect from the proposed conversion of the existing facility into the casino.

C. Existing Traffic Volume Peak Hours

Data was collected for turning movements in the study area during Friday and Saturday peak hours. The study considers the weekday PM and Saturday peak periods.

TABLE 4
PEAK HOUR SUMMARY

Intersection	Peak Weekday PM	Peak Saturday PM
All	4:45 – 5:45	10:45 – 11:45

D. Improvements Proposed by Others

At this time no roadway improvements are proposed for the SR 0040 Corridor within the study area. A Needs Study is being considered to upgrade SR 0040 from SR 0381 to SR 2011.

E. Traffic Signal Warrant Analysis

The need for a traffic signal at a particular intersection is based upon criteria in Chapter 201, Engineering and Traffic Studies[2], of the Pennsylvania Code, Title 67, under traffic Signal Warrants, Signalization is based on factors such as traffic volumes, vehicular movements, capacity analysis, speed data, and accident analysis. One or more of the traffic signal warrants must be met to justify a traffic signal.

A traffic signal warrant analysis has been performed for the intersection. The site driveway does warrant a traffic signal.

Results of the Warrant Analysis are presented in Appendix 8.

F. Highway Capacity Analysis

The Highway Capacity Manual[3] defines capacity analysis as a set of procedures used to estimate the traffic-carrying ability of a facility over a range of defined operational conditions. The operations conditions are described in terms of a letter from “A” to “F” with “A” being the most desirable condition. A description of the various levels of service is outlined in the Highway Capacity Manual.

The level of service at signalized intersections measures the average stop delay time per vehicle and also the volume to capacity ratio as it relates to the specific intersection. The capacity ratio compares the peak hour traffic volumes to the theoretical maximum traffic volumes that the facility can accommodate.

The level of service for an un-signalized intersection measures the delay to turning traffic to find a gap in a major street traffic flow to allow for the successful completion of the desired turning movement. The critical movements at un-signalized intersections are left turns on the main streets and left turns on the side streets.

Capacity analyses were performed for the weekday PM and Saturday Peak periods at the study intersections. The capacity analysis results are provided in detail in Appendix 2 through 5.

Capacity analyses were performed for 2006 and 2016 weekday peak PM and Saturday peak periods. Results of the analysis are compared for base and developed conditions. Summaries of the traffic volume and levels of service are presented in Figures 6 -9 and Table 5.

G. <u>Queue Analysis</u>

See Appendix 7 for the queue analysis for the left turn lanes to be added as a result of this development.

H. <u>Peak Hour Factors</u>

Peak hour factors were calculated for the weekday PM and Saturday peak hours of traffic volume. The peak hours are based upon the peak fifteen minute volumes observed for each of the peak hour periods. Calculations are provided in Appendix 6.

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.1	A/9.6
Approach		
SR 381S Northbound		
Left and Right Turns	E/37.8	D/27.7
Approach	E/37.8	D/27.7

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.0	A/9.4
Approach		
SR 381S Northbound		
Left and Right Turns	E/36.4	C/24.9
Approach	E/36.4	C/24.9

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/8.9	A/8.9
Approach		
SR 381N Southbound		
Left and Right Turns	D/29.0	E/35.5
Approach	D/29.0	E/35.5

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/8.9	A/8.7
Approach		
SR381N Southbound		
Left and Right Turns	D/29.5	D/29.8
Approach	D/29.5	D/29.8

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.5
Approach		
Hawes Road Southbound		
Left and Right Turns	C/20.9	C/20.9
Approach	C/20.9	C/20.9

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2006 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.3	A/8.3
Approach		
Hawes Road Southbound		
Left and Right Turns	C/20.6	C/19.3
Approach	C/20.6	C/19.3

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs		
Approach		
Secondary Driveway Southbound		
Left and Right Turns		
Approach		

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs	A/8.3	A/8.2
Approach		
Secondary Driveway Southbound		
Left and Right Turns	C/15.1	C/15.1
Approach	C/15.1	C/15.1

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Westbound		
Left Turns and Throughs	A/8.8	A/9.0
Approach		
Marker Road Northbound		
Left and Right Turns	B/14.3	C/16.0
Approach	B/14.3	C/16.0

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Eastbound		
Left Turns	C/31.1	C/31.5
Right Turns and Throughs	B/16.2	B/14.7
Approach	B/17.9	B/17.0
Route 40 Westbound		
Left Turns	C/28.6	C/28.5
Right Turns and Throughs	B/13.4	B/12.9
Approach	B/13.7	B/13.2
Marker Road Northbound		
Left, Right Turns and Throughs	C/24.3	C/24.2
Approach	C/24.3	C/24.2
Main Driveway Southbound		
Left Turns	C/25.2	C/25.3
Right Turns and Throughs	C/25.1	C/25.2
Approach	C/25.2	C/25.3
Entire Intersection LOS	B/17.0	B/16.4

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.3	A/8.4
Approach		
Smith School Road Southbound		
Left and Right Turns	C/15.3	C/17.5
Approach	C/15.3	C/17.5

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.2	A/8.5
Approach		
Smith School Road Southbound		
Left and Right Turns	C/15.1	C/18.7
Approach	C/15.1	C/18.7

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.3	A/8.2
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/8.8	A/8.8
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	D/27.8	D/33.8
Approach	D/27.8	D/33.8
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	D/31.9	C/24.9
Approach	D/31.9	C/24.9

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2006 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2006 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.3	A/8.1
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/8.7	A/8.7
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	D/27.2	D/30.3
Approach	D/27.2	D/30.3
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	D/31.2	C/23.0
Approach	D/31.2	C/23.0

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.4	B/10.0
Approach		
SR 381S Northbound		
Left and Right Turns	F/59.3	E/38.0
Approach	F/59.3	E/38.0

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381S		
Route 40 Westbound		
Left Turns and Throughs	A/9.3	A/9.8
Approach		
SR 381S Northbound		
Left and Right Turns	F/56.6	D/32.9
Approach	F/56.6	D/32.9

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/9.2	A/9.1
Approach		
SR 381N Southbound		
Left and Right Turns	E/41.6	F/53.3
Approach	E/41.6	F/53.3

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and SR 381N		
Route 40 Eastbound		
Left Turns and Throughs	A/9.1	A/8.9
Approach		
SR381N Southbound		
Left and Right Turns	E/41.3	E/42.2
Approach	E/41.3	E/42.2

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.6	A/8.7
Approach		
Hawes Road Southbound		
Left and Right Turns	D/25.9	C/24.7
Approach	D/25.9	C/24.7

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Hawes Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.5	A/8.5
Approach		
Hawes Road Southbound		
Left and Right Turns	D/25.6	C/22.8
Approach	D/25.6	C/22.8

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs		
Approach		
Secondary Driveway Southbound		
Left and Right Turns		
Approach		

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Secondary Driveway		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.6
Approach		
Secondary Driveway Southbound		
Left and Right Turns	C/16.5	C/18.7
Approach	C/16.5	C/18.7

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Westbound		
Left Turns and Throughs	A/9.0	A/9.3
Approach		
Marker Road Northbound		
Left and Right Turns	C/15.2	C/17.1
Approach	C/15.2	C/17.1

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Marker Road/Main Driveway		
Route 40 Eastbound		
Left Turns	C/31.1	C/31.5
Right Turns and Throughs	B/18.6	B/16.3
Approach	B/19.8	B/18.1
Route 40 Westbound		
Left Turns	C/28.6	C/28.6
Right Turns and Throughs	B/14.2	B/13.5
Approach	B/14.5	B/13.8
Marker Road Northbound		
Left, Right Turns and Throughs	C/24.3	C/24.2
Approach	C/24.3	C/24.2
Main Driveway Southbound		
Left Turns	C/25.2	C/25.3
Right Turns and Throughs	C/25.1	C/25.3
Approach	C/25.2	C/25.3
Entire Intersection LOS	B/18.3	B/17.2

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITHOUT DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.6
Approach		
Smith School Road Southbound		
Left and Right Turns	C/16.7	C/20.0
Approach	C/16.7	C/20.0

TABLE 5
INTERSECTION LEVEL OF SERVICE SUMMARY
2016 CONDITIONS WITH DEVELOPMENT
ROUTE 40
Wharton Township, Fayette County, Pennsylvania
Prepared by: McMillen Engineering Inc.

	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Smith School Road		
Route 40 Eastbound		
Left Turns and Throughs	A/8.4	A/8.5
Approach		
Smith School Road Southbound		
Left and Right Turns	C/16.4	C/18.9
Approach	C/16.4	C/18.9

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITHOUT DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions Without Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.4	A/8.4
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/9.0	A/9.0
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	E/35.3	E/48.4
Approach	E/35.3	E/48.4
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	E/44.4	D/31.8
Approach	E/44.4	D/31.8

TABLE 5 INTERSECTION LEVEL OF SERVICE SUMMARY 2016 CONDITIONS WITH DEVELOPMENT ROUTE 40 Wharton Township, Fayette County, Pennsylvania Prepared by: McMillen Engineering Inc.		
	Level of Service/Average Seconds of Delay (Signalized Intersections) or Reserve Capacity (Un-signalized Intersections) 2016 Conditions With Development	
Intersection/Approach/Movement	Weekday Peak PM	Saturday Peak Hour
Route 40 and Dinner Bell Road		
Route 40 Eastbound		
Left, Right Turns and Throughs	A/8.4	A/8.3
Approach		
Route 40 Westbound		
Left, Right Turns and Throughs	A/8.9	A/8.9
Approach		
Dinner Bell Road Northbound		
Left, Right Turns and Throughs	D/34.6	E/41.8
Approach	D/34.6	E/41.8
Dinner Bell Road Southbound		
Left, Right Turns and Throughs	E/42.8	D/28.7
Approach	E/42.8	D.28.7

IV. DESIGN CONDITIONS

A. Design Year and Assumptions

The future year of 2016 was selected as the design year based upon the PaDOT policy of designing improvements for ten years beyond the proposed development. Additional assumptions include the traffic growth rate, current Transportation Improvement Program (TIP) items, and traffic volumes generated by other developments in the study area or close vicinity.

The traffic growth rate was obtained from the Southwestern Pennsylvania Regional Planning Commission (SPC).

B. Left-Turn Lane Analysis

The need for left turn lanes at each of the study intersections were evaluated based on the criteria proved in the Intersection Channelization Guide, NCHRP Report 279, published by the Transportation Research Board. The proposed site driveway meets the requirements of a left turn lane.

C. Development Scenarios on Proposed Roadway Improvements

The recommended roadway improvements outlined in Section IV D and shown in Figure 3 were developed based on projected full development.

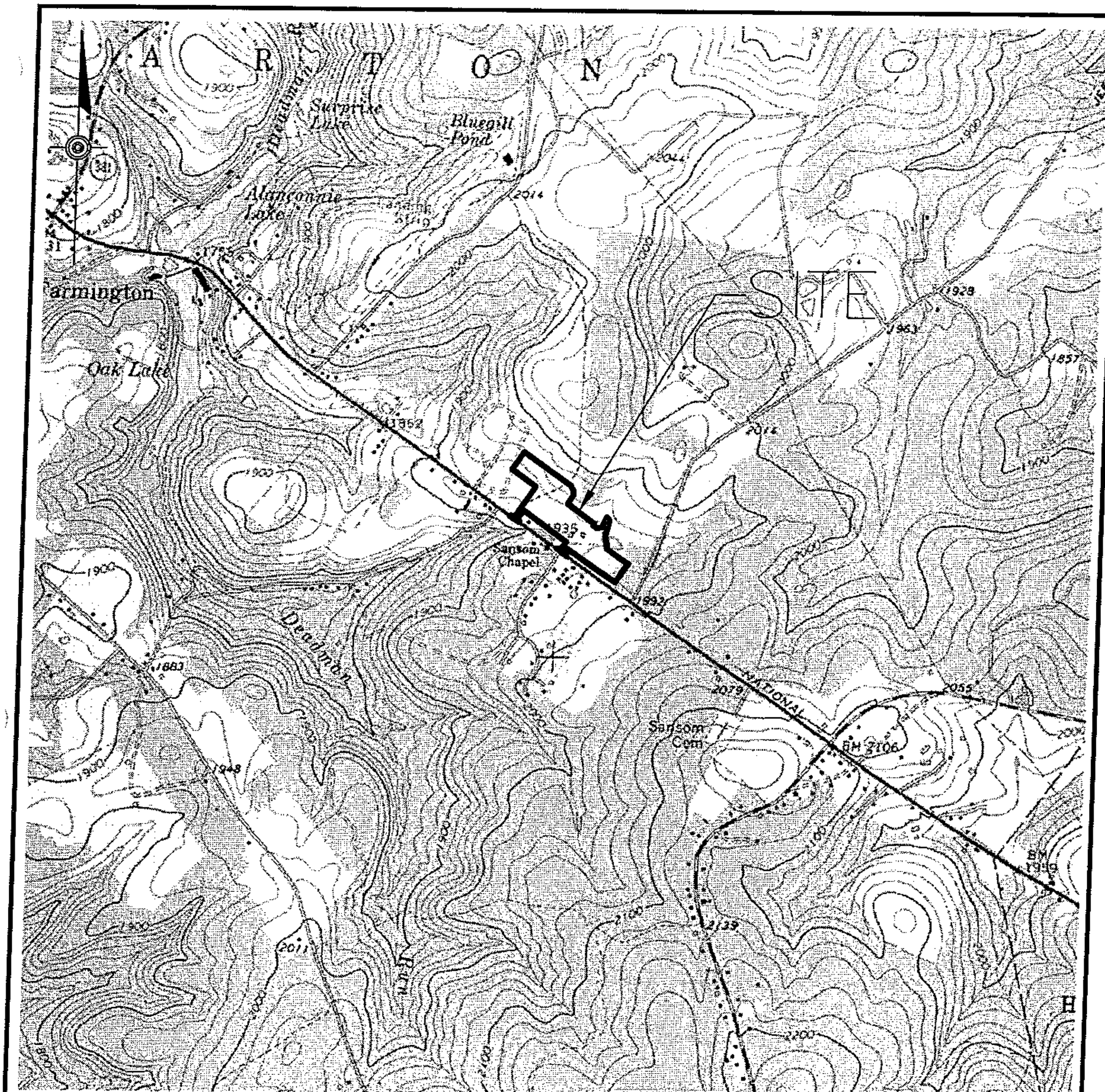
Final roadway improvement details will be determined as part of final development and design.

D. Recommendations

McMillen Engineering recommends the improvements to the corridor as outlined in the analysis and this report. The improvements include:

1. **SR 0040 / Casino (Main) Driveway**
   - Install medium volume signalized driveway with left turn lanes for both Route 40 approaches.

FIGURES



QUADRANGLE: FORT NECESSITY, PA

SCALE: 1"=2000'

FIGURE 1

USGS LOCATION MAP

NWL - OUTDOOR STORE RENOVATION

Wharton Township

Fayette County

Pennsylvania

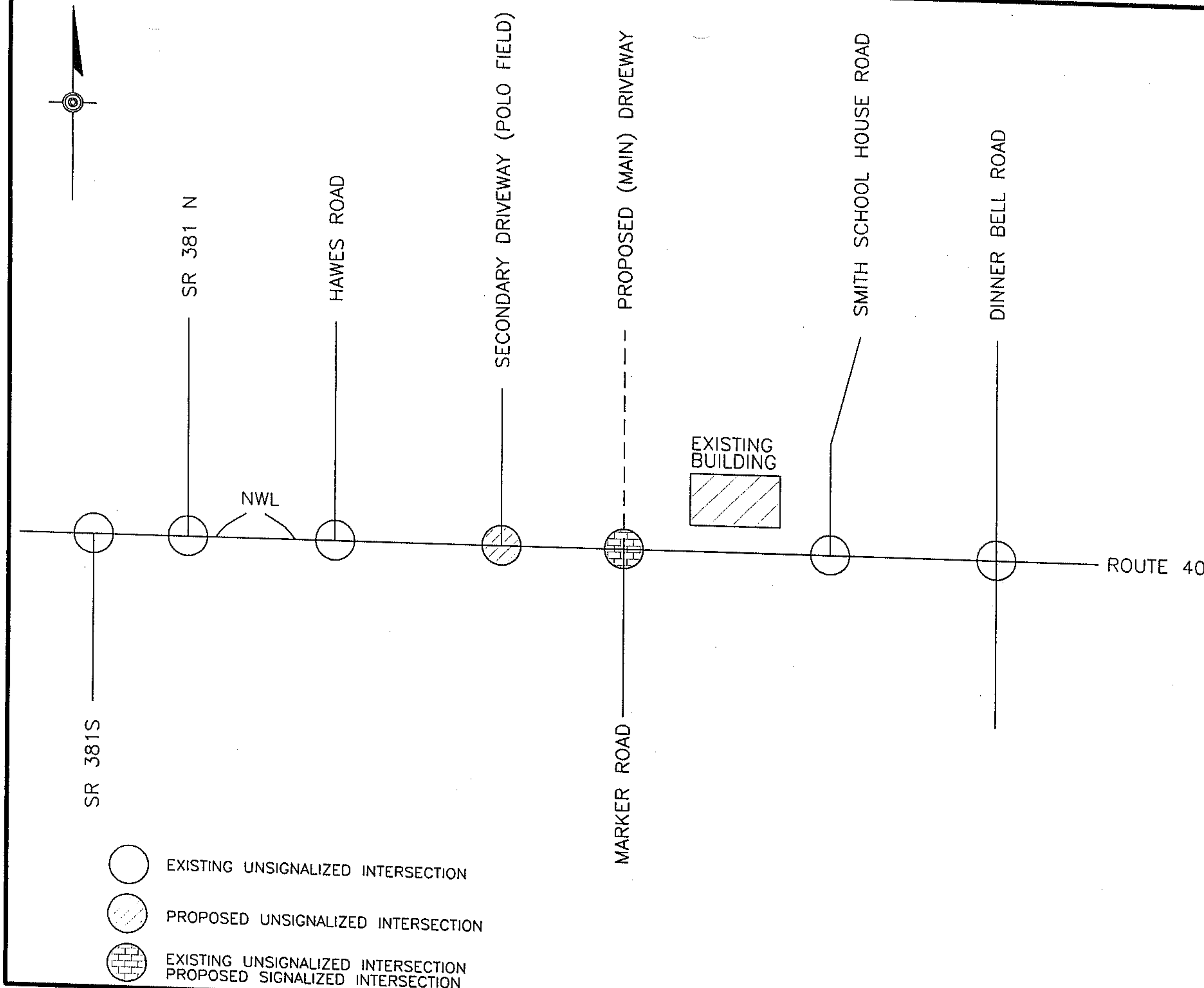
Prepared by

McMILLEN ENGINEERING

CIVIL ENGINEERS/LAND SURVEYORS

115 Wayland Smith Drive, Uniontown, PA 15401

Phone (724) 439-8110



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY

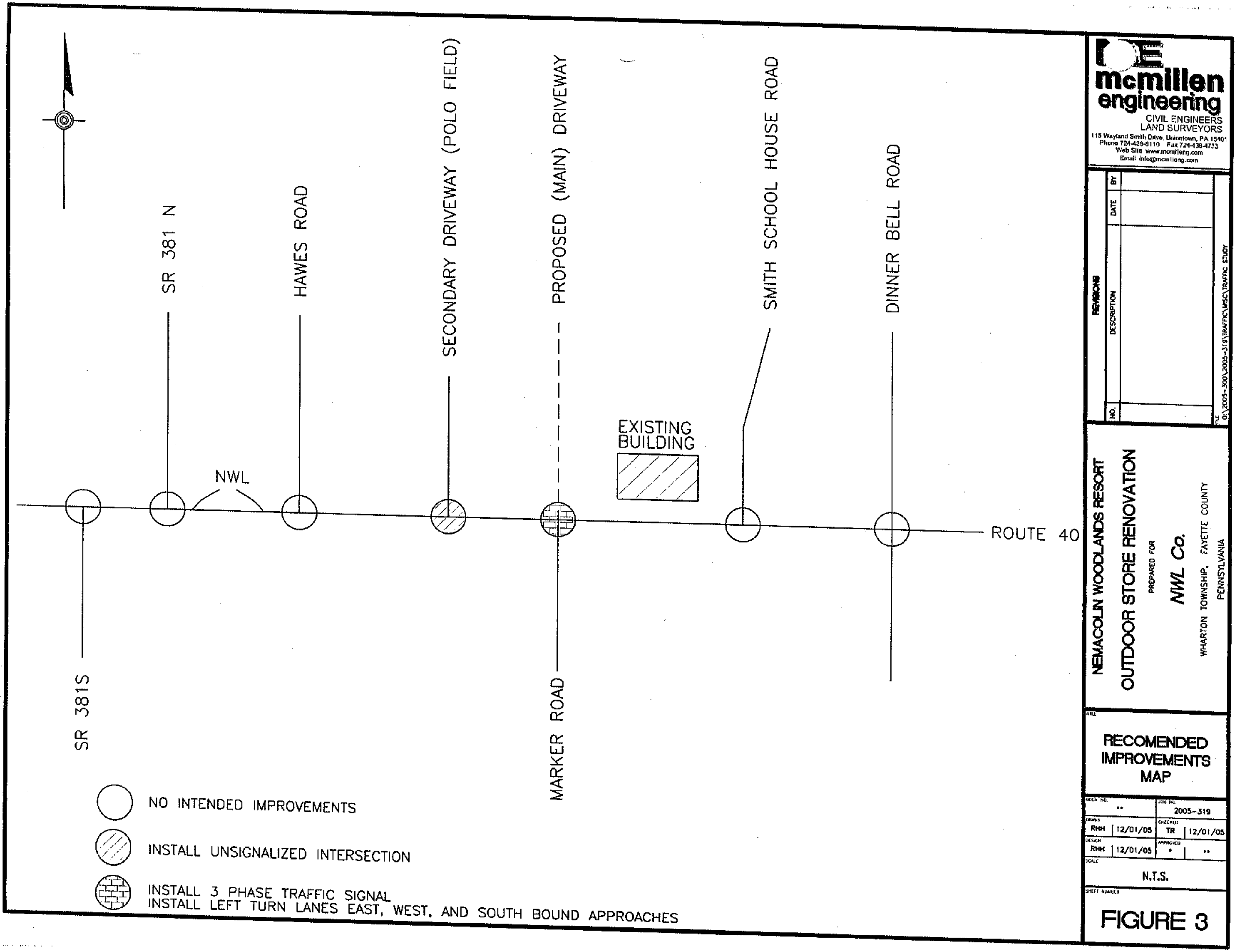
FILE: G:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

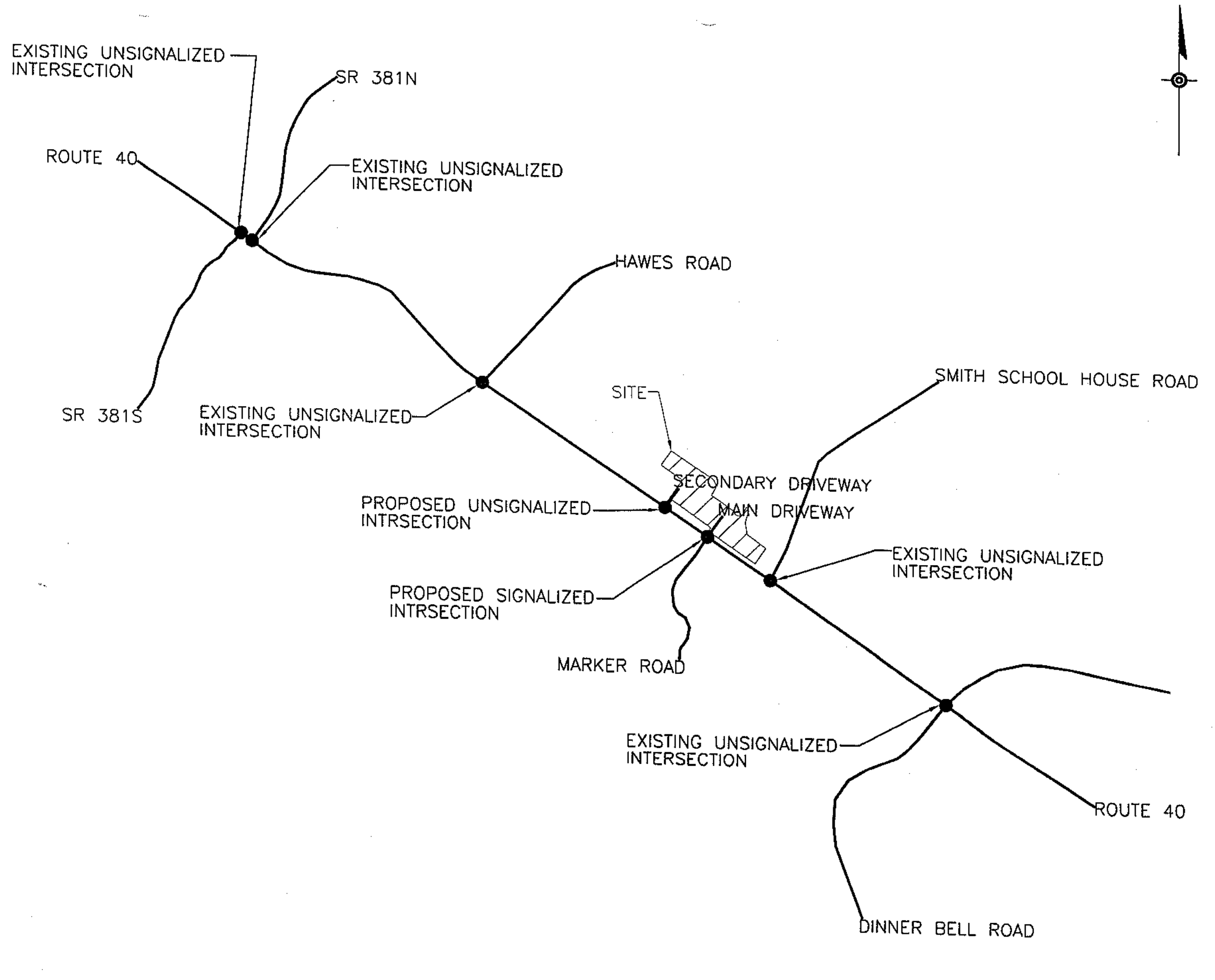
NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE RENOVATION
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
TRAFFIC ANALYSIS
AREA MAP

BOOK NO. **	JOB NO. 2005-319
DRAWN RMH 12/01/05	CHECKED TR 12/01/05
DESIGN RMH 12/01/05	APPROVED * **
SCALE N.T.S.	

SHEET NUMBER
FIGURE 2


SR 381 N
HAWES ROAD
SECONDARY DRIVEWAY (POLO FIELD)
PROPOSED (MAIN) DRIVEWAY
SMITH SCHOOL HOUSE ROAD
DINNER BELL ROAD
NWL
EXISTING BUILDING
ROUTE 40
SR 381S
MARKER ROAD
NO INTENDED IMPROVEMENTS
INSTALL UNSIGNALIZED INTERSECTION
INSTALL 3 PHASE TRAFFIC SIGNAL
INSTALL LEFT TURN LANES EAST, WEST, AND SOUTH BOUND APPROACHES
mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com
REVISIONS
NO.
DESCRIPTION
DATE
BY
FILE
O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY
NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE RENOVATION
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA
TITLE
RECOMENDED IMPROVEMENTS MAP
BOOK NO. **
JOB NO. 2005-319
DRAWN RHH 12/01/05
CHECKED TR 12/01/05
DESIGN RHH 12/01/05
APPROVED * **
SCALE N.T.S.
SHEET NUMBER
FIGURE 3



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
.	.	.	.

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE RENOVATION

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

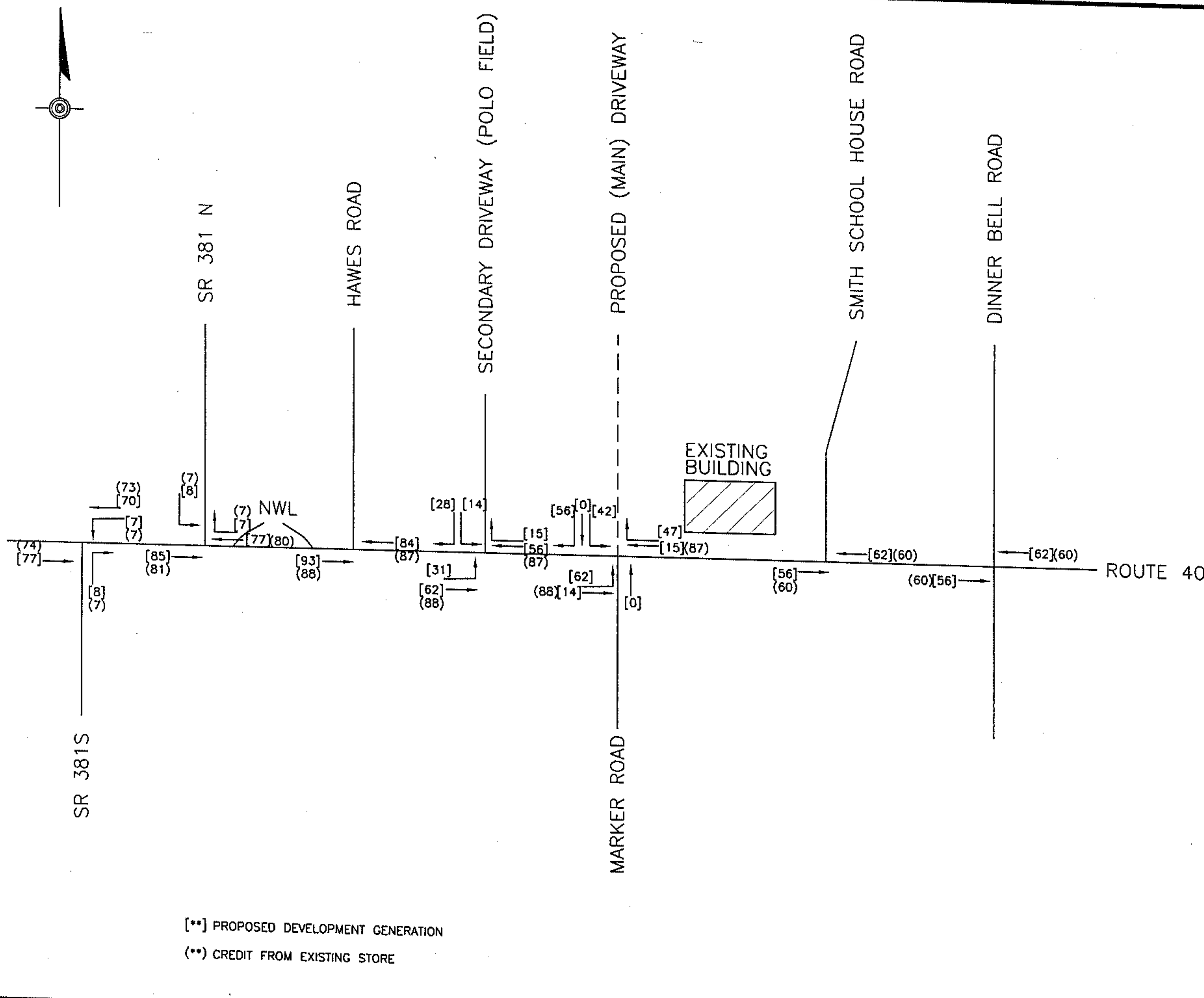
TITLE

TRANSPORTATION PLAN

BOOK NO. **	JOB NO. 2005-319
DRAWN RHH 11/23/05	CHECKED TR 11/23/05
DESIGN RHH 11/23/05	APPROVED * **
SCALE N.T.S.	

SHEET NUMBER

FIGURE 4



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

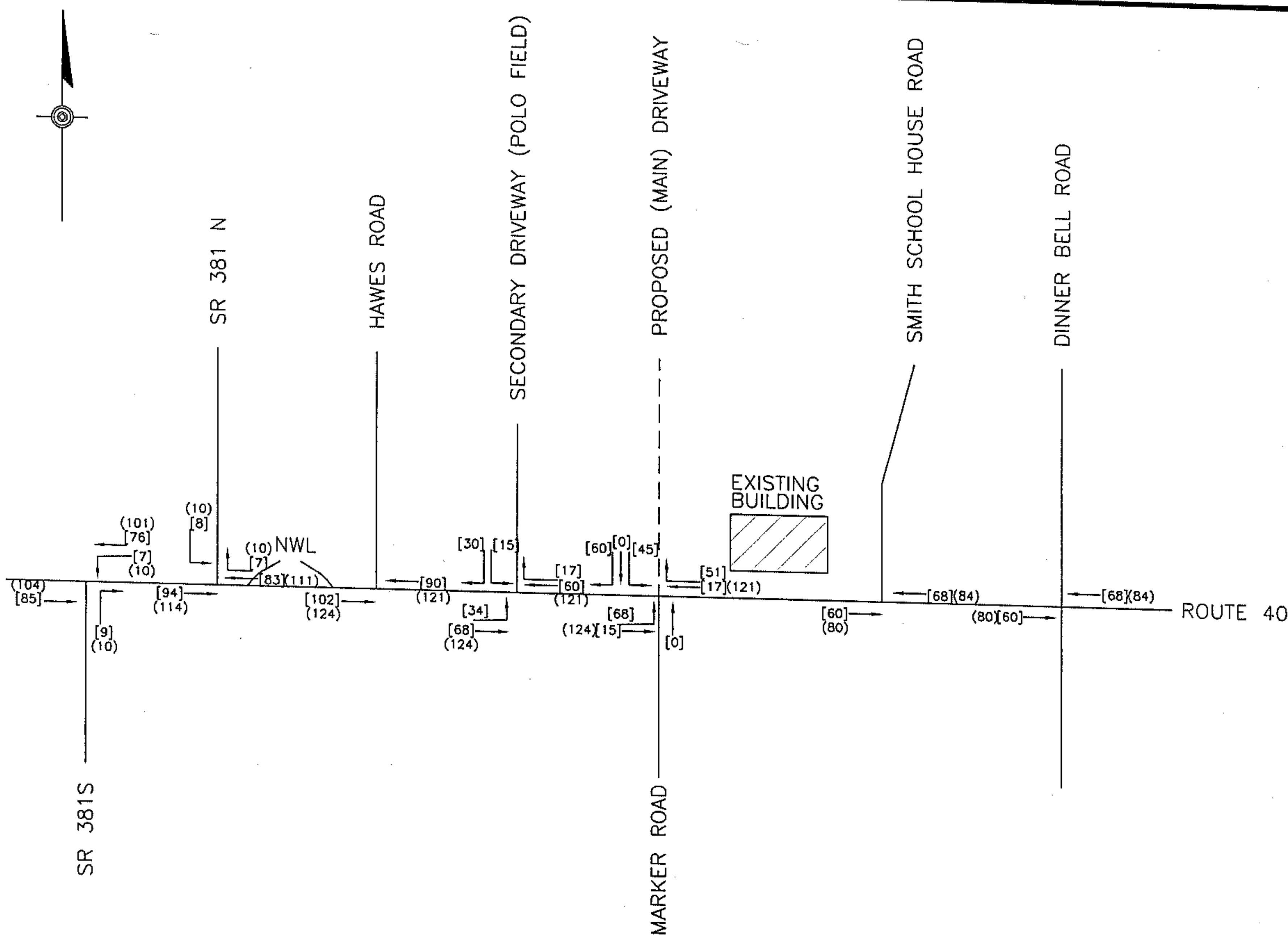
FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
WEEKDAY PM DISTRIBUTION MAP

BOOK NO. **		JOB NO. 2005-319	
DRAWN RHH	11/23/05	CHECKED TR	11/23/05
DESIGN RHH	11/23/05	APPROVED *	**
SCALE N.T.S.			

SHEET NUMBER
FIGURE 5A



[**] PROPOSED DEVELOPMENT GENERATION

(**) CREDIT FROM EXISTING STORE

mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

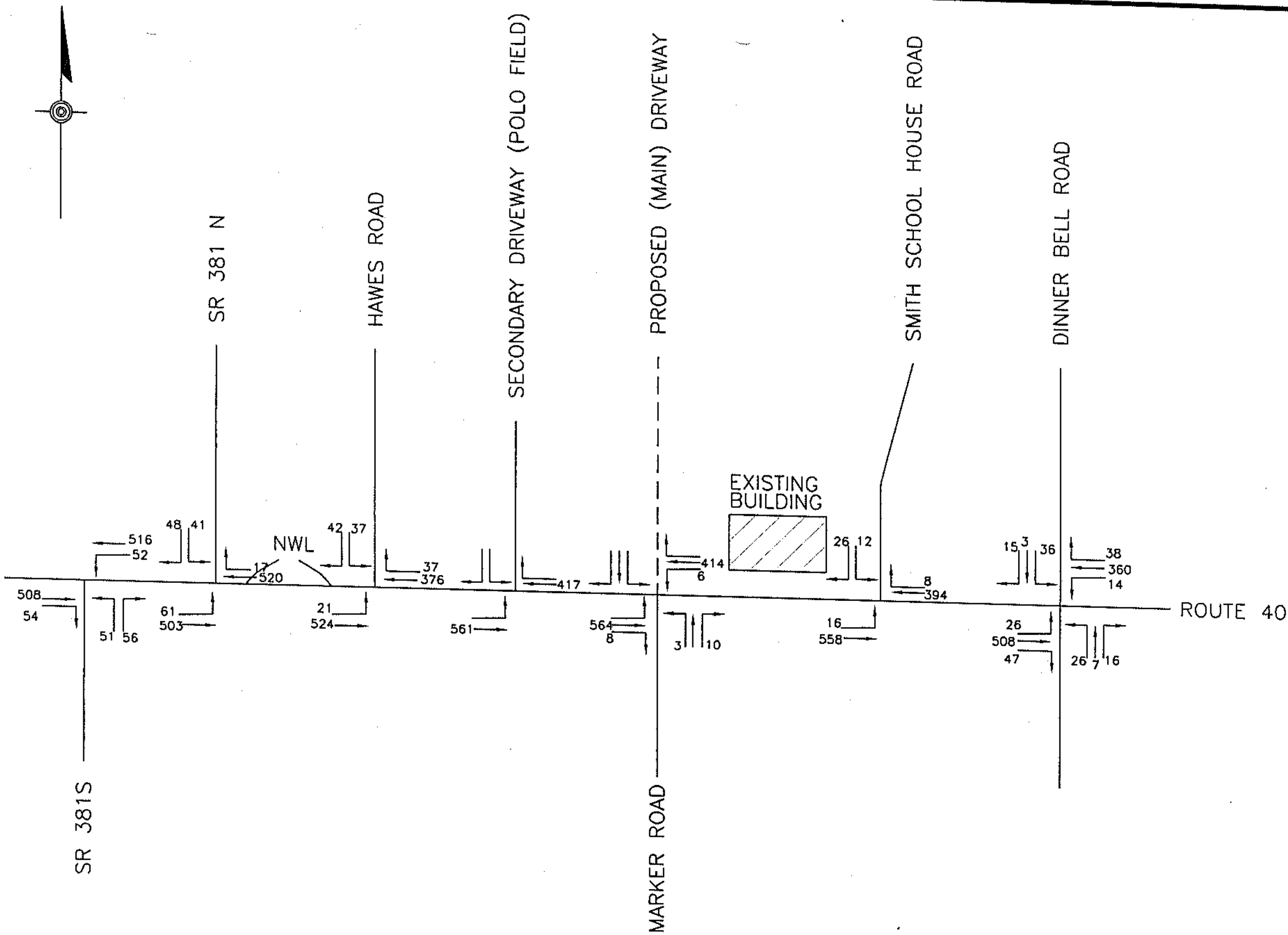
REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

FILE: O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
SATURDAY DISTRIBUTION MAP

BOOK NO. **	JOB NO. 2005-319
DRAWN RHH 11/23/05	CHECKED TR 11/23/05
DESIGN RHH 11/23/05	APPROVED * **
SCALE N.T.S.	
SHEET NUMBER FIGURE 5B	



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
1.			

FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

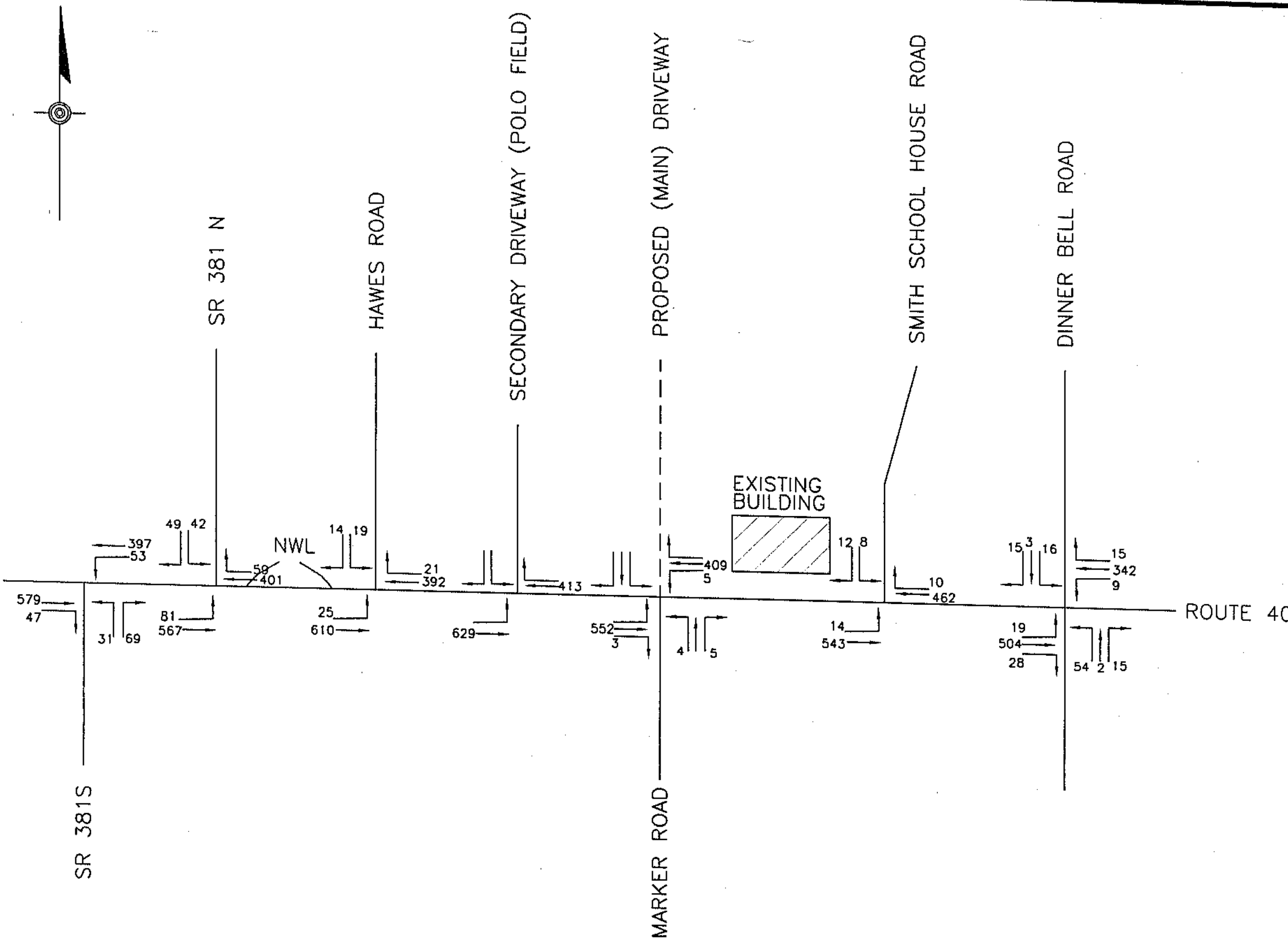
NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 WEEKDAY PM PEAK HOUR BASE VOLUMES

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **

SCALE N.T.S.

SHEET NUMBER
FIGURE 6A



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

FILE: O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

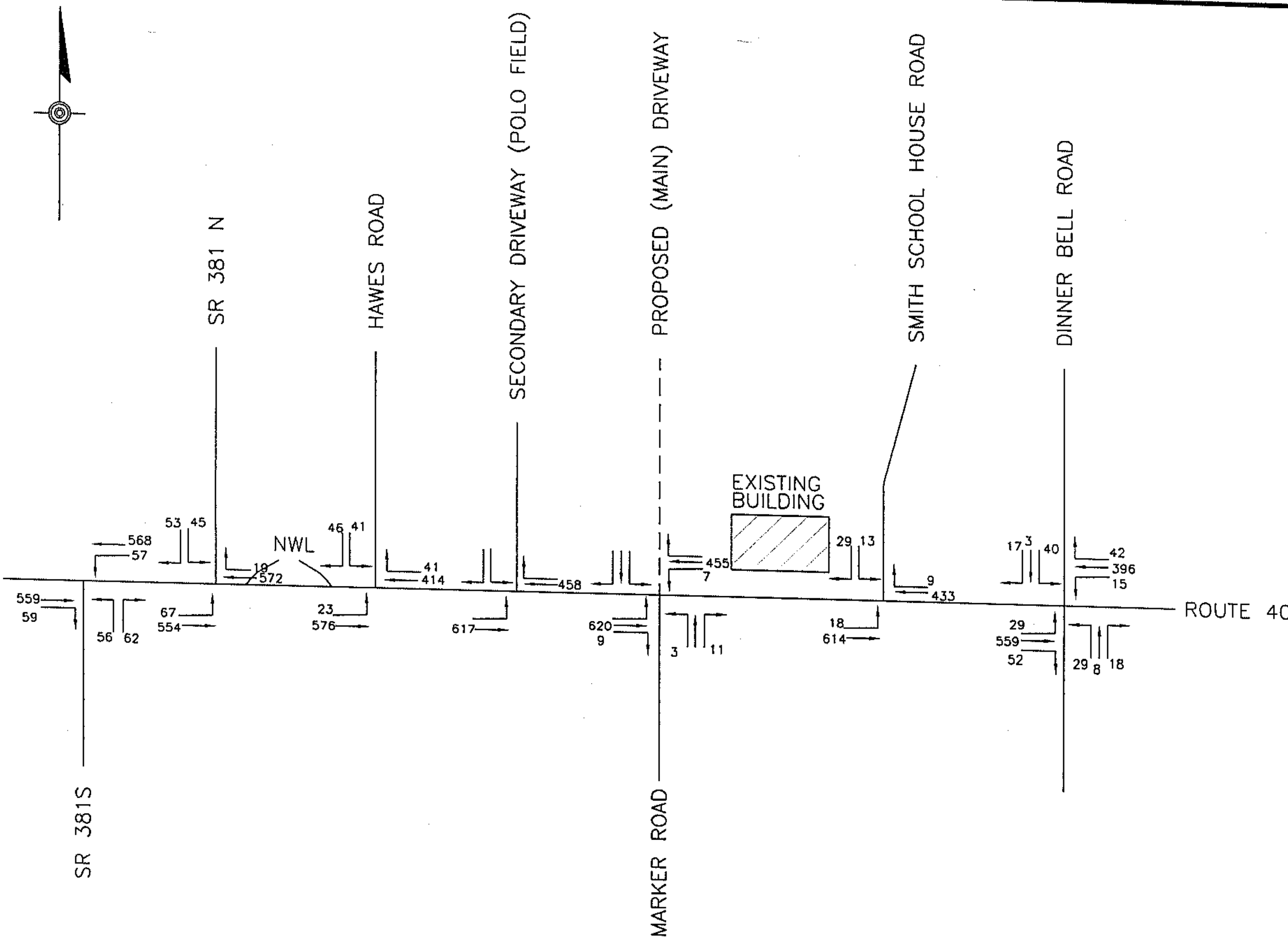
TITLE

2006 SATURDAY PEAK HOUR BASE VOLUMES

BOOK NO. **		JOB NO. 2005-319	
DRAWN RHH	11/23/05	CHECKED TR	11/23/05
DESIGN RHH	11/23/05	APPROVED *	**
SCALE N.T.S.			

SHEET NUMBER

FIGURE 6B



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1			

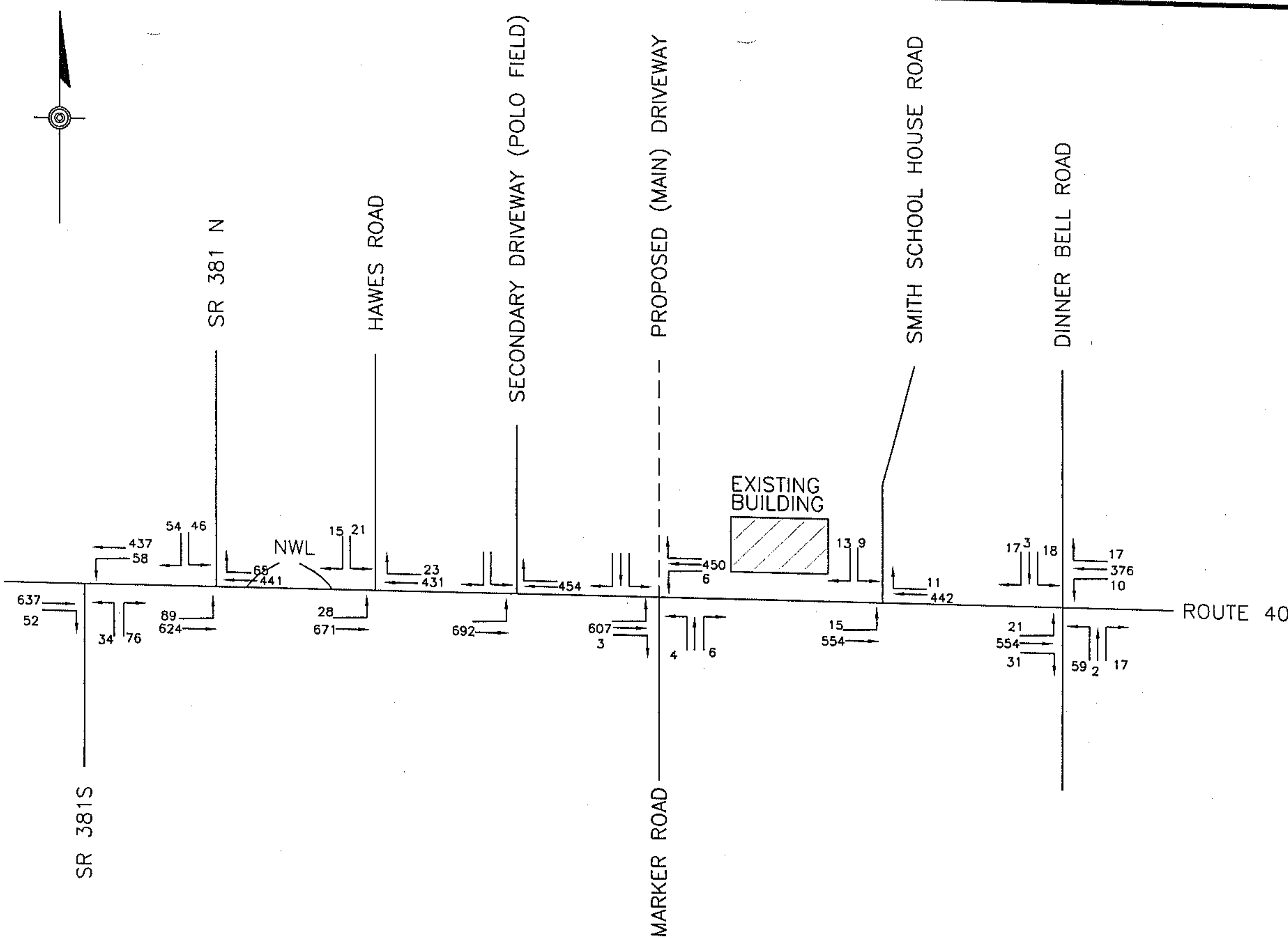
FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2016 WEEKDAY PM PEAK HOUR BASE VOLUMES

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER
FIGURE 6C



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1			

FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

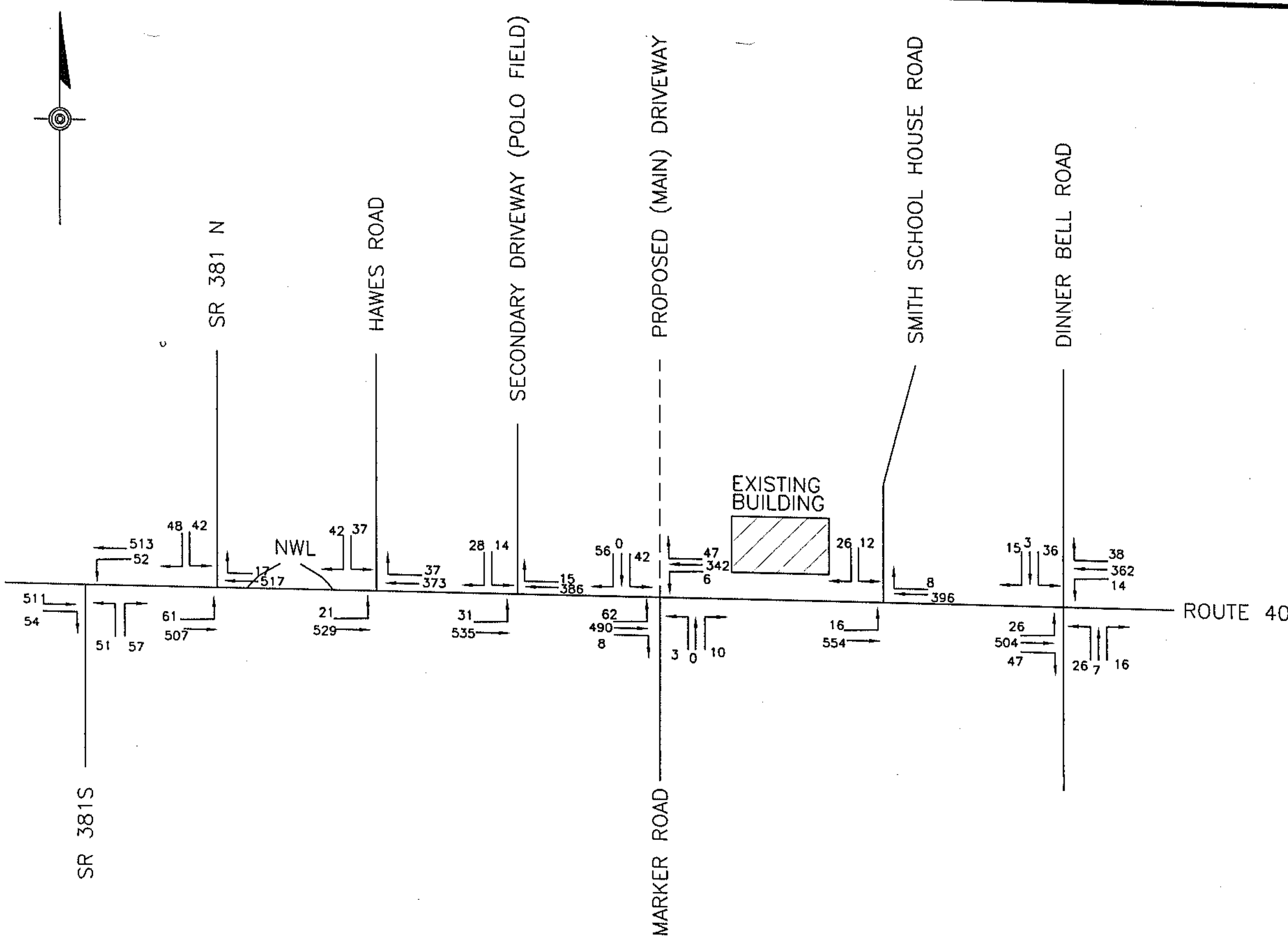
NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2016 SATURDAY PEAK HOUR BASE VOLUMES

BOOK NO. **	JOB NO. 2005-319
DRAWN RHH 11/23/05	CHECKED TR 11/23/05
DESIGN RHH 11/23/05	APPROVED * **

SCALE N.T.S.

SHEET NUMBER
FIGURE 6D



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
1.			

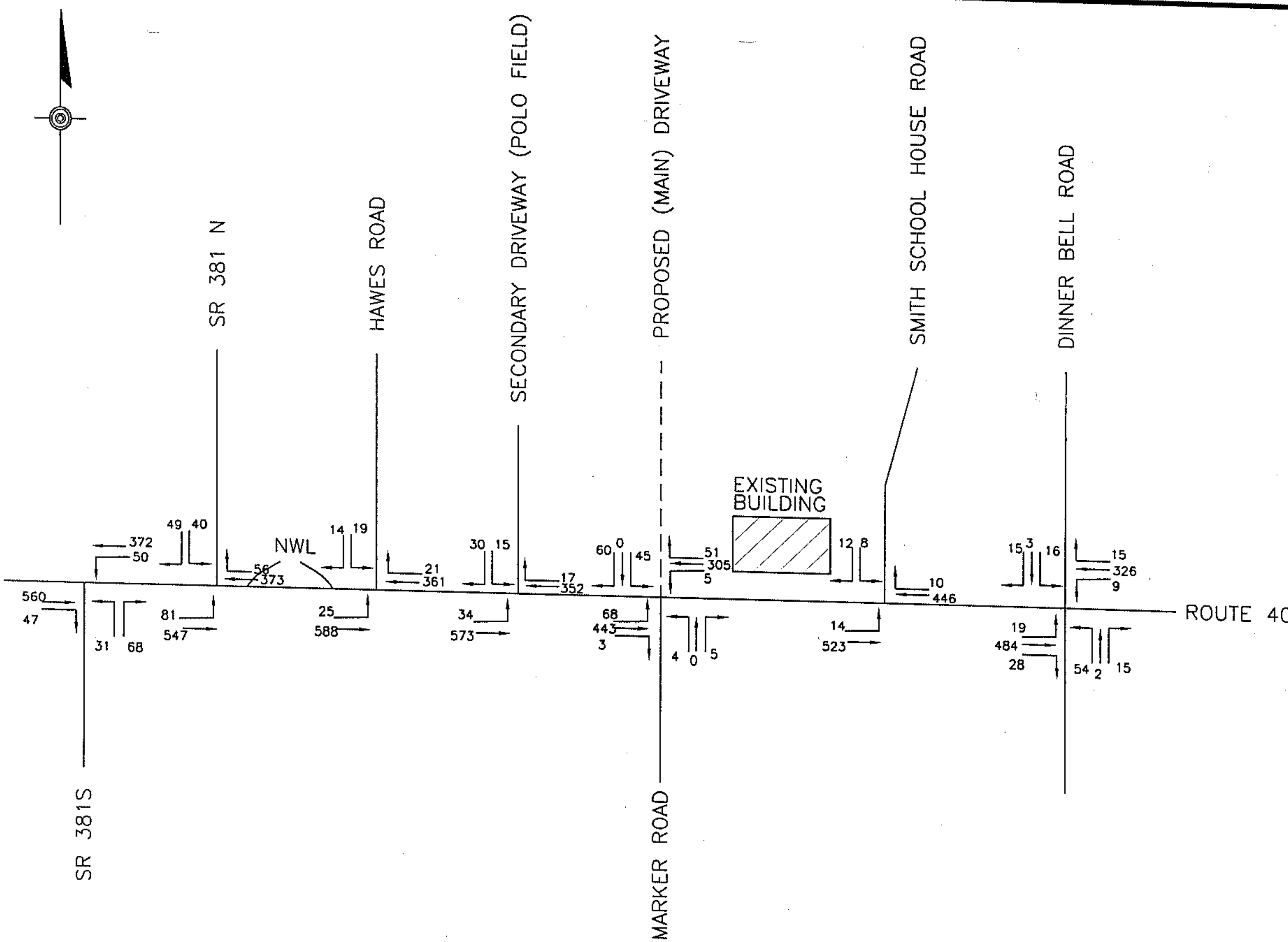
FILE: O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 WEEKDAY PM PEAK HOUR DEVELOPED VOLUMES

DOUR NO. **		JOB NO. 2005-319	
DRAWN RHH	11/23/05	CHECKED TR	11/23/05
DESIGN RHH	11/23/05	APPROVED *	**
SCALE N.T.S.			

SHEET NUMBER
FIGURE 7A



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
-			

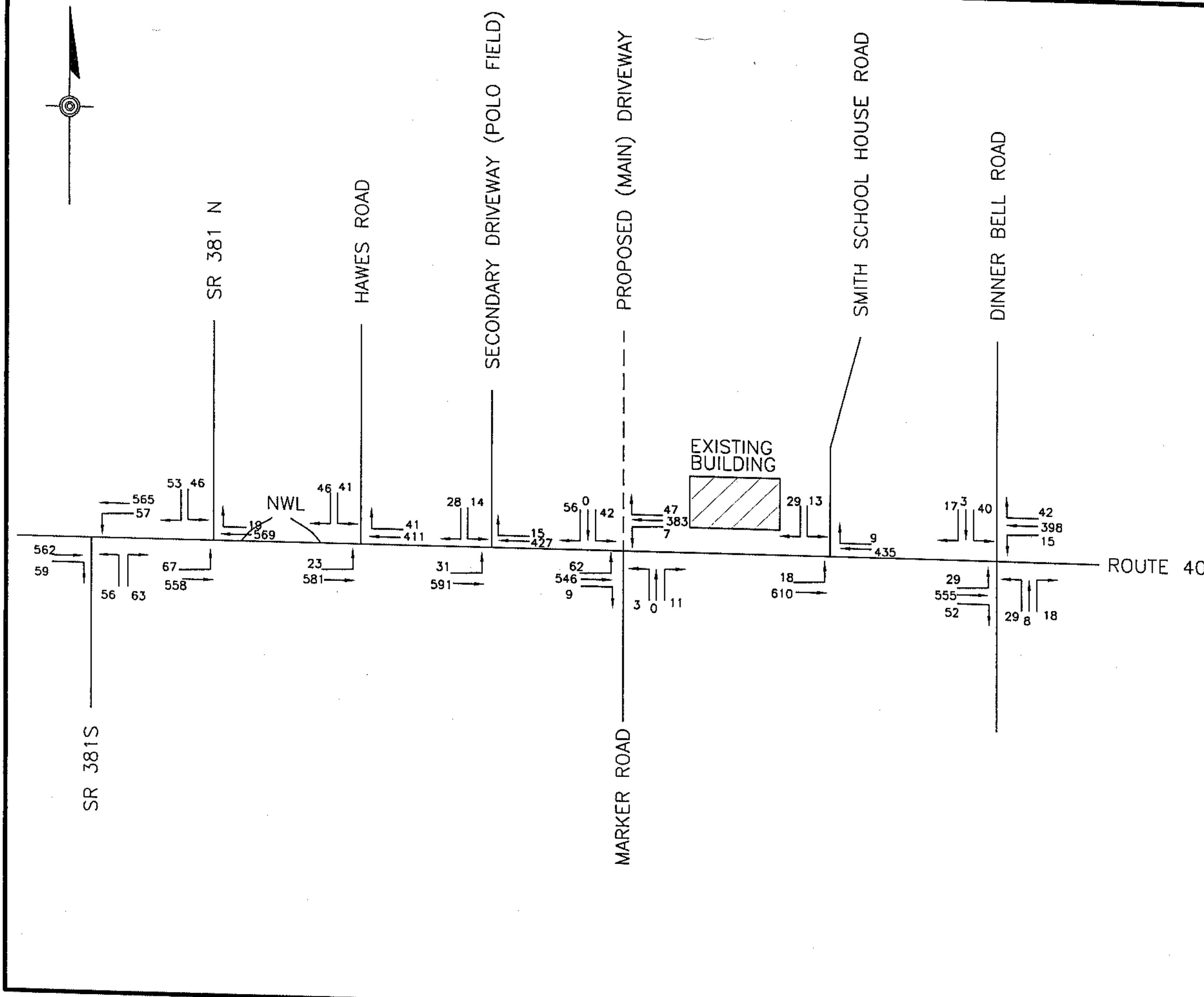
FILE O:\2005-300\2005-319\TRAFFIC\MSC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 SATURDAY PEAK HOUR DEVELOPED VOLUMES

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER
FIGURE 7B



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

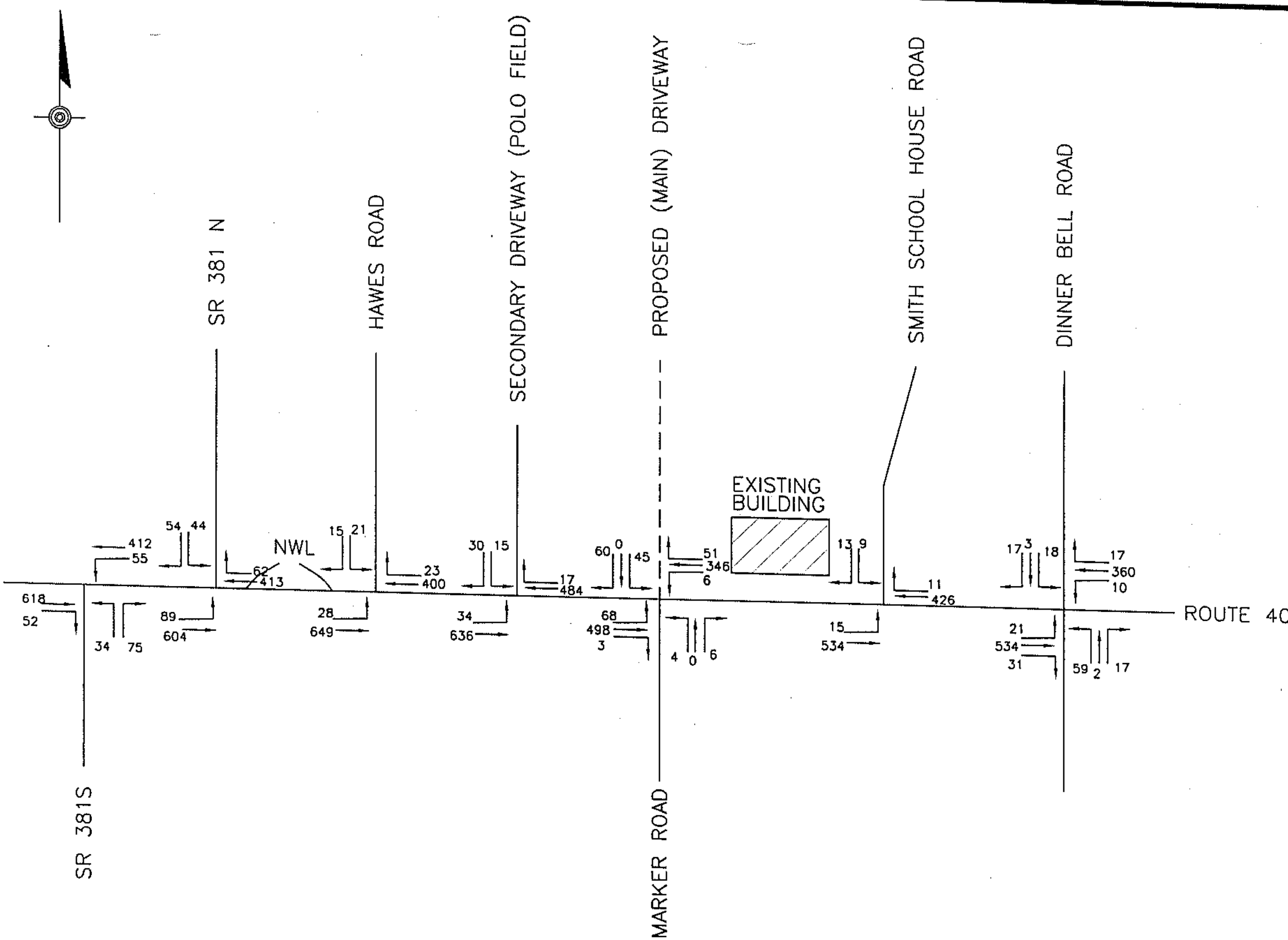
FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2016 WEEKDAY PM PEAK HOUR DEVELOPED VOLUMES

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER
FIGURE 7C



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
-			

FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

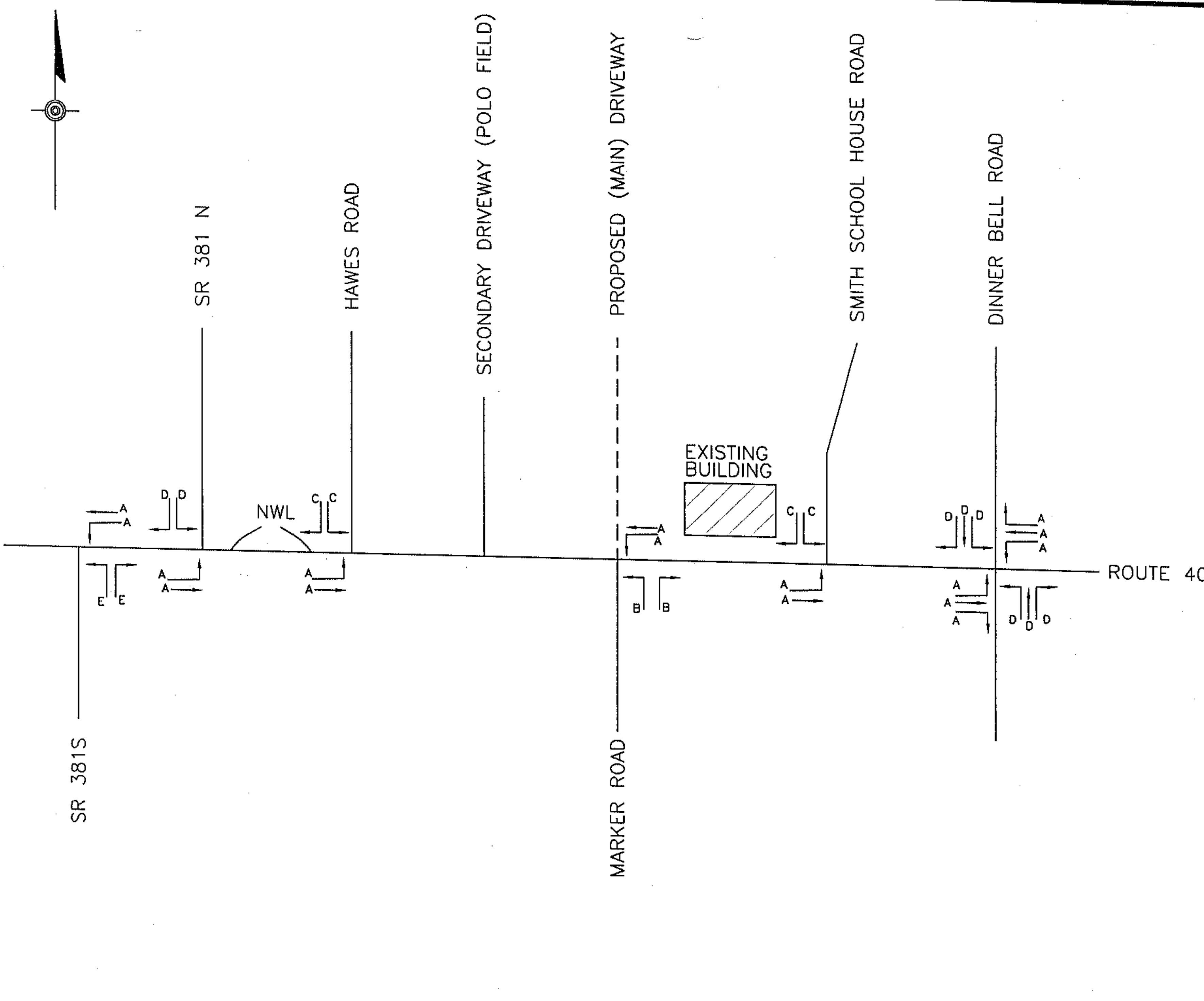
TITLE

2016 SATURDAY PEAK HOUR DEVELOPED VOLUMES

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER

FIGURE 7D



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
1.			

FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

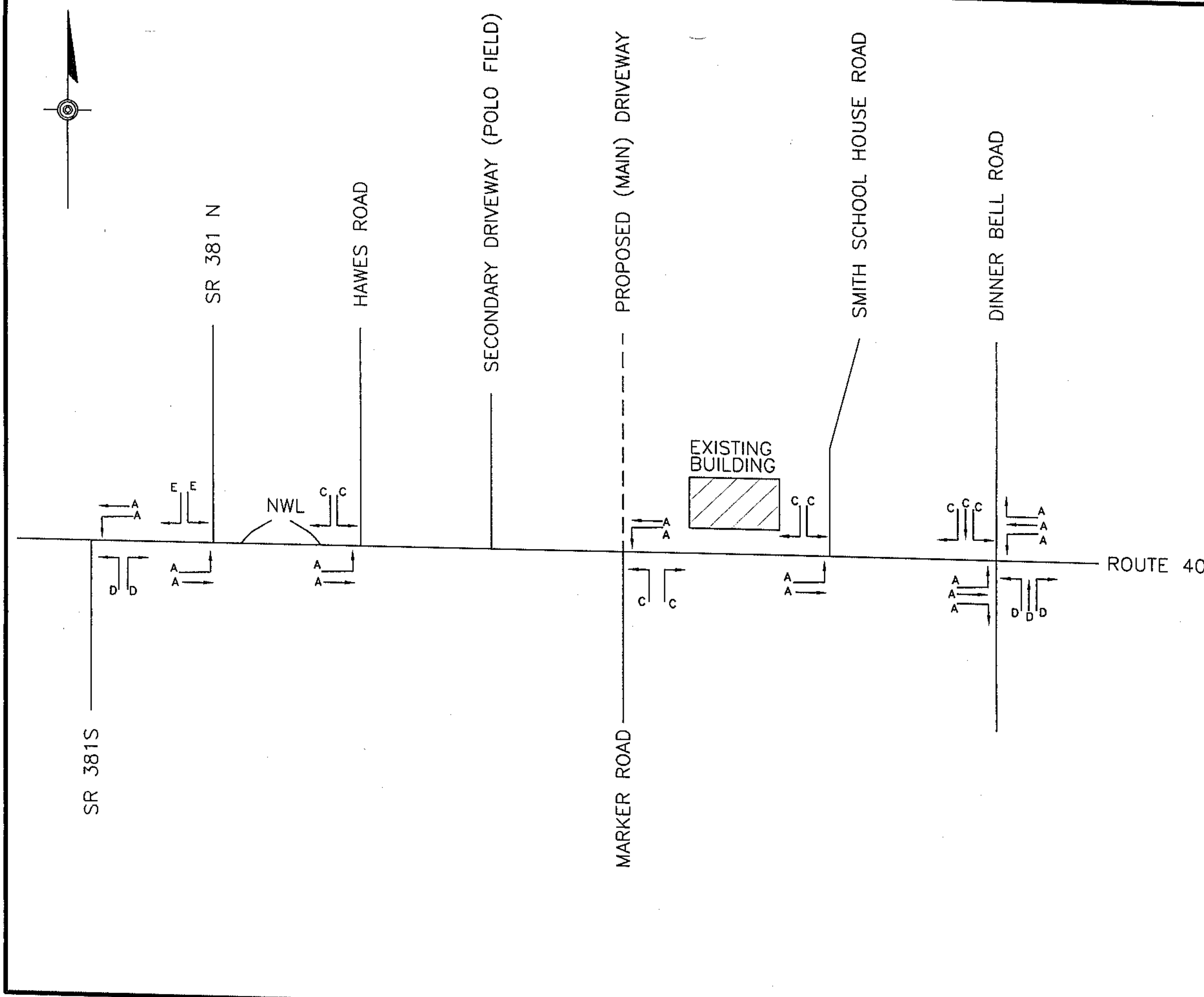
NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 WEEKDAY PM
PEAK HOUR BASE
LEVEL OF SERVICE

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **

SCALE N.T.S.

SHEET NUMBER
FIGURE 8A



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

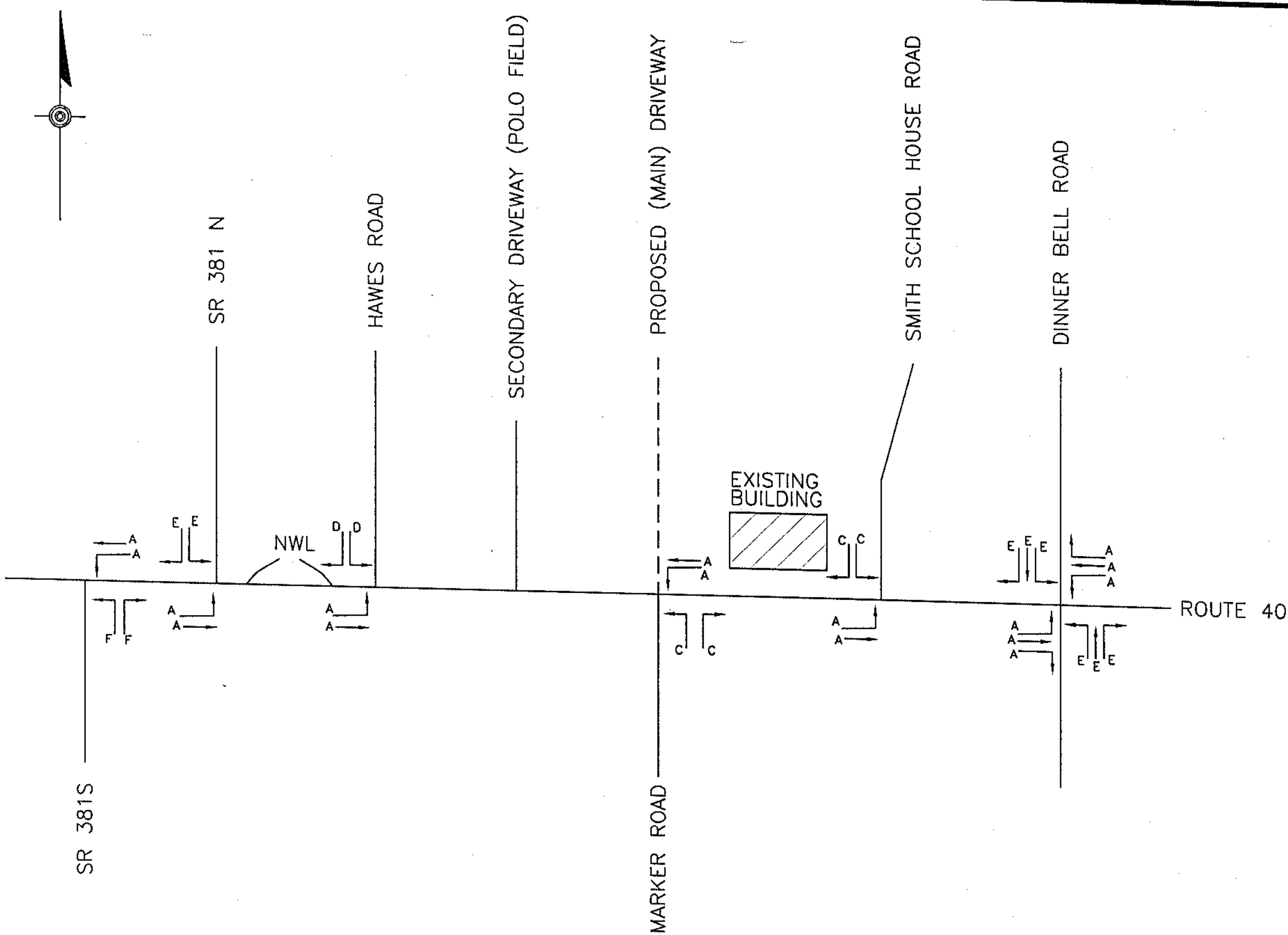
FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 SATURDAY PEAK HOUR BASE LEVEL OF SERVICE

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER
FIGURE 8B



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

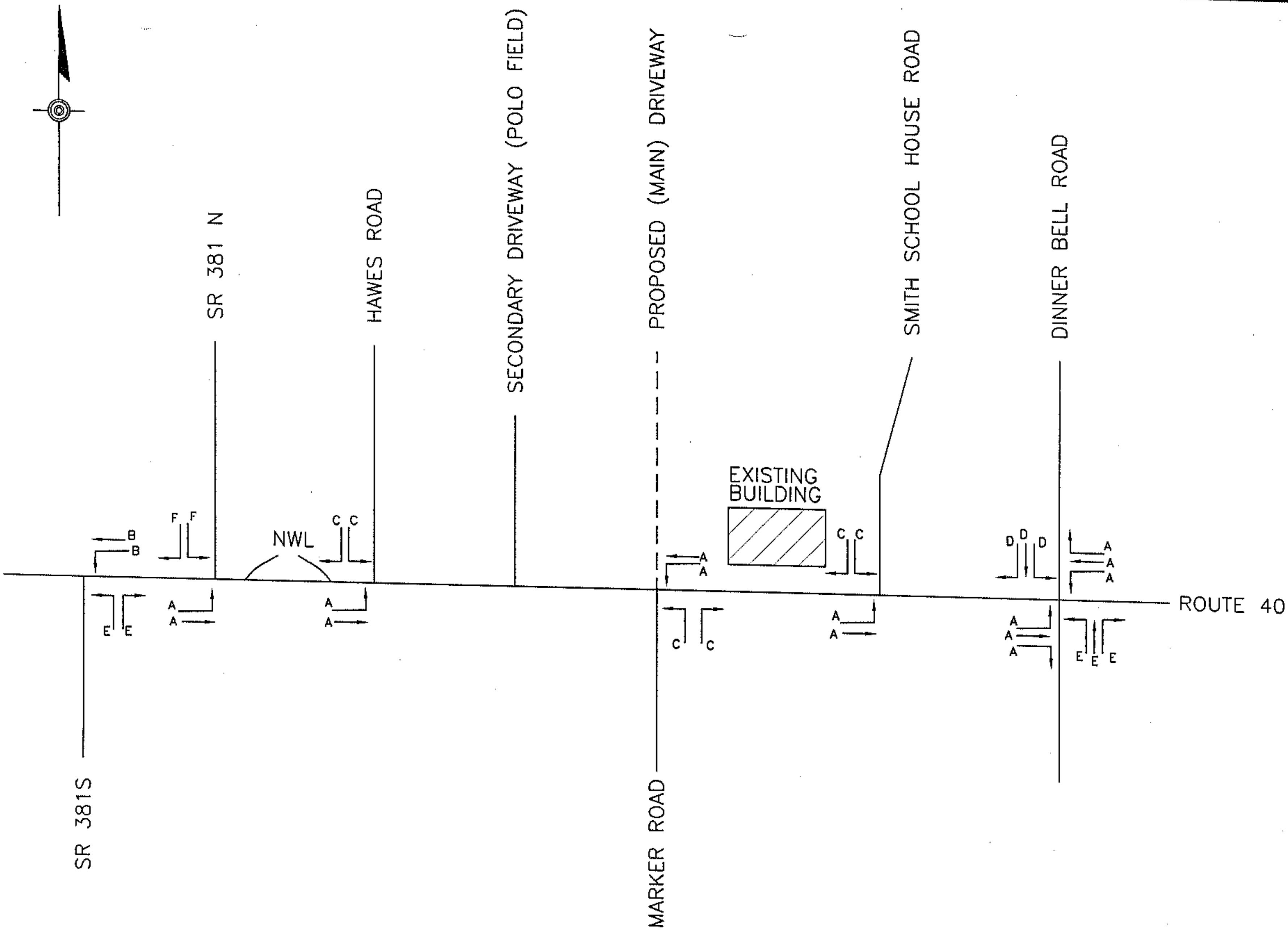
FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2016 WEEKDAY PM PEAK HOUR BASE LEVEL OF SERVICE

BOOK NO. **		JOB NO. 2005-319	
DRAWN RHH	11/23/05	CHECKED TR	11/23/05
DESIGN RHH	11/23/05	APPROVED *	**
SCALE N.T.S.			

SHEET NUMBER
FIGURE 8C



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
--			

FILE: O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT

OUTDOOR STORE

PREPARED FOR

NWL Co.

WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

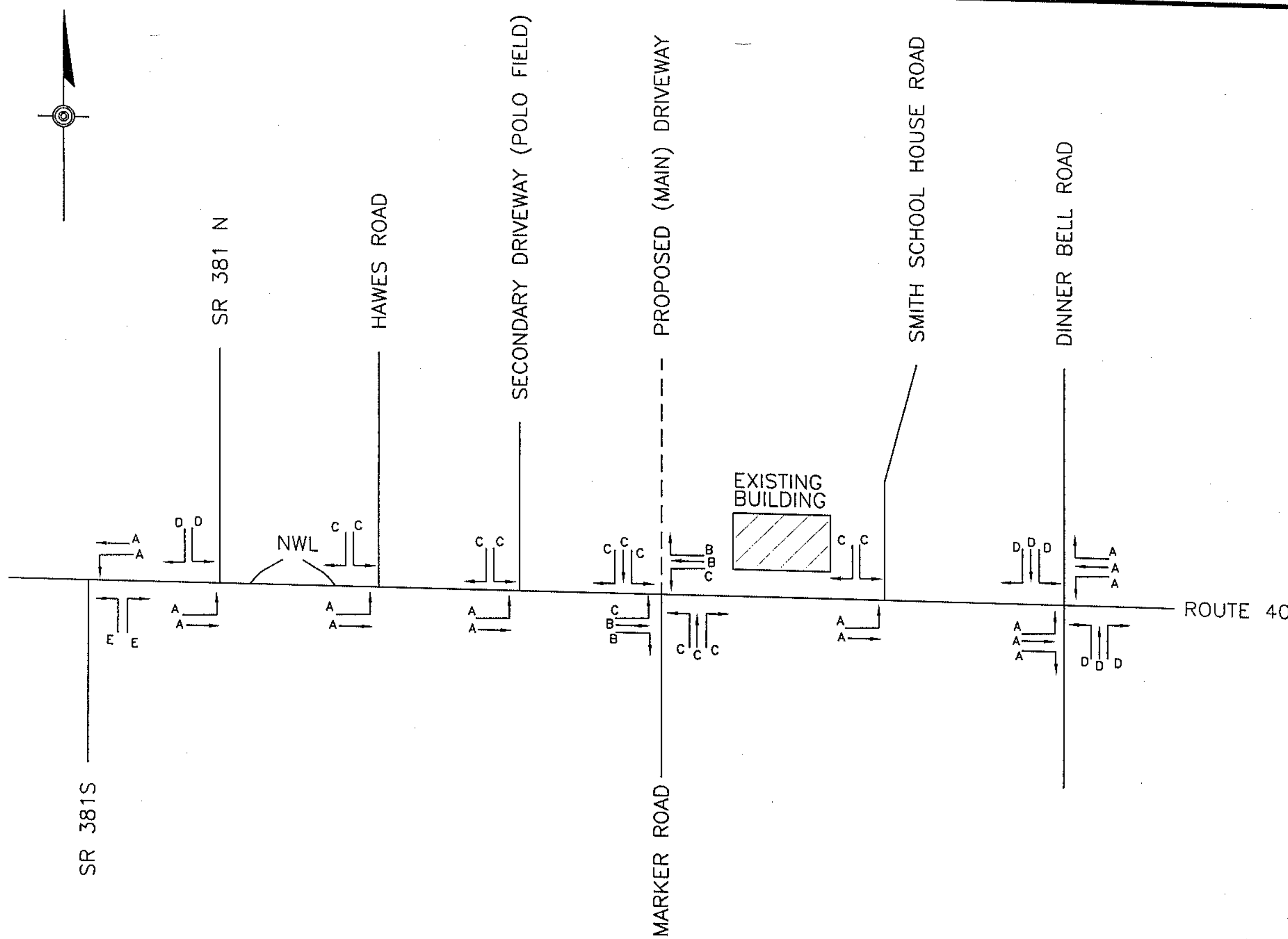
TITLE

2016 SATURDAY PEAK HOUR BASE LEVEL OF SERVICE

BOOK NO.	**		JOB NO.	2005-319	
DRAWN	RHH	11/23/05	CHECKED	TR	11/23/05
DESIGN	RHH	11/23/05	APPROVED	*	**
SCALE	N.T.S.				

SHEET NUMBER

FIGURE 8D



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
1.			

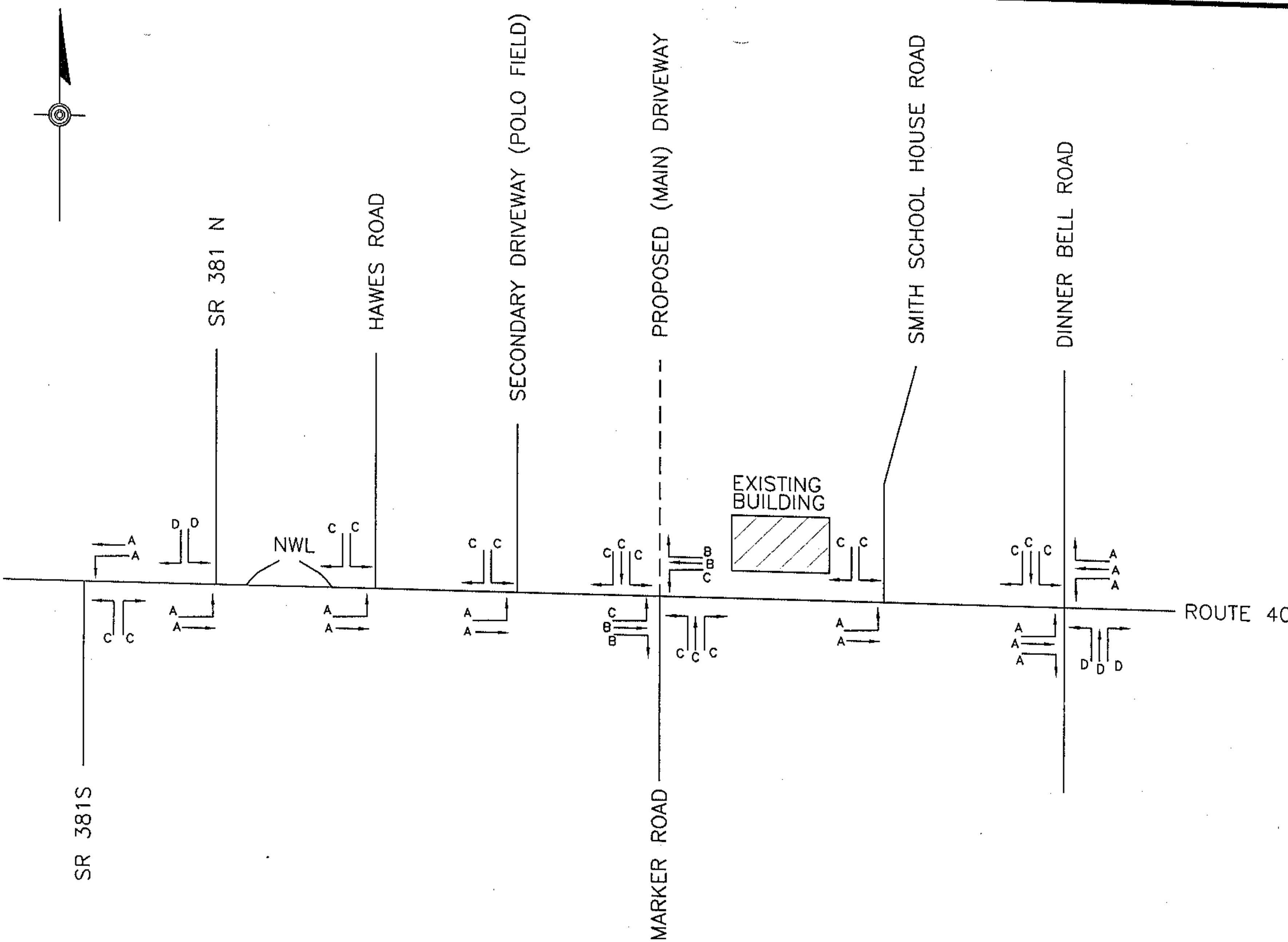
FILE O:\2005-300\2005-319\TRAFFIC\MSC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 WEEKDAY PM PEAK HOUR DEVELOPED LEVEL OF SERVICE

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER
FIGURE 9A



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
1.			

FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

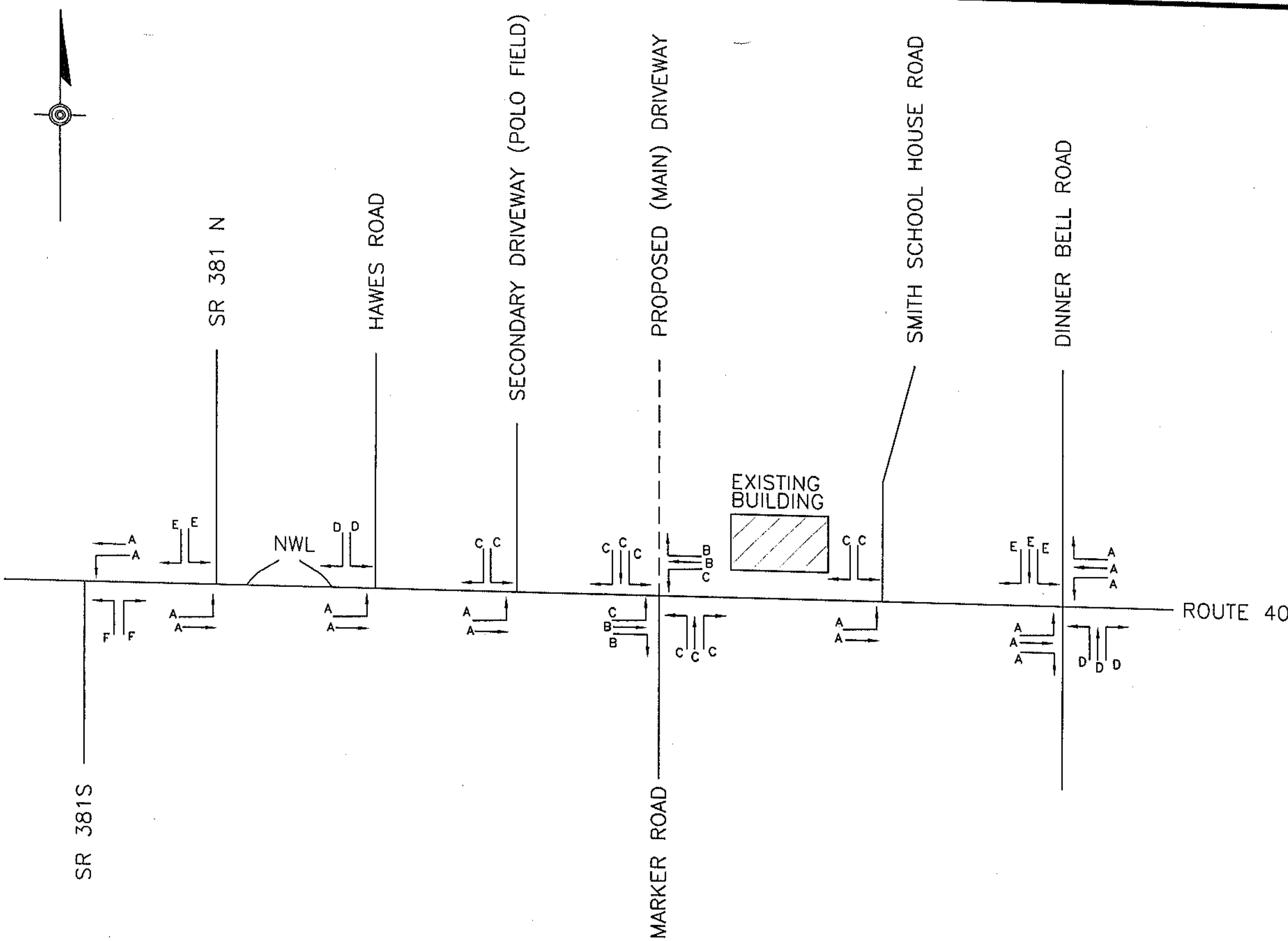
NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2006 SATURDAY PEAK HOUR DEVELOPED LEVEL OF SERVICE

BOOK NO. **	JOB NO. 2005-319
DRAWN RHH 11/23/05	CHECKED TR 11/23/05
DESIGN RHH 11/23/05	APPROVED * **

SCALE N.T.S.

SHEET NUMBER
FIGURE 9B



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1.			

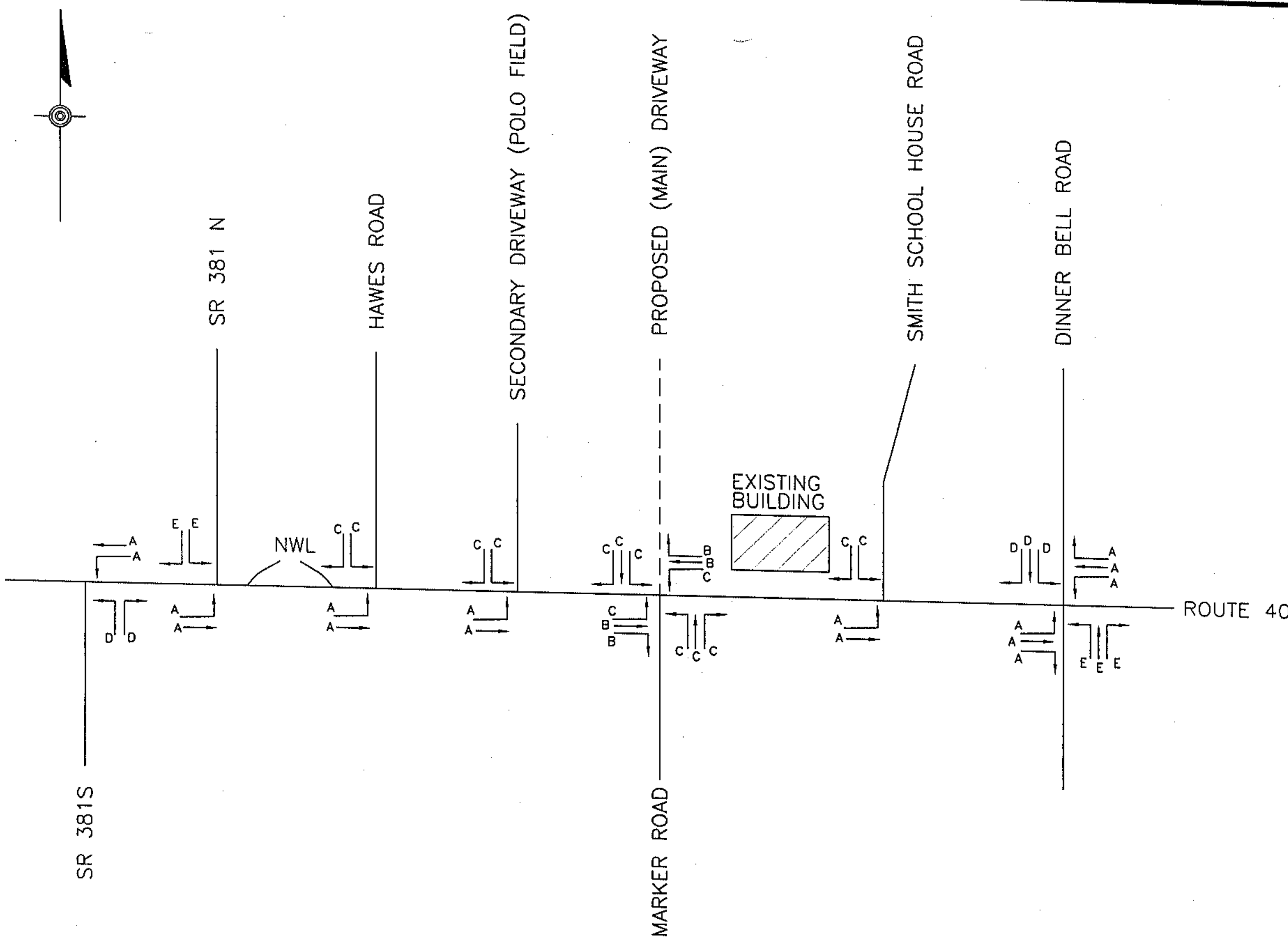
FILE O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2016 WEEKDAY PM PEAK HOUR DEVELOPED LEVEL OF SERVICE

BOOK NO.	**	JOB NO.	2005-319
DRAWN	RHH 11/23/05	CHECKED	TR 11/23/05
DESIGN	RHH 11/23/05	APPROVED	* **
SCALE	N.T.S.		

SHEET NUMBER
FIGURE 9C



mcmillen engineering
CIVIL ENGINEERS
LAND SURVEYORS
115 Wayland Smith Drive, Uniontown, PA 15401
Phone 724-439-8110 Fax 724-439-4733
Web Site www.mcmilleng.com
Email info@mcmilleng.com

REVISIONS

NO.	DESCRIPTION	DATE	BY
1.			

FILE: O:\2005-300\2005-319\TRAFFIC\MISC\TRAFFIC STUDY

NEMACOLIN WOODLANDS RESORT
OUTDOOR STORE
PREPARED FOR
NWL Co.
WHARTON TOWNSHIP, FAYETTE COUNTY
PENNSYLVANIA

TITLE
2016 SATURDAY PEAK HOUR DEVELOPED LEVEL OF SERVICE

BOOK NO. **	JOB NO. 2005-319
DRAWN RHH 11/23/05	CHECKED TR 11/23/05
DESIGN RHH 11/23/05	APPROVED * **
SCALE N.T.S.	

SHEET NUMBER
FIGURE 9D

APPENDIX 1

TRAFFIC COUNT DATA

NWL Outdoor Store Traffic Counts
8/12/05 and 8/13/05

Friday 8/12/05 PM

Route 40/SR 381

	Route 40 EB			SR 381 NB		SR 381 SB		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Right	Left	Thru	Right	
4:00-4:15	20	125	6	8	12	11	19	13	110	9	333
4:15-4:30	15	109	12	4	5	16	16	12	139	7	335
4:30-4:45	10	109	9	11	13	12	21	14	118	5	322
4:45-5:00	13	112	11	18	14	15	6	11	133	3	336
5:00-5:15	13	129	18	7	14	13	9	10	142	5	360
5:15-5:30	17	126	18	13	14	10	16	18	107	4	343
5:30-5:45	17	136	7	13	14	3	17	13	133	5	358
5:45-6:00	16	141	14	9	20	8	15	7	84	7	321

Route 40/Hawes Rd

	Route 40 EB			Hawes Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
4:00-4:15	11	***	***	5	13	***	***	6	35
4:15-4:30	9			9	17			4	39
4:30-4:45	4			9	10			3	26
4:45-5:00	8			8	11			4	31
5:00-5:15	5			15	16			11	47
5:15-5:30	5			7	10			18	40
5:30-5:45	3			7	5			8	23
5:45-6:00	2			7	4			3	16

Route 40/Marker Rd

	Route 40 EB			Marker Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
4:00-4:15		135	1	1	0	0	***		137
4:15-4:30		128	1	3	0	0			132
4:30-4:45		112	4	1	2	0			119
4:45-5:00		127	2	1	2	1			133
5:00-5:15		138	1	0	4	2			145
5:15-5:30		145	3	1	1	3			153
5:30-5:45		148	2	1	3	0			154
5:45-6:00		114	1	0	1	1			117

Route 40/Smith School House Rd

	Route 40 EB			Smith SH Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
4:00-4:15	4	***		3	15		72	3	97
4:15-4:30	4			1	7		102	4	118
4:30-4:45	3			5	7		84	6	105
4:45-5:00	1			3	7		104	2	117
5:00-5:15	4			2	6		89	2	103
5:15-5:30	5			3	6		101	1	116
5:30-5:45	6			4	7		96	3	116
5:45-6:00	3			5	2		75	1	86

Route 40/Dinner Bell Rd

	Route 40 EB			DBR NB			DBR SB			Route 40 WB			TOTAL
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
4:00-4:15	3	***	10	7	1	1	11	0	7	3	***	6	49
4:15-4:30	6		7	4	1	3	5	2	5	6		3	42
4:30-4:45	2		9	9	0	0	6	2	1	2		2	33
4:45-5:00	2		7	3	3	5	9	0	6	2		11	48
5:00-5:15	6		14	8	1	2	7	0	2	6		10	56
5:15-5:30	2		15	7	1	6	12	1	6	2		5	57
5:30-5:45	4		11	8	2	3	8	2	1	4		12	55
5:45-6:00	2		4	6	0	3	5	0	4	2		4	30

Saturday 8/13/05

Route 40/SR 381

	Route 40 EB			SR 381 NB		SR 381 SB		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Right	Left	Thru	Right	
10:00-10:15	13	111	7	8	13	10	10	11	104	19	306
10:15-10:30	24	114	8	7	24	8	10	14	89	18	316
10:30-10:45	19	105	10	9	19	9	52	15	115	11	364
10:45-11:00	16	142	12	4	14	8	13	12	114	16	351
11:00-11:15	26	120	8	9	21	15	11	9	118	19	356
11:15-11:30	16	140	9	9	12	11	9	18	80	14	318
11:30-11:45	22	171	18	9	22	8	16	14	85	10	375
11:45-12:00	15	135	15	9	11	10	14	16	104	15	344

Route 40/Hawes Rd

	Route 40 EB			Hawes Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
10:00-10:15	6	***	***	5	2	***	***	6	19
10:15-10:30	3			0	2			10	15
10:30-10:45	11			4	4			9	28
10:45-11:00	8			5	2			9	24
11:00-11:15	2			5	6			1	14
11:15-11:30	7			6	4			6	23
11:30-11:45	8			3	2			5	18
11:45-12:00	1			5	4			5	15

Route 40/Marker Rd

	Route 40 EB			Marker Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
10:00-10:15		105	6	0	1	0	***		112
10:15-10:30		115	0	1	2	2			120
10:30-10:45		113	1	2	2	1			119
10:45-11:00		129	1	1	0	0			131
11:00-11:15		111	0	1	1	2			115
11:15-11:30		137	1	1	1	2			142
11:30-11:45		170	1	1	3	1			176
11:45-12:00		122	3	1	0	0			126

Route 40/Smith School House Rd

	Route 40 EB			Smith SH Rd		Route 40 WB			TOTAL
	Left	Thru	Right	Left	Right	Left	Thru	Right	
10:00-10:15	2	***		0	8		94	2	106
10:15-10:30	0			3	3		93	3	102
10:30-10:45	2			1	4		122	3	132
10:45-11:00	1			3	5		114	2	125
11:00-11:15	2			5	1		109	2	119
11:15-11:30	4			0	3		89	1	97
11:30-11:45	7			0	3		86	5	101
11:45-12:00	2			2	5		92	3	104

Route 40/Dinner Bell Rd

	Route 40 EB			DBR NB			DBR SB			Route 40 WB			TOTAL
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
10:00-10:15	1	***	6	9	0	13	4	1	7	2	***	7	50
10:15-10:30	2		5	17	2	3	3	0	3	3		5	43
10:30-10:45	4		1	31	3	3	6	2	1	2		6	59
10:45-11:00	7		10	16	0	2	3	1	6	1		1	47
11:00-11:15	3		6	11	1	0	2	1	6	3		6	39
11:15-11:30	2		5	13	0	4	3	1	0	3		5	36
11:30-11:45	7		7	14	1	9	8	0	3	2		3	54
11:45-12:00	1		7	7	0	6	4	0	2	5		5	37

APPENDIX 2

CAPACITY ANALYSIS
(2006 BASE CONDITIONS)

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		508	54	52	516	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Hourly Flow Rate, HFR		552	72	72	567	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	51	0	56			
Peak Hour Factor, PHF	0.71	0.50	1.00			
Hourly Flow Rate, HFR	71	0	56			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		72		127				
C(m) (vph)		952		232				
v/c		0.08		0.55				
95% queue length		0.24		2.96				
Control Delay		9.1		37.8				
LOS		A		E				
Approach Delay				37.8				
Approach LOS				E				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		508	54	52	516	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Peak-15 Minute Volume		138	18	18	142	
Hourly Flow Rate, HFR		552	72	72	567	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	51	0	56			
Peak Hour Factor, PHF	0.71	0.50	1.00			
Peak-15 Minute Volume	18	0	14			
Hourly Flow Rate, HFR	71	0	56			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		567
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.07	0.07	0.07	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
roportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
onstrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		624	1299	1299	588			
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	588	
Potential Capacity	506	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	506	
Probability of Queue free St.	0.89	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	624	
Potential Capacity	952	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	952	
Probability of Queue free St.	0.92	1.00
Maj L-Shared Prob Q free St.	0.89	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1299	
Potential Capacity	160	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	142	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1299	
Potential Capacity	176	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.92	0.81
Movement Capacity	163	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1299	
Potential Capacity	160	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	142	

Result for 2 stage process:		
a		
y		
C t	142	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1299	
Potential Capacity	176	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.92	0.81
Movement Capacity	163	

Results for Two-stage process:		
a		
y		
C t	163	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	71	0	56			
Movement Capacity (vph)	163	142	506			
Shared Lane Capacity (vph)		232				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	163	142	506			
Volume	71	0	56			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		232				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		72		127				
C(m) (vph)		952		232				
v/c		0.08		0.55				
95% queue length		0.24		2.96				
Control Delay		9.1		37.8				
OS		A		E				
.pproach Delay				37.8				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.92
v(il), Volume for stream 2 or 5		567
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.89
d(M,LT), Delay for stream 1 or 4		9.1
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.0

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday PeakBase
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		579	47	53	397	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Hourly Flow Rate, HFR		689	72	71	472	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	31	0	69			
Peak Hour Factor, PHF	0.86	0.50	0.78			
Hourly Flow Rate, HFR	36	0	88			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		71		124				
C(m) (vph)		847		280				
v/c		0.08		0.44				
95% queue length		0.27		2.15				
Control Delay		9.6		27.7				
LOS		A		D				
Approach Delay				27.7				
Approach LOS				D				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday PeakBase
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		579	47	53	397	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Peak-15 Minute Volume		172	18	18	118	
Hourly Flow Rate, HFR		689	72	71	472	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	31	0	69			
Peak Hour Factor, PHF	0.86	0.50	0.78			
Peak-15 Minute Volume	9	0	22			
Hourly Flow Rate, HFR	36	0	88			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		472
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.07	0.07	0.07	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		761	1339	1339	725			
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	725	
Potential Capacity	423	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	423	
Probability of Queue free St.	0.79	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	761	
Potential Capacity	847	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	847	
Probability of Queue free St.	0.92	1.00
Maj L-Shared Prob Q free St.	0.89	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1339	
Potential Capacity	151	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	134	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1339	
Potential Capacity	167	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.92	0.72
Movement Capacity	153	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1339	
Potential Capacity	151	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	134	

Result for 2 stage process:		
a		
y		
C t	134	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1339	
Potential Capacity	167	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.92	0.72
Movement Capacity	153	

Results for Two-stage process:		
a		
y		
C t	153	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	36	0	88			
Movement Capacity (vph)	153	134	423			
Shared Lane Capacity (vph)		280				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	153	134	423			
Volume	36	0	88			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		280				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		71		124				
C(m) (vph)		847		280				
v/c		0.08		0.44				
95% queue length		0.27		2.15				
Control Delay		9.6		27.7				
LOS		A		D				
Approach Delay				27.7				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.92
v(il), Volume for stream 2 or 5		472
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.89
d(M,LT), Delay for stream 1 or 4		9.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Eastbound			Westbound		
	Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		61	503			520	17
Peak-Hour Factor, PHF		0.88	0.92			0.91	0.85
Hourly Flow Rate, HFR		69	546			571	19
Percent Heavy Vehicles		3	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1			1	0
Configuration		LT				TR	
Upstream Signal?			No			No	

Minor Street:	Approach	Northbound			Southbound		
	Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume					41	0	48
Peak Hour Factor, PHF					0.71	0.50	0.68
Hourly Flow Rate, HFR					57	0	70
Percent Heavy Vehicles					3	3	3
Percent Grade (%)			-5			-7	
Flared Approach:	Exists?/Storage			/		No	/
Lanes					0	1	0
Configuration						LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	69						127	
C(m) (vph)	981						274	
v/c	0.07						0.46	
95% queue length	0.23						2.30	
Control Delay	8.9						29.0	
LOS	A						D	
Approach Delay							29.0	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	61	503			520	17
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Peak-15 Minute Volume	17	137			143	5
Hourly Flow Rate, HFR	69	546			571	19
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				41	0	48
Peak Hour Factor, PHF				0.71	0.50	0.68
Peak-15 Minute Volume				14	0	18
Hourly Flow Rate, HFR				57	0	70
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	546	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.07	-0.07	-0.07
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

ɔmputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	590					1264	1264	580
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		580
Potential Capacity		513
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		513
Probability of Queue free St.	1.00	0.86

Step 2: LT from Major St.	4	1
Conflicting Flows		590
Potential Capacity		981
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		981
Probability of Queue free St.	1.00	0.93
Maj L-Shared Prob Q free St.		0.90

Step 3: TH from Minor St.	8	11
Conflicting Flows		1264
Potential Capacity		169
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		152
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1264
Potential Capacity		187
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.90	
Maj. L, Min T Adj. Imp Factor.	0.92	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.93
Movement Capacity		174

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1264
Potential Capacity		169
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		152

Result for 2 stage process:		
a		
y		
C t		152
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1264
Potential Capacity		187
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.90	
Maj. L, Min T Adj. Imp Factor.	0.92	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.93
Movement Capacity		174

Results for Two-stage process:		
a		
y		
C t		174

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				57	0	70
Movement Capacity (vph)				174	152	513
Shared Lane Capacity (vph)					274	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				174	152	513
Volume				57	0	70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					274	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	69						127	
C(m) (vph)	981						274	
v/c	0.07						0.46	
95% queue length	0.23						2.30	
Control Delay	8.9						29.0	
LOS	A						D	
Approach Delay							29.0	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.93	1.00
v(il), Volume for stream 2 or 5	546	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.90	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.9	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	81	567			401	59
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Hourly Flow Rate, HFR	89	675			477	75
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				42	0	49
Peak Hour Factor, PHF				0.70	0.50	0.77
Hourly Flow Rate, HFR				60	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	89						123	
C(m) (vph)	1013						237	
v/c	0.09						0.52	
95% queue length	0.29						2.72	
Control Delay	8.9						35.5	
LOS	A						E	
Approach Delay							35.5	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	81	567			401	59
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Peak-15 Minute Volume	22	169			119	19
Hourly Flow Rate, HFR	89	675			477	75
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				42	0	49
Peak Hour Factor, PHF				0.70	0.50	0.77
Peak-15 Minute Volume				15	0	16
Hourly Flow Rate, HFR				60	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	675	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.07	-0.07	-0.07
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	552					1367	1367	514
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		514
Potential Capacity		559
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		559
Probability of Queue free St.	1.00	0.89

Step 2: LT from Major St.	4	1
Conflicting Flows		552
Potential Capacity		1013
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1013
Probability of Queue free St.	1.00	0.91
Maj L-Shared Prob Q free St.		0.86

Step 3: TH from Minor St.	8	11
Conflicting Flows		1367
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		126
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1367
Potential Capacity		162
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.86	
Maj. L, Min T Adj. Imp Factor.	0.89	
Cap. Adj. factor due to Impeding mvmnt	0.79	0.91
Movement Capacity		148

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1367
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		126

Result for 2 stage process:		
a		
y		
C t		126
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1367
Potential Capacity		162
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.86	
Maj. L, Min T Adj. Imp Factor.	0.89	
Cap. Adj. factor due to Impeding mvmnt	0.79	0.91
Movement Capacity		148

Results for Two-stage process:		
a		
y		
C t		148

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				60	0	63
Movement Capacity (vph)				148	126	559
Shared Lane Capacity (vph)					237	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				148	126	559
Volume				60	0	63
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					237	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	89						123	
C(m) (vph)	1013						237	
v/c	0.09						0.52	
95% queue length	0.29						2.72	
Control Delay	8.9						35.5	
LOS	A						E	
Approach Delay							35.5	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.91	1.00
v(il), Volume for stream 2 or 5	675	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.86	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	524			376	37
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Hourly Flow Rate, HFR	31	569			413	56
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				37	0	42
Peak Hour Factor, PHF				0.62	0.50	0.66
Hourly Flow Rate, HFR				59	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	31						122	
C(m) (vph)	1087						347	
v/c	0.03						0.35	
95% queue length	0.09						1.54	
Control Delay	8.4						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	21	524			376	37
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Peak-15 Minute Volume	8	142			103	14
Hourly Flow Rate, HFR	31	569			413	56
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				37	0	42
Peak Hour Factor, PHF				0.62	0.50	0.66
Peak-15 Minute Volume				15	0	16
Hourly Flow Rate, HFR				59	0	63
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	569	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.10	-0.10	-0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	469					1072	1072	441
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		441
Potential Capacity		615
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		615
Probability of Queue free St.	1.00	0.90

Step 2: LT from Major St.	4	1
Conflicting Flows		469
Potential Capacity		1087
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1087
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1072
Potential Capacity		221
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		212
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1072
Potential Capacity		244
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.87	0.97
Movement Capacity		237

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1072
Potential Capacity		221
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		212

Result for 2 stage process:		
a		
y		
C t		212
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1072
Potential Capacity		244
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.87	0.97
Movement Capacity		237

Results for Two-stage process:		
a		
y		
C t		237

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				59	0	63
Movement Capacity (vph)				237	212	615
Shared Lane Capacity (vph)					347	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				237	212	615
Volume				59	0	63
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					347	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	31						122	
C(m) (vph)	1087						347	
v/c	0.03						0.35	
95% queue length	0.09						1.54	
Control Delay	8.4						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	569	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	25	610			392	21
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Hourly Flow Rate, HFR	32	726			466	36
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				19	0	14
Peak Hour Factor, PHF				0.79	0.50	0.58
Hourly Flow Rate, HFR				24	0	24
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	32						48	
C(m) (vph)	1057						274	
v/c	0.03						0.18	
95% queue length	0.09						0.62	
Control Delay	8.5						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	25	610			392	21
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Peak-15 Minute Volume	8	182			117	9
Hourly Flow Rate, HFR	32	726			466	36
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				19	0	14
Peak Hour Factor, PHF				0.79	0.50	0.58
Peak-15 Minute Volume				6	0	6
Hourly Flow Rate, HFR				24	0	24
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	726	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.10	-0.10	-0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	502					1274	1274	484
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		484
Potential Capacity		582
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		582
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		502
Potential Capacity		1057
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1057
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		1274
Potential Capacity		168
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		159
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1274
Potential Capacity		185
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.97
Movement Capacity		179

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1274
Potential Capacity		168
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		159

Result for 2 stage process:		
a		
y		
C t		159
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1274
Potential Capacity		185
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.97
Movement Capacity		179

Results for Two-stage process:		
a		
y		
C t		179

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				24	0	24
Movement Capacity (vph)				179	159	582
Shared Lane Capacity (vph)					274	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				179	159	582
Volume				24	0	24
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					274	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement Lane Config	1 LT	4	7	8	9	10	11 LTR	12
v (vph)	32						48	
C(m) (vph)	1057						274	
v/c	0.03						0.18	
95% queue length	0.09						0.62	
Control Delay	8.5						20.9	
LOS	A						C	
Approach Delay							20.9	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	726	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		564	8	6	414	
Peak-Hour Factor, PHF		0.94	0.67	0.50	0.94	
Hourly Flow Rate, HFR		600	11	12	440	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	3	0	10			
Peak Hour Factor, PHF	0.75	0.50	0.62			
Hourly Flow Rate, HFR	4	0	16			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		12		20				
C(m) (vph)		963		409				
v/c		0.01		0.05				
95% queue length		0.04		0.15				
Control Delay		8.8		14.3				
LOS		A		B				
Approach Delay				14.3				
Approach LOS				B				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		564	8	6	414	
Peak-Hour Factor, PHF		0.94	0.67	0.50	0.94	
Peak-15 Minute Volume		150	3	3	110	
Hourly Flow Rate, HFR		600	11	12	440	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume	3	0	10				
Peak Hour Factor, PHF	0.75	0.50	0.62				
Peak-15 Minute Volume	1	0	4				
Hourly Flow Rate, HFR	4	0	16				
Percent Heavy Vehicles	3	3	3				
Percent Grade (%)		-5			3		
Flared Approach: Exists?/Storage			No	/			/
RT Channelized?							
Lanes	0	1	0				
Configuration		LTR					

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		440
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		611	1070	1070	606			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	606	
Potential Capacity	496	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	496	
Probability of Queue free St.	0.97	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	611	
Potential Capacity	963	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	963	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.98	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1070	
Potential Capacity	221	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	217	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1070	
Potential Capacity	244	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.96
Movement Capacity	241	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1070	
Potential Capacity	221	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	217	

Result for 2 stage process:		
a		
y		
C t	217	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1070	
Potential Capacity	244	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.96
Movement Capacity	241	

Results for Two-stage process:		
a		
y		
C t	241	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	0	16			
Movement Capacity (vph)	241	217	496			
Shared Lane Capacity (vph)		409				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	241	217	496			
Volume	4	0	16			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		409				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		12		20				
C(m) (vph)		963		409				
v/c		0.01		0.05				
95% queue length		0.04		0.15				
Control Delay		8.8		14.3				
LOS		A		B				
Approach Delay				14.3				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		440
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.98
d(M,LT), Delay for stream 1 or 4		8.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		552	3	5	409	
Peak-Hour Factor, PHF		0.80	0.75	0.62	0.87	
Hourly Flow Rate, HFR		689	4	8	470	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	4	0	5			
Peak Hour Factor, PHF	1.00	0.50	0.42			
Hourly Flow Rate, HFR	4	0	11			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		8		15				
C(m) (vph)		898		341				
v/c		0.01		0.04				
95% queue length		0.03		0.14				
Control Delay		9.0		16.0				
LOS		A		C				
Approach Delay				16.0				
Approach LOS				C				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		552	3	5	409	
Peak-Hour Factor, PHF		0.80	0.75	0.62	0.87	
Peak-15 Minute Volume		172	1	2	118	
Hourly Flow Rate, HFR		689	4	8	470	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	0	5			
Peak Hour Factor, PHF	1.00	0.50	0.42			
Peak-15 Minute Volume	1	0	3			
Hourly Flow Rate, HFR	4	0	11			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		470
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		693	1177	1177	691			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	691	
Potential Capacity	443	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	443	
Probability of Queue free St.	0.98	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	693	
Potential Capacity	898	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	898	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1177	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	189	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1177	
Potential Capacity	211	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.97
Movement Capacity	209	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1177	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	189	

Result for 2 stage process:		
a		
y		
C t	189	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1177	
Potential Capacity	211	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.97
Movement Capacity	209	
Results for Two-stage process:		
a		
y		
C t	209	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	0	11			
Movement Capacity (vph)	209	189	443			
Shared Lane Capacity (vph)		341				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	209	189	443			
Volume	4	0	11			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		341				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		8		15				
C(m) (vph)		898		341				
v/c		0.01		0.04				
95% queue length		0.03		0.14				
Control Delay		9.0		16.0				
LOS		A		C				
Approach Delay				16.0				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		470
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.99
d(M,LT), Delay for stream 1 or 4		9.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	16	558			394	8
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Hourly Flow Rate, HFR	23	593			419	11
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				12	0	26
Peak Hour Factor, PHF				0.75	0.38	0.93
Hourly Flow Rate, HFR				16	0	27
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	23						43	
C(m) (vph)	1124						392	
v/c	0.02						0.11	
95% queue length	0.06						0.37	
Control Delay	8.3						15.3	
LOS	A						C	
Approach Delay							15.3	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	16	558			394	8
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Peak-15 Minute Volume	6	148			105	3
Hourly Flow Rate, HFR	23	593			419	11
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				12	0	26
Peak Hour Factor, PHF				0.75	0.38	0.93
Peak-15 Minute Volume				4	0	7
Hourly Flow Rate, HFR				16	0	27
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	593	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100							0.10	0.10	0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.6	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	430					1063	1063	424
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		424
Potential Capacity		627
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		627
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		430
Potential Capacity		1124
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1124
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows		1063
Potential Capacity		221
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		214
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1063
Potential Capacity		245
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.98	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.98
Movement Capacity		240

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1063
Potential Capacity		221
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		214

Result for 2 stage process:		
a		
y		
C t		214
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1063
Potential Capacity		245
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.98	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.98
Movement Capacity		240

Results for Two-stage process:		
a		
y		
C t		240

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				16	0	27
Movement Capacity (vph)				240	214	627
Shared Lane Capacity (vph)					392	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				240	214	627
Volume				16	0	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					392	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	23						43	
C(m) (vph)	1124						392	
v/c	0.02						0.11	
95% queue length	0.06						0.37	
Control Delay	8.3						15.3	
LOS	A						C	
Approach Delay							15.3	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	593	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	14	504			402	10
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Hourly Flow Rate, HFR	28	579			462	20
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				8	0	12
Peak Hour Factor, PHF				0.40	0.38	0.60
Hourly Flow Rate, HFR				19	0	19
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	28						38	
C(m) (vph)	1075						325	
v/c	0.03						0.12	
95% queue length	0.08						0.39	
Control Delay	8.4						17.5	
LOS	A						C	
Approach Delay							17.5	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	14	504			402	10
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Peak-15 Minute Volume	7	145			116	5
Hourly Flow Rate, HFR	28	579			462	20
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				8	0	12
Peak Hour Factor, PHF				0.40	0.38	0.60
Peak-15 Minute Volume				5	0	5
Hourly Flow Rate, HFR				19	0	19
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	579	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100							0.10	0.10	0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.6	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	482					1107	1107	472
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		472
Potential Capacity		589
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		589
Probability of Queue free St.	1.00	0.97

Step 2: LT from Major St.	4	1
Conflicting Flows		482
Potential Capacity		1075
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1075
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1107
Potential Capacity		208
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		200
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1107
Potential Capacity		230
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.97
Movement Capacity		224

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1107
Potential Capacity		208
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		200

Result for 2 stage process:		
a		
y		
C t		200
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1107
Potential Capacity		230
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.97
Movement Capacity		224

Results for Two-stage process:		
a		
y		
C t		224

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				19	0	19
Movement Capacity (vph)				224	200	589
Shared Lane Capacity (vph)					325	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				224	200	589
Volume				19	0	19
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					325	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	28						38	
C(m) (vph)	1075						325	
v/c	0.03						0.12	
95% queue length	0.08						0.39	
Control Delay	8.4						17.5	
LOS	A						C	
Approach Delay							17.5	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	579	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	26	508	47	14	360	38
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Hourly Flow Rate, HFR	32	540	60	24	382	48
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	26	7	16	36	3	15
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Hourly Flow Rate, HFR	32	12	23	48	7	23
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	32	24		67			78	
C(m) (vph)	1124	972		224			210	
v/c	0.03	0.02		0.30			0.37	
95% queue length	0.09	0.08		1.21			1.61	
Control Delay	8.3	8.8		27.8			31.9	
LOS	A	A		D			D	
Approach Delay				27.8			31.9	
Approach LOS				D			D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	26	508	47	14	360	38
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	8	135	15	6	96	12
Hourly Flow Rate, HFR	32	540	60	24	382	48
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	26	7	16	36	3	15
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	8	3	6	12	2	6
Hourly Flow Rate, HFR	32	12	23	48	7	23
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	540	382
Shared ln volume, major rt vehicles:	60	48
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3	3	3	3	3	3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	430	600	1103	1112	570	1106	1118	406
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	570	406
Potential Capacity	519	643
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	519	643
Probability of Queue free St.	0.96	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	600	430
Potential Capacity	972	1124
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	972	1124
Probability of Queue free St.	0.98	0.97
Maj L-Shared Prob Q free St.	0.97	0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows	1112	1118
Potential Capacity	208	206
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	193	191
Probability of Queue free St.	0.94	0.96

Step 4: LT from Minor St.	7	10
Conflicting Flows	1103	1106
Potential Capacity	188	187
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.89	0.87
Maj. L, Min T Adj. Imp Factor.	0.92	0.90
Cap. Adj. factor due to Impeding mvmnt	0.88	0.86
Movement Capacity	166	161

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1112	1118
Potential Capacity	208	206
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	193	191

Result for 2 stage process:		
a		
y		
C t	193	191
Probability of Queue free St.	0.94	0.96

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1103	1106
Potential Capacity	188	187
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.89	0.87
Maj. L, Min T Adj. Imp Factor.	0.92	0.90
Cap. Adj. factor due to Impeding mvmnt	0.88	0.86
Movement Capacity	166	161

Results for Two-stage process:		
a		
y		
C t	166	161

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	32	12	23	48	7	23
Movement Capacity (vph)	166	193	519	161	191	643
Shared Lane Capacity (vph)		224			210	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	166	193	519	161	191	643
Volume	32	12	23	48	7	23
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		224			210	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	32	24		67			78	
C(m) (vph)	1124	972		224			210	
v/c	0.03	0.02		0.30			0.37	
95% queue length	0.09	0.08		1.21			1.61	
Control Delay	8.3	8.8		27.8			31.9	
LOS	A	A		D			D	
Approach Delay				27.8			31.9	
Approach LOS				D			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.98
v(il), Volume for stream 2 or 5	540	382
v(i2), Volume for stream 3 or 6	60	48
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.96	0.97
d(M,LT), Delay for stream 1 or 4	8.3	8.8
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.4	0.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	19	504	28	9	342	15
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	25	579	44	13	393	21
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	54	2	15	16	3	15
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	64	4	35	32	4	24
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	25	13		103			60	
C(m) (vph)	1140	953		225			240	
v/c	0.02	0.01		0.46			0.25	
95% queue length	0.07	0.04		2.21			0.96	
Control Delay	8.2	8.8		33.8			24.9	
LOS	A	A		D			C	
Approach Delay				33.8			24.9	
Approach LOS				D			C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/2/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2006
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	19	504	28	9	342	15
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	6	145	11	3	98	5
Hourly Flow Rate, HFR	25	579	44	13	393	21
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	54	2	15	16	3	15
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	16	1	9	8	1	6
Hourly Flow Rate, HFR	64	4	35	32	4	24
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	579	393
Shared ln volume, major rt vehicles:	44	21
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3	3	3	3	3	3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	414	623	1095	1091	601	1100	1103	404
s								
Px								
V c,u,x								

r,x	
C plat,x	

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	601	404
Potential Capacity	499	644
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	499	644
Probability of Queue free St.	0.93	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	623	414
Potential Capacity	953	1140
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	953	1140
Probability of Queue free St.	0.99	0.98
Maj L-Shared Prob Q free St.	0.98	0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows	1091	1103
Potential Capacity	214	210
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	203	199
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10
Conflicting Flows	1095	1100
Potential Capacity	191	188
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.91	0.88
Movement Capacity	174	166

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1091	1103
Potential Capacity	214	210
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	203	199

Result for 2 stage process:		
a		
y		
C t	203	199
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1095	1100
Potential Capacity	191	188
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.91	0.88
Movement Capacity	174	166

Results for Two-stage process:		
a		
y		
C t	174	166

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	64	4	35	32	4	24
Movement Capacity (vph)	174	203	499	166	199	644
Shared Lane Capacity (vph)		225			240	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	174	203	499	166	199	644
Volume	64	4	35	32	4	24
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		225			240	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	25	13		103			60	
C(m) (vph)	1140	953		225			240	
v/c	0.02	0.01		0.46			0.25	
95% queue length	0.07	0.04		2.21			0.96	
Control Delay	8.2	8.8		33.8			24.9	
LOS	A	A		D			C	
Approach Delay				33.8			24.9	
Approach LOS				D			C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	0.99
v(il), Volume for stream 2 or 5	579	393
v(i2), Volume for stream 3 or 6	44	21
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.97	0.98
d(M,LT), Delay for stream 1 or 4	8.2	8.8
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.2

APPENDIX 3

CAPACITY ANALYSIS
(2006 DEVELOPED CONDITIONS)

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		511	54	52	513	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Hourly Flow Rate, HFR		555	72	72	563	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	51	0	57			
Peak Hour Factor, PHF	0.71	1.00	1.00			
Hourly Flow Rate, HFR	71	0	57			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		72		128				
C(m) (vph)		965		238				
v/c		0.07		0.54				
95% queue length		0.24		2.89				
Control Delay		9.0		36.4				
LOS		A		E				
Approach Delay				36.4				
Approach LOS				E				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		511	54	52	513	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Peak-15 Minute Volume		139	18	18	141	
Hourly Flow Rate, HFR		555	72	72	563	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	51	0	57			
Peak Hour Factor, PHF	0.71	1.00	1.00			
Peak-15 Minute Volume	18	0	14			
Hourly Flow Rate, HFR	71	0	57			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		563
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			0	0	0	0			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		627	1298	1298	591			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	591	
Potential Capacity	511	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	511	
Probability of Queue free St.	0.89	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	627	
Potential Capacity	965	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	965	
Probability of Queue free St.	0.93	1.00
Maj L-Shared Prob Q free St.	0.89	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1298	
Potential Capacity	163	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	145	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1298	
Potential Capacity	180	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.93	0.81
Movement Capacity	167	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1298	
Potential Capacity	163	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.89	0.89
Movement Capacity	145	

Result for 2 stage process:		
a		
y		
C t	145	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1298	
Potential Capacity	180	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.89
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.93	0.81
Movement Capacity	167	
Results for Two-stage process:		
a		
y		
C t	167	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	71	0	57			
Movement Capacity (vph)	167	145	511			
Shared Lane Capacity (vph)		238				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	167	145	511			
Volume	71	0	57			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		238				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		72		128				
C(m) (vph)		965		238				
v/c		0.07		0.54				
95% queue length		0.24		2.89				
Control Delay		9.0		36.4				
LOS		A		E				
Approach Delay				36.4				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.93
v(il), Volume for stream 2 or 5		563
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.89
d(M,LT), Delay for stream 1 or 4		9.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.0

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		560	47	50	372	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Hourly Flow Rate, HFR		666	72	67	442	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	31	0	68			
Peak Hour Factor, PHF	0.86	1.00	0.78			
Hourly Flow Rate, HFR	36	0	87			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		67		123				
C(m) (vph)		877		302				
v/c		0.08		0.41				
95% queue length		0.25		1.90				
Control Delay		9.4		24.9				
LOS		A		C				
Approach Delay				24.9				
Approach LOS				C				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		560	47	50	372	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Peak-15 Minute Volume		167	18	17	111	
Hourly Flow Rate, HFR		666	72	67	442	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	31	0	68			
Peak Hour Factor, PHF	0.86	1.00	0.78			
Peak-15 Minute Volume	9	0	22			
Hourly Flow Rate, HFR	36	0	87			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		442
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			0	0	0	0			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		738	1278	1278	702			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	702	
Potential Capacity	442	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	442	
Probability of Queue free St.	0.80	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	738	
Potential Capacity	877	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	877	
Probability of Queue free St.	0.92	1.00
Maj L-Shared Prob Q free St.	0.90	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1278	
Potential Capacity	168	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity	151	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1278	
Potential Capacity	185	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.92	0.74
Movement Capacity	171	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1278	
Potential Capacity	168	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity	151	

Result for 2 stage process:		
a		
y		
C t	151	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1278	
Potential Capacity	185	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.92	0.74
Movement Capacity	171	

Results for Two-stage process:		
a		
y		
C t	171	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	36	0	87			
Movement Capacity (vph)	171	151	442			
Shared Lane Capacity (vph)		302				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	171	151	442			
Volume	36	0	87			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		302				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		67		123				
C(m) (vph)		877		302				
v/c		0.08		0.41				
95% queue length		0.25		1.90				
Control Delay		9.4		24.9				
LOS		A		C				
Approach Delay				24.9				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.92
v(il), Volume for stream 2 or 5		442
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.90
d(M,LT), Delay for stream 1 or 4		9.4
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.0

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	61	507			517	17
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Hourly Flow Rate, HFR	69	551			568	19
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				42	0	48
Peak Hour Factor, PHF				0.71	1.00	0.68
Hourly Flow Rate, HFR				59	0	70
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	69						129	
C(m) (vph)	998						273	
v/c	0.07						0.47	
95% queue length	0.22						2.37	
Control Delay	8.9						29.5	
LOS	A						D	
Approach Delay							29.5	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	61	507			517	17
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Peak-15 Minute Volume	17	138			142	5
Hourly Flow Rate, HFR	69	551			568	19
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				42	0	48
Peak Hour Factor, PHF				0.71	1.00	0.68
Peak-15 Minute Volume				15	0	18
Hourly Flow Rate, HFR				59	0	70
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	551	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	587					1267	1267	578
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		578
Potential Capacity		519
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		519
Probability of Queue free St.	1.00	0.87

Step 2: LT from Major St.	4	1
Conflicting Flows		587
Potential Capacity		998
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		998
Probability of Queue free St.	1.00	0.93
Maj L-Shared Prob Q free St.		0.90

Step 3: TH from Minor St.	8	11
Conflicting Flows		1267
Potential Capacity		170
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		153
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1267
Potential Capacity		188
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.90	
Maj. L, Min T Adj. Imp Factor.	0.92	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.93
Movement Capacity		175

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
tential Capacity		
edestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1267
Potential Capacity		170
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		153

Result for 2 stage process:		
a		
y		
C t		153
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1267
Potential Capacity		188
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.90	
Maj. L, Min T Adj. Imp Factor.	0.92	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.93
Movement Capacity		175

Results for Two-stage process:		
a		
y		
C t		175

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				59	0	70
Movement Capacity (vph)				175	153	519
Shared Lane Capacity (vph)					273	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				175	153	519
Volume				59	0	70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					273	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	69						129	
C(m) (vph)	998						273	
v/c	0.07						0.47	
95% queue length	0.22						2.37	
Control Delay	8.9						29.5	
LOS	A						D	
Approach Delay							29.5	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.93	1.00
v(il), Volume for stream 2 or 5	551	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.90	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.9	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	81	547			373	56
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Hourly Flow Rate, HFR	89	651			444	71
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				40	0	49
Peak Hour Factor, PHF				0.70	1.00	0.77
Hourly Flow Rate, HFR				57	0	63
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	89						120	
C(m) (vph)	1061						262	
v/c	0.08						0.46	
95% queue length	0.27						2.25	
Control Delay	8.7						29.8	
LOS	A						D	
Approach Delay							29.8	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	81	547			373	56
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Peak-15 Minute Volume	22	163			111	18
Hourly Flow Rate, HFR	89	651			444	71
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				40	0	49
Peak Hour Factor, PHF				0.70	1.00	0.77
Peak-15 Minute Volume				14	0	16
Hourly Flow Rate, HFR				57	0	63
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	651	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	515					1309	1309	480
s								
Px								
V c,u,x								
Cr,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		480
Potential Capacity		590
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		590
Probability of Queue free St.	1.00	0.89

Step 2: LT from Major St.	4	1
Conflicting Flows		515
Potential Capacity		1061
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1061
Probability of Queue free St.	1.00	0.92
Maj L-Shared Prob Q free St.		0.87

Step 3: TH from Minor St.	8	11
Conflicting Flows		1309
Potential Capacity		161
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity		140
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1309
Potential Capacity		177
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	
Maj. L, Min T Adj. Imp Factor.	0.90	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.92
Movement Capacity		162

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1309
Potential Capacity		161
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity		140

Result for 2 stage process:		
a		
y		
C t		140
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1309
Potential Capacity		177
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	
Maj. L, Min T Adj. Imp Factor.	0.90	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.92
Movement Capacity		162

Results for Two-stage process:		
a		
y		
C t		162

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
volume (vph)				57	0	63
Movement Capacity (vph)				162	140	590
Shared Lane Capacity (vph)					262	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				162	140	590
Volume				57	0	63
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					262	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	89						120	
C(m) (vph)	1061						262	
v/c	0.08						0.46	
95% queue length	0.27						2.25	
Control Delay	8.7						29.8	
LOS	A						D	
Approach Delay							29.8	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.92	1.00
v(il), Volume for stream 2 or 5	651	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.87	
d(M,LT), Delay for stream 1 or 4	8.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.1	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	529			373	37
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Hourly Flow Rate, HFR	31	574			409	56
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				37	0	42
Peak Hour Factor, PHF				0.62	1.00	0.66
Hourly Flow Rate, HFR				59	0	63
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	31						122	
C(m) (vph)	1107						351	
v/c	0.03						0.35	
95% queue length	0.09						1.52	
Control Delay	8.3						20.6	
LOS	A						C	
Approach Delay							20.6	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	529			373	37
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Peak-15 Minute Volume	8	144			102	14
Hourly Flow Rate, HFR	31	574			409	56
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				37	0	42
Peak Hour Factor, PHF				0.62	1.00	0.66
Peak-15 Minute Volume				15	0	16
Hourly Flow Rate, HFR				59	0	63
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	574	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1					7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0					0	0	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Grade/100			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00					0.70	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1					6.4	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)		
Arrival Type		
Effective Green, g (sec)		
Cycle Length, C (sec)		
Rp (from Exhibit 16-11)		
Proportion vehicles arriving on green P		
g(q1)		
g(q2)		
g(q)		

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	465					1073	1073	437
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
/(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		437
Potential Capacity		624
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		624
Probability of Queue free St.	1.00	0.90

Step 2: LT from Major St.	4	1
Conflicting Flows		465
Potential Capacity		1107
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1107
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

tep 3: TH from Minor St.	8	11
Conflicting Flows		1073
Potential Capacity		222
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		213
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1073
Potential Capacity		246
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.87	0.97
Movement Capacity		239

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
tential Capacity		
edestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1073
Potential Capacity		222
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		213

Result for 2 stage process:		
a		
y		
C t		213
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1073
Potential Capacity		246
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.87	0.97
Movement Capacity		239

Results for Two-stage process:		
a		
y		
C t		239

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
volume (vph)				59	0	63
Movement Capacity (vph)				239	213	624
Shared Lane Capacity (vph)					351	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				239	213	624
Volume				59	0	63
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					351	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	31						122	
C(m) (vph)	1107						351	
v/c	0.03						0.35	
95% queue length	0.09						1.52	
Control Delay	8.3						20.6	
LOS	A						C	
Approach Delay							20.6	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	574	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	25	588			361	21
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Hourly Flow Rate, HFR	32	700			429	36
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				19	0	14
Peak Hour Factor, PHF				0.79	1.00	0.58
Hourly Flow Rate, HFR				24	0	24
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	32						48	
C(m) (vph)	1107						299	
v/c	0.03						0.16	
95% queue length	0.09						0.56	
Control Delay	8.3						19.3	
LOS	A						C	
Approach Delay							19.3	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	25	588			361	21
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Peak-15 Minute Volume	8	175			107	9
Hourly Flow Rate, HFR	32	700			429	36
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				19	0	14
Peak Hour Factor, PHF				0.79	1.00	0.58
Peak-15 Minute Volume				6	0	6
Hourly Flow Rate, HFR				24	0	24
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	700	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

˙ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

›mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	465					1211	1211	447
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		447
Potential Capacity		616
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		616
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		465
Potential Capacity		1107
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1107
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		1211
Potential Capacity		184
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		175
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1211
Potential Capacity		203
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		197

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1211
Potential Capacity		184
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		175

Result for 2 stage process:		
a		
y		
C t		175
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1211
Potential Capacity		203
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		197

Results for Two-stage process:		
a		
y		
C t		197

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				24	0	24
Movement Capacity (vph)				197	175	616
Shared Lane Capacity (vph)					299	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				197	175	616
Volume				24	0	24
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					299	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	32						48	
C(m) (vph)	1107						299	
v/c	0.03						0.16	
95% queue length	0.09						0.56	
Control Delay	8.3						19.3	
LOS	A						C	
Approach Delay							19.3	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	700	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	31	535			386	15
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	34	594			428	16
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				14	0	28
Peak Hour Factor, PHF				0.90	0.90	0.90
Hourly Flow Rate, HFR				15	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						46	
C(m) (vph)	1127						402	
v/c	0.03						0.11	
95% queue length	0.09						0.38	
Control Delay	8.3						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
olume	31	535			386	15
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	9	149			107	4
Hourly Flow Rate, HFR	34	594			428	16
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				14	0	28
Peak Hour Factor, PHF				0.90	0.90	0.90
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				15	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	594	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

ımputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	444					1098	1098	436
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		436
Potential Capacity		625
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		625
Probability of Queue free St.	1.00	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows		444
Potential Capacity		1127
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1127
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		1098
Potential Capacity		215
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		205
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1098
Potential Capacity		238
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.97
Movement Capacity		231

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1098
Potential Capacity		215
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		205

Result for 2 stage process:		
a		
y		
C t		205
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1098
Potential Capacity		238
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.97
Movement Capacity		231

Results for Two-stage process:		
a		
y		
C t		231

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
volume (vph)				15	0	31
Movement Capacity (vph)				231	205	625
Shared Lane Capacity (vph)					402	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				231	205	625
Volume				15	0	31
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					402	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						46	
C(m) (vph)	1127						402	
v/c	0.03						0.11	
95% queue length	0.09						0.38	
Control Delay	8.3						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	594	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	34	573			352	17
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	37	636			391	18
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				15	0	30
Peak Hour Factor, PHF				0.90	0.90	0.90
Hourly Flow Rate, HFR				16	0	33
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	37						49	
C(m) (vph)	1161						405	
v/c	0.03						0.12	
95% queue length	0.10						0.41	
Control Delay	8.2						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	RHH
Agency/Co.:	McMILLEN ENGINEERING
Date Performed:	11/23/2005
Analysis Time Period:	SATURDAY PEAK DEVELOPED
Intersection:	SR40 / SEC. DRIVE
Jurisdiction:	WHARTON TOWNSHIP
Units: U. S. Customary	
Analysis Year:	2006
Project ID: 2005-319	
East/West Street:	ROUTE 40
North/South Street:	SECONDARY DRIVEWAY
Intersection Orientation: EW	Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	34	573			352	17
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	9	159			98	5
Hourly Flow Rate, HFR	37	636			391	18
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				15	0	30
Peak Hour Factor, PHF				0.90	0.90	0.90
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				16	0	33
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	636	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	409					1110	1110	400
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		400
Potential Capacity		654
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		654
Probability of Queue free St.	1.00	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows		409
Potential Capacity		1161
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1161
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		1110
Potential Capacity		211
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		201
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1110
Potential Capacity		234
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		227

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1110
Potential Capacity		211
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		201

Result for 2 stage process:		
a		
y		
C t		201
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1110
Potential Capacity		234
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		227

Results for Two-stage process:		
a		
y		
C t		227

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				16	0	33
Movement Capacity (vph)				227	201	654
Shared Lane Capacity (vph)					405	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				227	201	654
Volume				16	0	33
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					405	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	37						49	
C(m) (vph)	1161						405	
v/c	0.03						0.12	
95% queue length	0.10						0.41	
Control Delay	8.2						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	636	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Signalized Intersections Release 4.1e

Analyst: RHH
Agency: McMILLEN ENGINEERING
Date: 12/5/2005
Period: WEEKDAY PM PEAK DEVELOPED
Project ID: 2005-319
E/W St: ROUTE 40

Inter.: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisd:
Year : 2006

N/S St: MAIN DRIVE/MARKER ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Volume	62	490	8	6	342	47	3	0	10	42	0	56
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			2			12			3			14

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A				NB Left	A			
Thru		A			Thru	A			
Right		A			Right	A			
Peds					Peds				
WB Left	A				SB Left	A			
Thru		A			Thru	A			
Right		A			Right	A			
Peds					Peds				
NB Right					EB Right				
SB Right					WB Right				
Green	7.0	33.0				12.0			
Yellow	4.0					4.0			
All Red	2.0	2.0				2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	171	1710	0.40	0.10	31.1	C		
TR	831	1762	0.66	0.47	16.2	B	17.9	B
Westbound								
L	171	1710	0.04	0.10	28.6	C		
TR	822	1743	0.51	0.47	13.4	B	13.7	B
Northbound								
LTR	265	1545	0.04	0.17	24.3	C	24.3	C
Southbound								
L	244	1426	0.19	0.17	25.2	C		
TR	262	1530	0.18	0.17	25.1	C	25.2	C

Intersection Delay = 17.0 (sec/veh) Intersection LOS = B

HCS2000: Signalized Intersections Release 4.1e

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 12/5/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisdiction:
Analysis Year: 2006
Project ID: 2005-319

East/West Street: ROUTE 40
North/South Street: MAIN DRIVE/MARKER ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	62	490	8	6	342	47	3	0	10	42	0	56
% Heavy Veh	0	2	0	0	2	0	0	2	0	0	2	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PK 15 Vol	17	136	2	2	95	13	1	0	3	12	0	16
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800		1800	1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			2			12			3			14
Adj Flow	69	551		7	419			11		47	47	
%InSharedLn												
Prop LTs		0.000			0.000			0.273		1.000	0.000	
Prop RTs		0.013			0.093			0.727			1.000	
Peds Bikes	0			0			0			0		
Buses	0	0		0	0			0		0	0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Arriv. Type	3	3		3	3			3		3	3	
Unit Ext.	3.0	3.0		3.0	3.0			3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0			2.0		2.0	2.0	

Ped Min g	3.2	3.2	3.2	3.2

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
WB Left	A				SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	7.0	33.0					12.0			
Yellow	4.0						4.0			
All Red	2.0	2.0					2.0			

Cycle Length: 70.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	62	490	8	6	342	47	3	0	10	42	0	56
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj flow	69	544	7	7	380	39	3	0	8	47	0	47
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
Lane group	L	TR		L	TR			LTR		L	TR	
Adj flow	69	551		7	419			11		47	47	
Prop LTs		0.000			0.000			0.273		1.000	0.000	
Prop RTs		0.013			0.093			0.727			1.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR			LTR		L	TR	
So	1800	1800		1800	1800			1800		1800	1800	
Lanes	1	1	0	1	1	0	0	1	0	1	1	0
fW	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fHV	1.000	0.981		1.000	0.982			1.000		1.000	1.000	
fG	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fP	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fBB	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fA	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRT		0.998			0.986			0.902			0.850	
fLT	0.950	1.000		0.950	1.000			0.952		0.792	1.000	
Sec.												
Lpb	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
rRpb		1.000			1.000			1.000			1.000	
S	1710	1762		1710	1743			1545		1426	1530	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	69	1710	# 0.04	0.10	171	0.40
Prot							
Perm							
Thru	TR	551	1762	# 0.31	0.47	831	0.66
Right							
Westbound							
Prot							
Perm							
Left	L	7	1710	0.00	0.10	171	0.04
Prot							
Perm							
Thru	TR	419	1743	0.24	0.47	822	0.51
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	11	1545	0.01	0.17	265	0.04
Right							
Southbound							
Prot							
Perm							
Left	L	47	1426	# 0.03	0.17	244	0.19
Prot							
Perm							
Thru	TR	47	1530	0.03	0.17	262	0.18
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.39
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.52

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.40	0.10	29.5	1.000	171	0.11	1.6	0.0	31.1	C		
TR	0.66	0.47	14.2	1.000	831	0.24	2.0	0.0	16.2	B	17.9	B
Westbound												
L	0.04	0.10	28.5	1.000	171	0.11	0.1	0.0	28.6	C		
TR	0.51	0.47	12.9	1.000	822	0.12	0.5	0.0	13.4	B	13.7	B
Northbound												
LTR	0.04	0.17	24.2	1.000	265	0.11	0.1	0.0	24.3	C	24.3	C
Southbound												
L	0.19	0.17	24.8	1.000	244	0.11	0.4	0.0	25.2	C		

TR	0.18	0.17	24.8	1.000	262	0.11	0.3	0.0	25.1	C	25.2	C

Intersection delay = 17.0 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				S
Cycle length, C 70.0 sec				
Total actual green time for LT lane group, G (s)				12.0
Effective permitted green time for LT lane group, g(s)				12.0
Opposing effective green time, go (s)				12.0
Number of lanes in LT lane group, N				1
Number of lanes in opposing approach, No				1
Adjusted LT flow rate, VLT (veh/h)				47
Proportion of LT in LT lane group, PLT				1.000
Proportion of LT in opposing flow, PLTo				0.27
Adjusted opposing flow rate, Vo (veh/h)				11
Lost time for LT lane group, tL				6.00
Computation				
LT volume per cycle, LTC=VLTC/3600				0.91
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				0.21
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g				0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				0.83
gq, (see Exhibit C16-4,5,6,7,8)				0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf				12.00
n=Max(gq-gf)/2,0)				0.00
PTHo=1-PLTo				0.73
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				1.00
EL1 (refer to Exhibit C16-3)				1.26
EL2=Max((1-Ptho**n)/Plto, 1.0)				1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				0.33
gdiff=max(gq-gf,0)				0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				0.79
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				0.792

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach			M	
Cycle length, C 70.0 sec				
Total actual green time for LT lane group, G (s)			12.0	
Effective permitted green time for LT lane group, g(s)			12.0	
Opposing effective green time, go (s)			12.0	

```
Number of lanes in LT lane group, N                                    1
Number of lanes in opposing approach, No                               1
Adjusted LT flow rate, VLT (veh/h)                                     3
Proportion of LT in LT lane group, PLT                     0.000 0.000 0.273 0.000
Proportion of LT in opposing flow, PLTo                                0.00
Adjusted opposing flow rate, Vo (veh/h)                                47
Lost time for LT lane group, tL                                        6.00
Computation
LT volume per cycle, LTC=VLTC/3600                                     0.06
Opposing lane util. factor, fLUo                           1.000 1.000 1.000 1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                    0.91
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                  4.7
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                      1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                           0.83
gq, (see Exhibit C16-4,5,6,7,8)                                        0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                  7.30
n=Max(gq-gf)/2,0)                                                      0.00
PTHo=1-PLTo                                                            1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                     0.27
EL1 (refer to Exhibit C16-3)                                           1.32
EL2=Max((1-Ptho**n)/Plto, 1.0)
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                     0.21
gdiff=max(gq-gf,0)                                                     0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                    0.95
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                              0.952

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

_______________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_______________
Permitted Left Turns
                                                           EB    WB    NB    SB
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Pedestrian flow rate, Vpedg (p/h)
OCCpedg
Opposing queue clearing green, gq (s)
Eff. ped. green consumed by opp. veh. queue, gq/gp
OCCpedu
Opposing flow rate, Vo (veh/h)
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion of left turns, PLT
Proportion of left turns using protected phase, PLTA
Left-turn adjustment, fLpb
Permitted Right Turns
Effective pedestrian green time, gp (s)
Conflicting pedestrian volume, Vped (p/h)
Conflicting bicycle volume, Vbic (bicycles/h)
Vpedg
OCCpedg
Effective green, g (s)
```

```
Vbicg
OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb
```

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

```
                                                      EBLT  WBLT  NBLT  SBLT
Cycle length, C                          70.0   sec
Adj. LT vol from Vol Adjustment Worksheet, v
v/c ratio from Capacity Worksheet, X
Protected phase effective green interval, g (s)
Opposing queue effective green interval, gq
Unopposed green interval, gu
Red time r=(C-g-gq-gu)
Arrival rate, qa=v/(3600(max[X,1.0]))
Protected ph. departure rate, Sp=s/3600
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)
XPerm
XProt
Case
Queue at beginning of green arrow, Qa
Queue at beginning of unsaturated green, Qu
Residual queue, Qr
Uniform Delay, d1
```

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
Westbound								
Northbound								
Southbound								

Intersection Delay 17.0 sec/veh   Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR			LTR		L	TR	
Init Queue	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Flow Rate	69	551		7	419			11		47	47	
So	1800	1800		1800	1800			1800		1800	1800	
No.Lanes	1	1	0	1	1	0	0	1	0	1	1	0
SL	1710	1762		1710	1743			1545		1426	1530	
LnCapacity	171	831		171	822			265		244	262	
Flow Ratio	0.04	0.31		0.00	0.24			0.01		0.03	0.03	
v/c Ratio	0.40	0.66		0.04	0.51			0.04		0.19	0.18	
Grn Ratio	0.10	0.47		0.10	0.47			0.17		0.17	0.17	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3			3		3	3	
Pltn Ratio	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
PF2	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Q1	1.3	8.2		0.1	5.7			0.2		0.8	0.8	
kB	0.2	0.5		0.2	0.5			0.3		0.3	0.3	
Q2	0.1	1.0		0.0	0.5			0.0		0.1	0.1	
Q Average	1.4	9.3		0.1	6.2			0.2		0.8	0.8	
Q Spacing	25.0	25.0		25.0	25.0			25.0		25.0	25.0	
Q Storage	0	0		0	0			0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2			1.2		1.2	1.2	
BOQ	1.7	10.9		0.2	7.4			0.2		1.0	1.0	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5			1.6		1.6	1.6	
BOQ	2.2	14.1		0.2	9.6			0.3		1.3	1.3	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.7		1.8	1.7			1.8		1.8	1.8	
BOQ	2.5	15.3		0.2	10.5			0.3		1.5	1.5	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.9		2.1	1.9			2.1		2.1	2.1	
BOQ	2.9	17.2		0.3	12.0			0.4		1.7	1.7	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.2		2.7	2.3			2.7		2.6	2.6	
BOQ	3.6	20.3		0.4	14.4			0.5		2.2	2.2	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS2000: Signalized Intersections Release 4.1e

Analyst: RHH
Agency: McMILLEN ENGINEERING
Date: 12/5/2005
Period: SATURDAY AM PEAK DEVELOPED
Project ID: 2005-319
E/W St: ROUTE 40

Inter.: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisd:
Year : 2006

N/S St: MAIN DRIVE/MARKER ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Volume	68	443	3	5	305	51	4	0	5	45	0	60
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			1			13			1			15

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds						Peds				
WB	Left	A				SB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		7.0	33.0					12.0			
Yellow		4.0	4.0					4.0			
All Red		2.0	2.0					2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	171	1710	0.44	0.10	31.5	C		
TR	832	1764	0.59	0.47	14.7	B	17.0	B
Westbound								
L	171	1710	0.04	0.10	28.5	C		
TR	820	1739	0.46	0.47	12.9	B	13.2	B
Northbound								
LTR	263	1532	0.03	0.17	24.2	C	24.2	C
Southbound								
L	245	1430	0.20	0.17	25.3	C		
TR	262	1530	0.19	0.17	25.2	C	25.3	C

Intersection Delay = 16.4 (sec/veh) Intersection LOS = B

HCS2000: Signalized Intersections Release 4.1e

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 12/5/2005
Analysis Time Period: SATURDAY AM PEAK DEVELOPED
Intersection: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisdiction:
Analysis Year: 2006
Project ID: 2005-319

East/West Street: ROUTE 40
North/South Street: MAIN DRIVE/MARKER ROAD

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	68	443	3	5	305	51	4	0	5	45	0	60
% Heavy Veh	0	2	0	0	2	0	0	2	0	0	2	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PK 15 Vol	19	123	1	2	85	14	1	0	2	13	0	17
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800		1800	1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			1			13			1			15
Adj Flow	76	494		6	381			8		50	50	
%InSharedLn												
Prop LTs		0.000			0.000			0.500		1.000	0.000	
Prop RTs		0.004			0.110			0.500			1.000	
Peds Bikes		0			0			0			0	
Buses	0	0		0	0			0		0	0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Arriv. Type	3	3		3	3			3		3	3	
Unit Ext.	3.0	3.0		3.0	3.0			3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0			2.0		2.0	2.0	

Ped Min g	3.2	3.2	3.2	3.2

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
WB Left	A				SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	7.0	33.0					12.0			
Yellow	4.0	4.0					4.0			
All Red	2.0	2.0					2.0			

Cycle Length: 70.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	68	443	3	5	305	51	4	0	5	45	0	60
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj flow	76	492	2	6	339	42	4	0	4	50	0	50
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
Lane group	L	TR		L	TR			LTR		L	TR	
Adj flow	76	494		6	381			8		50	50	
Prop LTs		0.000			0.000			0.500		1.000	0.000	
Prop RTs		0.004			0.110			0.500			1.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR			LTR		L	TR	
So	1800	1800		1800	1800			1800		1800	1800	
Lanes	1	1	0	1	1	0	0	1	0	1	1	0
fW	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fHV	1.000	0.980		1.000	0.983			1.000		1.000	1.000	
fG	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fP	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fBB	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fA	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRT		0.999			0.983			0.933			0.850	
fLT	0.950	1.000		0.950	1.000			0.912		0.794	1.000	
Sec.												
pb	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
Rpb		1.000			1.000			1.000			1.000	
S	1710	1764		1710	1739			1532		1430	1530	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	76	1710	# 0.04	0.10	171	0.44
Prot							
Perm							
Thru	TR	494	1764	# 0.28	0.47	832	0.59
Right							
Westbound							
Prot							
Perm							
Left	L	6	1710	0.00	0.10	171	0.04
Prot							
Perm							
Thru	TR	381	1739	0.22	0.47	820	0.46
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	8	1532	0.01	0.17	263	0.03
Right							
Southbound							
Prot							
Perm							
Left	L	50	1430	# 0.03	0.17	245	0.20
Prot							
Perm							
Thru	TR	50	1530	0.03	0.17	262	0.19
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.36
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.48

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.44	0.10	29.7	1.000	171	0.11	1.8	0.0	31.5	C		
TR	0.59	0.47	13.6	1.000	832	0.18	1.2	0.0	14.7	B	17.0	B
Westbound												
L	0.04	0.10	28.4	1.000	171	0.11	0.1	0.0	28.5	C		
TR	0.46	0.47	12.5	1.000	820	0.11	0.4	0.0	12.9	B	13.2	B
Northbound												
LTR	0.03	0.17	24.2	1.000	263	0.11	0.0	0.0	24.2	C	24.2	C
Southbound												
L	0.20	0.17	24.9	1.000	245	0.11	0.4	0.0	25.3	C		

TR	0.19	0.17	24.8	1.000	262	0.11	0.4	0.0	25.2	C	25.3	C

Intersection delay = 16.4 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach					S
Cycle length, C	70.0 sec				
Total actual green time for LT lane group, G (s)					12.0
Effective permitted green time for LT lane group, g(s)					12.0
Opposing effective green time, go (s)					12.0
Number of lanes in LT lane group, N					1
Number of lanes in opposing approach, No					1
Adjusted LT flow rate, VLT (veh/h)					50
Proportion of LT in LT lane group, PLT					1.000
Proportion of LT in opposing flow, PLTo					0.50
Adjusted opposing flow rate, Vo (veh/h)					8
Lost time for LT lane group, tL					6.00
Computation					
LT volume per cycle, LTC=VLTC/3600					0.97
Opposing lane util. factor, fLUo		1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)					0.16
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g					0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)					1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]					0.83
gq, (see Exhibit C16-4,5,6,7,8)					0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf					12.00
n=Max(gq-gf)/2,0)					0.00
PTHo=1-PLTo					0.50
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]					1.00
EL1 (refer to Exhibit C16-3)					1.26
EL2=Max((1-Ptho**n)/Plto, 1.0)					1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g					0.33
gdiff=max(gq-gf,0)					0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)					0.79
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00) or flt=[fm+0.91(N-1)]/N**					
Left-turn adjustment, fLT					0.794

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET
for shared lefts

Input		EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				M	
Cycle length, C	70.0 sec				
Total actual green time for LT lane group, G (s)				12.0	
Effective permitted green time for LT lane group, g(s)				12.0	
Opposing effective green time, go (s)				12.0	

Number of lanes in LT lane group, N			1	
Number of lanes in opposing approach, No			1	
Adjusted LT flow rate, VLT (veh/h)			4	
Proportion of LT in LT lane group, PLT	0.000	0.000	0.500	0.000
Proportion of LT in opposing flow, PLTo			0.00	
Adjusted opposing flow rate, Vo (veh/h)			50	
Lost time for LT lane group, tL			6.00	
Computation				
LT volume per cycle, LTC=VLTC/3600			0.08	
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			0.97	
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			4.4	
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.83	
gq, (see Exhibit C16-4,5,6,7,8)			0.00	
gu=g-gq if gq>=gf, or = g-gf if gq<gf			7.58	
n=Max(gq-gf)/2,0)			0.00	
PTHo=1-PLTo			1.00	
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.50	
EL1 (refer to Exhibit C16-3)			1.32	
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.25	
gdiff=max(gq-gf,0)			0.00	
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.91	
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00) or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT			0.912	

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				

Vbicg
OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

			EBLT	WBLT	NBLT	SBLT
Cycle length, C	70.0	sec				
Adj. LT vol from Vol Adjustment Worksheet, v						
v/c ratio from Capacity Worksheet, X						
Protected phase effective green interval, g (s)						
Opposing queue effective green interval, gq						
Unopposed green interval, gu						
Red time r=(C-g-gq-gu)						
Arrival rate, qa=v/(3600(max[X,1.0]))						
Protected ph. departure rate, Sp=s/3600						
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)						
XPerm						
XProt						
Case						
Queue at beginning of green arrow, Qa						
Queue at beginning of unsaturated green, Qu						
Residual queue, Qr						
Uniform Delay, d1						

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
Westbound								
Northbound								
Southbound								

Intersection Delay 16.4 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR			LTR		L	TR	
Init Queue	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Flow Rate	76	494		6	381			8		50	50	
So	1800	1800		1800	1800			1800		1800	1800	
No.Lanes	1	1	0	1	1	0	0	1	0	1	1	0
SL	1710	1764		1710	1739			1532		1430	1530	
LnCapacity	171	832		171	820			263		245	262	
Flow Ratio	0.04	0.28		0.00	0.22			0.01		0.03	0.03	
v/c Ratio	0.44	0.59		0.04	0.46			0.03		0.20	0.19	
Grn Ratio	0.10	0.47		0.10	0.47			0.17		0.17	0.17	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3			3		3	3	
Pltn Ratio	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
PF2	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Q1	1.4	7.1		0.1	5.0			0.1		0.8	0.8	
kB	0.2	0.5		0.2	0.5			0.3		0.3	0.3	
Q2	0.2	0.8		0.0	0.5			0.0		0.1	0.1	
Q Average	1.6	7.8		0.1	5.5			0.1		0.9	0.9	
Q Spacing	25.0	25.0		25.0	25.0			25.0		25.0	25.0	
Q Storage	0	0		0	0			0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2			1.2		1.2	1.2	
BOQ	1.9	9.2		0.1	6.5			0.2		1.1	1.1	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.6			1.6		1.6	1.6	
BOQ	2.5	12.0		0.2	8.5			0.2		1.4	1.4	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.7		1.8	1.7			1.8		1.8	1.8	
BOQ	2.8	13.1		0.2	9.3			0.2		1.6	1.6	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.9		2.1	1.9			2.1		2.1	2.1	
BOQ	3.2	14.8		0.2	10.6			0.3		1.9	1.9	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.2		2.7	2.4			2.7		2.6	2.6	
BOQ	4.0	17.6		0.3	12.9			0.4		2.4	2.4	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	16	554			396	8
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Hourly Flow Rate, HFR	23	589			421	11
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				12	0	26
Peak Hour Factor, PHF				0.75	0.90	0.93
Hourly Flow Rate, HFR				16	0	27
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	23						43	
C(m) (vph)	1138						398	
v/c	0.02						0.11	
95% queue length	0.06						0.36	
Control Delay	8.2						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
olume	16	554			396	8
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Peak-15 Minute Volume	6	147			105	3
Hourly Flow Rate, HFR	23	589			421	11
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				12	0	26
Peak Hour Factor, PHF				0.75	0.90	0.93
Peak-15 Minute Volume				4	0	7
Hourly Flow Rate, HFR				16	0	27
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	589	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	432					1061	1061	426
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		426
Potential Capacity		633
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		633
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		432
Potential Capacity		1138
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1138
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows		1061
Potential Capacity		226
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		219
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1061
Potential Capacity		250
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.98	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.98
Movement Capacity		245

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1061
Potential Capacity		226
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		219

Result for 2 stage process:		
a		
y		
C t		219
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1061
Potential Capacity		250
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.98	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.98
Movement Capacity		245

Results for Two-stage process:		
a		
y		
C t		245

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				16	0	27
Movement Capacity (vph)				245	219	633
Shared Lane Capacity (vph)					398	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				245	219	633
Volume				16	0	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					398	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	23						43	
C(m) (vph)	1138						398	
v/c	0.02						0.11	
95% queue length	0.06						0.36	
Control Delay	8.2						15.1	
LOS	A						C	
Approach Delay							15.1	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	589	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	8.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.2	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	14	523			446	10
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Hourly Flow Rate, HFR	28	601			512	20
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				8	0	12
Peak Hour Factor, PHF				0.40	0.90	0.60
Hourly Flow Rate, HFR				19	0	19
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	28						38	
C(m) (vph)	1046						301	
v/c	0.03						0.13	
95% queue length	0.08						0.43	
Control Delay	8.5						18.7	
LOS	A						C	
Approach Delay							18.7	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	14	523			446	10
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Peak-15 Minute Volume	7	150			128	5
Hourly Flow Rate, HFR	28	601			512	20
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				8	0	12
Peak Hour Factor, PHF				0.40	0.90	0.60
Peak-15 Minute Volume				5	0	5
Hourly Flow Rate, HFR				19	0	19
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	601	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	532					1179	1179	522
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		522
Potential Capacity		559
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		559
Probability of Queue free St.	1.00	0.97

Step 2: LT from Major St.	4	1
Conflicting Flows		532
Potential Capacity		1046
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1046
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1179
Potential Capacity		192
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		184
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1179
Potential Capacity		212
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.97
Movement Capacity		206

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1179
Potential Capacity		192
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		184

Result for 2 stage process:		
a		
y		
C t		184
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1179
Potential Capacity		212
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.97
Movement Capacity		206

Results for Two-stage process:		
a		
y		
C t		206

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				19	0	19
Movement Capacity (vph)				206	184	559
Shared Lane Capacity (vph)					301	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				206	184	559
Volume				19	0	19
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					301	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	28						38	
C(m) (vph)	1046						301	
v/c	0.03						0.13	
95% queue length	0.08						0.43	
Control Delay	8.5						18.7	
LOS	A						C	
Approach Delay							18.7	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	601	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	26	504	47	14	362	38
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Hourly Flow Rate, HFR	32	536	60	24	385	48
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	26	7	16	36	3	15
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Hourly Flow Rate, HFR	32	12	23	48	7	23
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	32	24		67			78	
C(m) (vph)	1137	990		228			214	
v/c	0.03	0.02		0.29			0.36	
95% queue length	0.09	0.07		1.18			1.57	
Control Delay	8.3	8.7		27.2			31.2	
LOS	A	A		D			D	
Approach Delay				27.2			31.2	
Approach LOS				D			D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	26	504	47	14	362	38
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	8	134	15	6	96	12
Hourly Flow Rate, HFR	32	536	60	24	385	48
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	26	7	16	36	3	15
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	8	3	6	12	2	6
Hourly Flow Rate, HFR	32	12	23	48	7	23
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	536	385
Shared ln volume, major rt vehicles:	60	48
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0	0	0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

›mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	433	596	1102	1111	566	1105	1117	409
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	566	409
Potential Capacity	528	647
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	528	647
Probability of Queue free St.	0.96	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	596	433
Potential Capacity	990	1137
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	990	1137
Probability of Queue free St.	0.98	0.97
Maj L-Shared Prob Q free St.	0.97	0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows	1111	1117
Potential Capacity	211	209
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	196	194
Probability of Queue free St.	0.94	0.96

Step 4: LT from Minor St.	7	10
Conflicting Flows	1102	1105
Potential Capacity	191	190
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.89	0.87
Maj. L, Min T Adj. Imp Factor.	0.92	0.90
Cap. Adj. factor due to Impeding mvmnt	0.89	0.86
Movement Capacity	169	164

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1111	1117
Potential Capacity	211	209
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity	196	194

Result for 2 stage process:		
a		
y		
C t	196	194
Probability of Queue free St.	0.94	0.96

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1102	1105
Potential Capacity	191	190
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.89	0.87
Maj. L, Min T Adj. Imp Factor.	0.92	0.90
Cap. Adj. factor due to Impeding mvmnt	0.89	0.86
Movement Capacity	169	164

Results for Two-stage process:		
a		
y		
C t	169	164

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	32	12	23	48	7	23
Movement Capacity (vph)	169	196	528	164	194	647
Shared Lane Capacity (vph)		228			214	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	169	196	528	164	194	647
Volume	32	12	23	48	7	23
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		228			214	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	32	24		67			78	
C(m) (vph)	1137	990		228			214	
v/c	0.03	0.02		0.29			0.36	
95% queue length	0.09	0.07		1.18			1.57	
Control Delay	8.3	8.7		27.2			31.2	
LOS	A	A		D			D	
Approach Delay				27.2			31.2	
Approach LOS				D			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.98
v(il), Volume for stream 2 or 5	536	385
v(i2), Volume for stream 3 or 6	60	48
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.96	0.97
d(M,LT), Delay for stream 1 or 4	8.3	8.7
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	19	484	28	9	326	15
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	25	556	44	13	374	21
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	54	2	15	16	3	15
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	64	4	35	32	4	24
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	25	13		103			60	
C(m) (vph)	1175	987		243			259	
v/c	0.02	0.01		0.42			0.23	
95% queue length	0.07	0.04		1.98			0.87	
Control Delay	8.1	8.7		30.3			23.0	
LOS	A	A		D			C	
Approach Delay				30.3			23.0	
Approach LOS				D			C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2006
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
olume	19	484	28	9	326	15
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	6	139	11	3	94	5
Hourly Flow Rate, HFR	25	556	44	13	374	21
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	54	2	15	16	3	15
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	16	1	9	8	1	6
Hourly Flow Rate, HFR	64	4	35	32	4	24
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	556	374
Shared ln volume, major rt vehicles:	44	21
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0	0	0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	395	600	1052	1049	578	1058	1060	384
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
7(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	578	384
Potential Capacity	519	668
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	519	668
Probability of Queue free St.	0.93	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	600	395
Potential Capacity	987	1175
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	987	1175
Probability of Queue free St.	0.99	0.98
Maj L-Shared Prob Q free St.	0.98	0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows	1049	1060
Potential Capacity	229	226
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	218	215
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10
Conflicting Flows	1052	1058
Potential Capacity	206	204
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.92	0.89
Movement Capacity	189	181

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1049	1060
Potential Capacity	229	226
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	218	215

Result for 2 stage process:		
a		
y		
C t	218	215
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1052	1058
Potential Capacity	206	204
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	0.93
Maj. L, Min T Adj. Imp Factor.	0.95	0.95
Cap. Adj. factor due to Impeding mvmnt	0.92	0.89
Movement Capacity	189	181

Results for Two-stage process:		
a		
y		
C t	189	181

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	64	4	35	32	4	24
Movement Capacity (vph)	189	218	519	181	215	668
Shared Lane Capacity (vph)		243			259	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	189	218	519	181	215	668
Volume	64	4	35	32	4	24
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		243			259	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	25	13		103			60	
C(m) (vph)	1175	987		243			259	
v/c	0.02	0.01		0.42			0.23	
95% queue length	0.07	0.04		1.98			0.87	
Control Delay	8.1	8.7		30.3			23.0	
LOS	A	A		D			C	
Approach Delay				30.3			23.0	
Approach LOS				D			C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	0.99
v(il), Volume for stream 2 or 5	556	374
v(i2), Volume for stream 3 or 6	44	21
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.97	0.98
d(M,LT), Delay for stream 1 or 4	8.1	8.7
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.1

APPENDIX 4

CAPACITY ANALYSIS
(2016 BASE CONDITIONS)

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		559	59	57	568	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Hourly Flow Rate, HFR		607	78	79	624	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	56	0	62			
Peak Hour Factor, PHF	0.71	0.50	1.00			
Hourly Flow Rate, HFR	78	0	62			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		79		140				
C(m) (vph)		904		196				
v/c		0.09		0.71				
95% queue length		0.29		4.55				
Control Delay		9.4		59.3				
LOS		A		F				
Approach Delay				59.3				
Approach LOS				F				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		559	59	57	568	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Peak-15 Minute Volume		152	20	20	156	
Hourly Flow Rate, HFR		607	78	79	624	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	56	0	62			
Peak Hour Factor, PHF	0.71	0.50	1.00			
Peak-15 Minute Volume	20	0	16			
Hourly Flow Rate, HFR	78	0	62			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		624
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.07	0.07	0.07	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		685	1428	1428	646			
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	646	
Potential Capacity	469	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	469	
Probability of Queue free St.	0.87	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	685	
Potential Capacity	904	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	904	
Probability of Queue free St.	0.91	1.00
Maj L-Shared Prob Q free St.	0.87	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1428	
Potential Capacity	134	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	116	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1428	
Potential Capacity	147	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.87
Maj. L, Min T Adj. Imp Factor.		0.90
Cap. Adj. factor due to Impeding mvmnt	0.91	0.78
Movement Capacity	134	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1428	
Potential Capacity	134	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	116	

Result for 2 stage process:		
a		
y		
C t	116	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1428	
Potential Capacity	147	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.87
Maj. L, Min T Adj. Imp Factor.		0.90
Cap. Adj. factor due to Impeding mvmnt	0.91	0.78
Movement Capacity	134	

Results for Two-stage process:		
a		
y		
C t	134	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	78	0	62			
Movement Capacity (vph)	134	116	469			
Shared Lane Capacity (vph)		196				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	134	116	469			
Volume	78	0	62			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		196				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		79		140				
C(m) (vph)		904		196				
v/c		0.09		0.71				
95% queue length		0.29		4.55				
Control Delay		9.4		59.3				
LOS		A		F				
Approach Delay				59.3				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.91
v(il), Volume for stream 2 or 5		624
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.87
d(M,LT), Delay for stream 1 or 4		9.4
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday PeakBase
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		637	52	58	437	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Hourly Flow Rate, HFR		758	80	78	520	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	34	0	76			
Peak Hour Factor, PHF	0.86	0.50	0.78			
Hourly Flow Rate, HFR	39	0	97			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No /			/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		78		136				
C(m) (vph)		792		240				
v/c		0.10		0.57				
95% queue length		0.33		3.16				
Control Delay		10.0+		38.0				
LOS		B		E				
Approach Delay				38.0				
Approach LOS				E				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday PeakBase
Intersection: Route 40/ SR 381 S
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 S
East/West Street: Route 40
North/South Street: SR 381 S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		637	52	58	437	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Peak-15 Minute Volume		190	20	20	130	
Hourly Flow Rate, HFR		758	80	78	520	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	34	0	76			
Peak Hour Factor, PHF	0.86	0.50	0.78			
Peak-15 Minute Volume	10	0	24			
Hourly Flow Rate, HFR	39	0	97			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		7			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		520
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.07	0.07	0.07	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		838	1474	1474	798			
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	798	
Potential Capacity	384	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	384	
Probability of Queue free St.	0.75	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	838	
Potential Capacity	792	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	792	
Probability of Queue free St.	0.90	1.00
Maj L-Shared Prob Q free St.	0.86	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1474	
Potential Capacity	125	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity	108	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1474	
Potential Capacity	138	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.86
Maj. L, Min T Adj. Imp Factor.		0.89
Cap. Adj. factor due to Impeding mvmnt	0.90	0.67
Movement Capacity	124	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1474	
Potential Capacity	125	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity	108	

Result for 2 stage process:		
a		
y		
C t	108	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1474	
Potential Capacity	138	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.86
Maj. L, Min T Adj. Imp Factor.		0.89
Cap. Adj. factor due to Impeding mvmnt	0.90	0.67
Movement Capacity	124	

Results for Two-stage process:		
a		
y		
C t	124	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	39	0	97			
Movement Capacity (vph)	124	108	384			
Shared Lane Capacity (vph)		240				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	124	108	384			
Volume	39	0	97			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		240				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		78		136				
C(m) (vph)		792		240				
v/c		0.10		0.57				
95% queue length		0.33		3.16				
Control Delay		10.0+		38.0				
LOS		B		E				
Approach Delay				38.0				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.90
v(il), Volume for stream 2 or 5		520
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.86
d(M,LT), Delay for stream 1 or 4		10.0+
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.4

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	67	554			572	19
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Hourly Flow Rate, HFR	76	602			628	22
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				45	0	53
Peak Hour Factor, PHF				0.71	0.50	0.68
Hourly Flow Rate, HFR				63	0	77
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	76						140	
C(m) (vph)	931						232	
v/c	0.08						0.60	
95% queue length	0.27						3.50	
Control Delay	9.2						41.6	
LOS	A						E	
Approach Delay							41.6	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	67	554			572	19
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Peak-15 Minute Volume	19	151			157	6
Hourly Flow Rate, HFR	76	602			628	22
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				45	0	53
Peak Hour Factor, PHF				0.71	0.50	0.68
Peak-15 Minute Volume				16	0	19
Hourly Flow Rate, HFR				63	0	77
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	602	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.07	-0.07	-0.07
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	650					1393	1393	639
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		639
Potential Capacity		475
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		475
Probability of Queue free St.	1.00	0.84

Step 2: LT from Major St.	4	1
Conflicting Flows		650
Potential Capacity		931
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		931
Probability of Queue free St.	1.00	0.92
Maj L-Shared Prob Q free St.		0.88

Step 3: TH from Minor St.	8	11
Conflicting Flows		1393
Potential Capacity		142
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		125
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1393
Potential Capacity		156
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	
Maj. L, Min T Adj. Imp Factor.	0.91	
Cap. Adj. factor due to Impeding mvmnt	0.76	0.92
Movement Capacity		143

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 3 - Single Stage		
Conflicting Flows		1393
Potential Capacity		142
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		125

Result for 2 stage process:		
a		
y		
C t		125
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 3 - Single Stage		
Conflicting Flows		1393
Potential Capacity		156
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	
Maj. L, Min T Adj. Imp Factor.	0.91	
Cap. Adj. factor due to Impeding mvmnt	0.76	0.92
Movement Capacity		143

Results for Two-stage process:		
a		
y		
C t		143

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				63	0	77
Movement Capacity (vph)				143	125	475
Shared Lane Capacity (vph)					232	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				143	125	475
Volume				63	0	77
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					232	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	76						140	
C(m) (vph)	931						232	
v/c	0.08						0.60	
95% queue length	0.27						3.50	
Control Delay	9.2						41.6	
LOS	A						E	
Approach Delay							41.6	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.92	1.00
v(il), Volume for stream 2 or 5	602	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.88	
d(M,LT), Delay for stream 1 or 4	9.2	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.1	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	89	624			441	65
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Hourly Flow Rate, HFR	97	742			525	83
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				46	0	54
Peak Hour Factor, PHF				0.70	0.50	0.77
Hourly Flow Rate, HFR				65	0	70
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	97						135	
C(m) (vph)	966						201	
v/c	0.10						0.67	
95% queue length	0.33						4.10	
Control Delay	9.1						53.3	
LOS	A						F	
Approach Delay							53.3	
Approach LOS							F	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/SR 381 N
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and SR 381 N
East/West Street: Route 40
North/South Street: SR 381 N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
olume	89	624			441	65
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Peak-15 Minute Volume	24	186			131	21
Hourly Flow Rate, HFR	97	742			525	83
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				46	0	54
Peak Hour Factor, PHF				0.70	0.50	0.77
Peak-15 Minute Volume				16	0	18
Hourly Flow Rate, HFR				65	0	70
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-7	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	742	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.07	-0.07	-0.07
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	608					1502	1502	566
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		566
Potential Capacity		522
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		522
Probability of Queue free St.	1.00	0.87

Step 2: LT from Major St.	4	1
Conflicting Flows		608
Potential Capacity		966
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		966
Probability of Queue free St.	1.00	0.90
Maj L-Shared Prob Q free St.		0.83

Step 3: TH from Minor St.	8	11
Conflicting Flows		1502
Potential Capacity		122
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.83	0.83
Movement Capacity		101
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1502
Potential Capacity		134
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.83	
Maj. L, Min T Adj. Imp Factor.	0.87	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.90
Movement Capacity		121

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1502
Potential Capacity		122
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.83	0.83
Movement Capacity		101

Result for 2 stage process:		
a		
y		
C t		101
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1502
Potential Capacity		134
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.83	
Maj. L, Min T Adj. Imp Factor.	0.87	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.90
Movement Capacity		121

Results for Two-stage process:		
a		
y		
C t		121

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				65	0	70
Movement Capacity (vph)				121	101	522
Shared Lane Capacity (vph)					201	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				121	101	522
Volume				65	0	70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					201	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	97						135	
C(m) (vph)	966						201	
v/c	0.10						0.67	
95% queue length	0.33						4.10	
Control Delay	9.1						53.3	
LOS	A						F	
Approach Delay							53.3	
Approach LOS							F	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.90	1.00
v(il), Volume for stream 2 or 5	742	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.83	
d(M,LT), Delay for stream 1 or 4	9.1	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.6	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	23	576			414	41
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Hourly Flow Rate, HFR	34	626			454	62
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				41	0	46
Peak Hour Factor, PHF				0.62	0.50	0.66
Hourly Flow Rate, HFR				66	0	69
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						135	
C(m) (vph)	1045						305	
v/c	0.03						0.44	
95% queue length	0.10						2.16	
Control Delay	8.6						25.9	
LOS	A						D	
Approach Delay							25.9	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	23	576			414	41
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Peak-15 Minute Volume	9	157			114	16
Hourly Flow Rate, HFR	34	626			454	62
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				41	0	46
Peak Hour Factor, PHF				0.62	0.50	0.66
Peak-15 Minute Volume				17	0	17
Hourly Flow Rate, HFR				66	0	69
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	626	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.10	-0.10	-0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

ɔmputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	516					1179	1179	485
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		485
Potential Capacity		581
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		581
Probability of Queue free St.	1.00	0.88
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows		516
Potential Capacity		1045
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1045
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95
Step 3: TH from Minor St.	**8**	**11**
Conflicting Flows		1179
Potential Capacity		191
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		181
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	**7**	**10**
Conflicting Flows		1179
Potential Capacity		211
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.85	0.97
Movement Capacity		204

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1179
Potential Capacity		191
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		181
Result for 2 stage process:		
a		
y		
C t		181
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1179
Potential Capacity		211
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.85	0.97
Movement Capacity		204
Results for Two-stage process:		
a		
y		
C t		204

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				66	0	69
Movement Capacity (vph)				204	181	581
Shared Lane Capacity (vph)					305	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				204	181	581
Volume				66	0	69
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					305	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						135	
C(m) (vph)	1045						305	
v/c	0.03						0.44	
95% queue length	0.10						2.16	
Control Delay	8.6						25.9	
LOS	A						D	
Approach Delay							25.9	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	626	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Hawes Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Hawes Road
East/West Street: Route 40
North/South Street: Hawes Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	28	671			431	23
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Hourly Flow Rate, HFR	35	798			513	39
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				21	0	15
Peak Hour Factor, PHF				0.79	0.50	0.58
Hourly Flow Rate, HFR				26	0	25
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	35						51	
C(m) (vph)	1013						233	
v/c	0.03						0.22	
95% queue length	0.11						0.81	
Control Delay	8.7						24.7	
LOS	A						C	
Approach Delay							24.7	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:	TR
Agency/Co.:	McMillen Engineering
Date Performed:	10/9/2005
Analysis Time Period:	Saturday Base
Intersection:	Route 40/ Hawes Road
Jurisdiction:	
Units: U. S. Customary	
Analysis Year:	2016
Project ID:	Route 40 and Hawes Road
East/West Street:	Route 40
North/South Street:	Hawes Road
Intersection Orientation:	EW

Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
olume	28	671			431	23
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Peak-15 Minute Volume	9	200			128	10
Hourly Flow Rate, HFR	35	798			513	39
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				21	0	15
Peak Hour Factor, PHF				0.79	0.50	0.58
Peak-15 Minute Volume				7	0	6
Hourly Flow Rate, HFR				26	0	25
Percent Heavy Vehicles				3	3	3
Percent Grade (%)		-5			-10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	798	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	-0.10	-0.10	-0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	552					1400	1400	532
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		532
Potential Capacity		546
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		546
Probability of Queue free St.	1.00	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows		552
Potential Capacity		1013
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1013
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.94

Step 3: TH from Minor St.	8	11
Conflicting Flows		1400
Potential Capacity		141
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		132
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1400
Potential Capacity		155
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		150

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
otential Capacity		
edestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1400
Potential Capacity		141
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		132

Result for 2 stage process:		
a		
y		
C t		132
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1400
Potential Capacity		155
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		150
Results for Two-stage process:		
a		
y		
C t		150

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				26	0	25
Movement Capacity (vph)				150	132	546
Shared Lane Capacity (vph)					233	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				150	132	546
Volume				26	0	25
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					233	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	35						51	
C(m) (vph)	1013						233	
v/c	0.03						0.22	
95% queue length	0.11						0.81	
Control Delay	8.7						24.7	
LOS	A						C	
pproach Delay							24.7	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	798	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.94	
d(M,LT), Delay for stream 1 or 4	8.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Eastbound			Westbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume			620	9	7	455	
Peak-Hour Factor, PHF			0.94	0.67	0.50	0.94	
Hourly Flow Rate, HFR			659	13	14	484	
Percent Heavy Vehicles			--	--	3	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0	0	1	
Configuration				TR	LT		
Upstream Signal?			No			No	

Minor Street:	Approach	Northbound			Southbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		3	0	11			
Peak Hour Factor, PHF		0.75	0.50	0.62			
Hourly Flow Rate, HFR		4	0	17			
Percent Heavy Vehicles		3	3	3			
Percent Grade (%)			-5			3	
Flared Approach:	Exists?/Storage			No	/		/
Lanes		0	1	0			
Configuration			LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		14		21				
C(m) (vph)		914		373				
v/c		0.02		0.06				
95% queue length		0.05		0.18				
Control Delay		9.0		15.2				
LOS		A		C				
Approach Delay				15.2				
Approach LOS				C				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		620	9	7	455	
Peak-Hour Factor, PHF		0.94	0.67	0.50	0.94	
Peak-15 Minute Volume		165	3	4	121	
Hourly Flow Rate, HFR		659	13	14	484	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	3	0	11			
Peak Hour Factor, PHF	0.75	0.50	0.62			
Peak-15 Minute Volume	1	0	4			
Hourly Flow Rate, HFR	4	0	17			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		484
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		672	1178	1178	666			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	666	
Potential Capacity	458	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	458	
Probability of Queue free St.	0.96	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	672	
Potential Capacity	914	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	914	
Probability of Queue free St.	0.98	1.00
Maj L-Shared Prob Q free St.	0.98	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1178	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	187	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1178	
Potential Capacity	211	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.95
Movement Capacity	208	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1178	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	187	

Result for 2 stage process:		
a		
y		
C t	187	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1178	
Potential Capacity	211	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.95
Movement Capacity	208	
Results for Two-stage process:		
a		
y		
C t	208	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	0	17			
Movement Capacity (vph)	208	187	458			
Shared Lane Capacity (vph)		373				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	208	187	458			
Volume	4	0	17			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		373				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		14		21				
C(m) (vph)		914		373				
v/c		0.02		0.06				
95% queue length		0.05		0.18				
Control Delay		9.0		15.2				
LOS		A		C				
Approach Delay				15.2				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5		484
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.98
d(M,LT), Delay for stream 1 or 4		9.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.2

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		607	3	6	450	
Peak-Hour Factor, PHF		0.80	0.75	0.62	0.87	
Hourly Flow Rate, HFR		758	4	9	517	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	4	0	6			
Peak Hour Factor, PHF	1.00	0.50	0.42			
Hourly Flow Rate, HFR	4	0	14			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		9		18				
C(m) (vph)		846		315				
v/c		0.01		0.06				
95% queue length		0.03		0.18				
Control Delay		9.3		17.1				
LOS		A		C				
Approach Delay				17.1				
Approach LOS				C				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Marker Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Marker/Proposed Main Driveway
East/West Street: Route 40
North/South Street: Marker Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		607	3	6	450	
Peak-Hour Factor, PHF		0.80	0.75	0.62	0.87	
Peak-15 Minute Volume		190	1	2	129	
Hourly Flow Rate, HFR		758	4	9	517	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4	0	6			
Peak Hour Factor, PHF	1.00	0.50	0.42			
Peak-15 Minute Volume	1	0	4			
Hourly Flow Rate, HFR	4	0	14			
Percent Heavy Vehicles	3	3	3			
Percent Grade (%)		-5			3	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		517
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1800
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			3	3	3	3			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.05	-0.05	-0.05	0.03	0.03	0.03
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3	3	3	3			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		762	1295	1295	760			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	760	
Potential Capacity	405	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	405	
Probability of Queue free St.	0.97	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	762	
Potential Capacity	846	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	846	
Probability of Queue free St.	0.99	1.00
Maj L-Shared Prob Q free St.	0.99	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1295	
Potential Capacity	162	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	160	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1295	
Potential Capacity	179	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.95
Movement Capacity	177	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1295	
Potential Capacity	162	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity	160	

Result for 2 stage process:		
a		
y		
C t	160	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1295	
Potential Capacity	179	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.99
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.99	0.95
Movement Capacity	177	

Results for Two-stage process:		
a		
y		
C t	177	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4	0	14			
Movement Capacity (vph)	177	160	405			
Shared Lane Capacity (vph)		315				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	177	160	405			
Volume	4	0	14			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		315				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		9		18				
C(m) (vph)		846		315				
v/c		0.01		0.06				
95% queue length		0.03		0.18				
Control Delay		9.3		17.1				
LOS		A		C				
Approach Delay				17.1				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.99
v(il), Volume for stream 2 or 5		517
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1800
P*(oj)		0.99
d(M,LT), Delay for stream 1 or 4		9.3
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	18	614			433	9
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Hourly Flow Rate, HFR	26	653			460	13
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				13	0	29
Peak Hour Factor, PHF				0.75	0.38	0.93
Hourly Flow Rate, HFR				17	0	31
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	26						48	
C(m) (vph)	1084						356	
v/c	0.02						0.13	
95% queue length	0.07						0.46	
Control Delay	8.4						16.7	
LOS	A						C	
Approach Delay							16.7	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone:
Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW
Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
olume	18	614			433	9
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Peak-15 Minute Volume	7	163			115	3
Hourly Flow Rate, HFR	26	653			460	13
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				13	0	29
Peak Hour Factor, PHF				0.75	0.38	0.93
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				17	0	31
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	653	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100							0.10	0.10	0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.6	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

›mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	473					1171	1171	466
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
/(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		466
Potential Capacity		594
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		594
Probability of Queue free St.	1.00	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows		473
Potential Capacity		1084
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1084
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.96

tep 3: TH from Minor St.	8	11
Conflicting Flows		1171
Potential Capacity		190
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		183
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1171
Potential Capacity		211
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		206

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
tential Capacity		
edestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1171
Potential Capacity		190
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		183

Result for 2 stage process:		
a		
y		
C t		183
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1171
Potential Capacity		211
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		206

Results for Two-stage process:		
a		
y		
C t		206

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				17	0	31
Movement Capacity (vph)				206	183	594
Shared Lane Capacity (vph)					356	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				206	183	594
Volume				17	0	31
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					356	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	26						48	
C(m) (vph)	1084						356	
v/c	0.02						0.13	
95% queue length	0.07						0.46	
Control Delay	8.4						16.7	
LOS	A						C	
Approach Delay							16.7	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	653	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 109/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	15	554			442	11
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Hourly Flow Rate, HFR	30	636			508	22
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				9	0	13
Peak Hour Factor, PHF				0.40	0.38	0.60
Hourly Flow Rate, HFR				22	0	21
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	30						43	
C(m) (vph)	1032						282	
v/c	0.03						0.15	
95% queue length	0.09						0.53	
Control Delay	8.6						20.0	
LOS	A						C	
Approach Delay							20.0	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 109/2005
Analysis Time Period: Saturday Peak Base
Intersection: Route 40/Smith School Hse Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Smith School House Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	15	554			442	11
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Peak-15 Minute Volume	8	159			127	6
Hourly Flow Rate, HFR	30	636			508	22
Percent Heavy Vehicles	3	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				9	0	13
Peak Hour Factor, PHF				0.40	0.38	0.60
Peak-15 Minute Volume				6	0	5
Hourly Flow Rate, HFR				22	0	21
Percent Heavy Vehicles				3	3	3
Percent Grade (%)					10	
Flared Approach: Exists?/Storage		/				No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	636	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1800	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3					3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100							0.10	0.10	0.10
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.6	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3					3	3	3
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	530					1215	1215	519
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		519
Potential Capacity		554
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		554
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		530
Potential Capacity		1032
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1032
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1215
Potential Capacity		179
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		171
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1215
Potential Capacity		198
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		192

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1215
Potential Capacity		179
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		171

Result for 2 stage process:		
a		
y		
C t		171
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1215
Potential Capacity		198
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		192

Results for Two-stage process:		
a		
y		
C t		192

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				22	0	21
Movement Capacity (vph)				192	171	554
Shared Lane Capacity (vph)					282	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				192	171	554
Volume				22	0	21
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					282	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	30						43	
C(m) (vph)	1032						282	
v/c	0.03						0.15	
95% queue length	0.09						0.53	
Control Delay	8.6						20.0	
LOS	A						C	
Approach Delay							20.0	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	636	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1800	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Eastbound			Westbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		29	559	52	15	396	42
Peak-Hour Factor, PHF		0.81	0.94	0.78	0.58	0.94	0.79
Hourly Flow Rate, HFR		35	594	66	25	421	53
Percent Heavy Vehicles		3	--	--	3	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1	0	0	1	0
Configuration			LTR			LTR	
Upstream Signal?			No			No	

Minor Street:	Approach	Northbound			Southbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		29	8	18	40	3	17
Peak Hour Factor, PHF		0.81	0.58	0.67	0.75	0.38	0.63
Hourly Flow Rate, HFR		35	13	26	53	7	26
Percent Heavy Vehicles		3	3	3	3	3	3
Percent Grade (%)			-4			3	
Flared Approach:	Exists?/Storage			No /			No /
Lanes		0	1	0	0	1	0
Configuration			LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1083	923		191			174	
v/c	0.03	0.03		0.39			0.49	
95% queue length	0.10	0.08		1.70			2.41	
Control Delay	8.4	9.0		35.3			44.4	
LOS	A	A		E			E	
Approach Delay				35.3			44.4	
Approach LOS				E			E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Weekday PM Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	559	52	15	396	42
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	9	149	17	6	105	13
Hourly Flow Rate, HFR	35	594	66	25	421	53
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	29	8	18	40	3	17
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	9	3	7	13	2	7
Hourly Flow Rate, HFR	35	13	26	53	7	26
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	594	421
Shared ln volume, major rt vehicles:	66	53
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3	3	3	3	3	3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
onstrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	474	660	1211	1221	627	1214	1228	448
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
?(x)								
/(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	627	448
Potential Capacity	482	608
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	482	608
Probability of Queue free St.	0.95	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	660	474
Potential Capacity	923	1083
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	923	1083
Probability of Queue free St.	0.97	0.97
Maj L-Shared Prob Q free St.	0.96	0.95

tep 3: TH from Minor St.	8	11
Conflicting Flows	1221	1228
Potential Capacity	179	177
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.91	0.91
Movement Capacity	164	162
Probability of Queue free St.	0.92	0.96

Step 4: LT from Minor St.	7	10
Conflicting Flows	1211	1214
Potential Capacity	159	157
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	0.84
Maj. L, Min T Adj. Imp Factor.	0.90	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	138	130

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
tential Capacity		
edestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1221	1228
Potential Capacity	179	177
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.91	0.91
Movement Capacity	164	162

Result for 2 stage process:		
a		
y		
C t	164	162
Probability of Queue free St.	0.92	0.96

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1211	1214
Potential Capacity	159	157
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	0.84
Maj. L, Min T Adj. Imp Factor.	0.90	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	138	130

Results for Two-stage process:		
a		
y		
C t	138	130

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
volume (vph)	35	13	26	53	7	26
Movement Capacity (vph)	138	164	482	130	162	608
Shared Lane Capacity (vph)		191			174	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	138	164	482	130	162	608
Volume	35	13	26	53	7	26
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		191			174	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1083	923		191			174	
v/c	0.03	0.03		0.39			0.49	
95% queue length	0.10	0.08		1.70			2.41	
Control Delay	8.4	9.0		35.3			44.4	
LOS	A	A		E			E	
Approach Delay				35.3			44.4	
Approach LOS				E			E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.97
v(il), Volume for stream 2 or 5	594	421
v(i2), Volume for stream 3 or 6	66	53
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.95	0.96
d(M,LT), Delay for stream 1 or 4	8.4	9.0
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.4	0.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	554	31	10	376	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	28	636	49	14	432	24
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1100	904		191			200	
v/c	0.03	0.02		0.60			0.34	
95% queue length	0.08	0.05		3.31			1.39	
Control Delay	8.4	9.0		48.4			31.8	
LOS	A	A		E			D	
Approach Delay				48.4			31.8	
Approach LOS				E			D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: TR
Agency/Co.: McMillen Engineering
Date Performed: 10/9/2005
Analysis Time Period: Saturday Base
Intersection: Route 40/ Dinner Bell Road
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2016
Project ID: Route 40 and Dinner Bell Road Intersection
East/West Street: Route 40
North/South Street: Dinner Bell Road
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	554	31	10	376	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	7	159	12	4	108	6
Hourly Flow Rate, HFR	28	636	49	14	432	24
Percent Heavy Vehicles	3	--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	18	1	10	9	1	7
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	3	3	3	3	3	3
Percent Grade (%)		-4			3	
Flared Approach: Exists?/Storage			No	/		No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	636	432
Shared ln volume, major rt vehicles:	49	24
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3	3	3	3	3	3	3	3
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				-0.04	-0.04	-0.04	0.03	0.03	0.03
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	3	3	3	3	3	3	3	3
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
onstrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	456	685	1204	1200	660	1210	1213	444
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	660	444
Potential Capacity	462	612
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	462	612
Probability of Queue free St.	0.91	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	685	456
Potential Capacity	904	1100
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	904	1100
Probability of Queue free St.	0.98	0.97
Maj L-Shared Prob Q free St.	0.98	0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows	1200	1213
Potential Capacity	185	181
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	174	170
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10
Conflicting Flows	1204	1210
Potential Capacity	161	158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	144	135

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 3 - Single Stage		
Conflicting Flows	1200	1213
Potential Capacity	185	181
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	174	170

Result for 2 stage process:		
a		
y		
C t	174	170
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10

Part 1 - First Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 3 - Single Stage		
Conflicting Flows	1204	1210
Potential Capacity	161	158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	144	135

Results for Two-stage process:		
a		
y		
C t	144	135

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
volume (vph)	70	4	40	36	4	27
Movement Capacity (vph)	144	174	462	135	170	612
Shared Lane Capacity (vph)		191			200	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	144	174	462	135	170	612
Volume	70	4	40	36	4	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		191			200	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1100	904		191			200	
v/c	0.03	0.02		0.60			0.34	
95% queue length	0.08	0.05		3.31			1.39	
Control Delay	8.4	9.0		48.4			31.8	
OS	A	A		E			D	
pproach Delay				48.4			31.8	
Approach LOS				E			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.98
v(il), Volume for stream 2 or 5	636	432
v(i2), Volume for stream 3 or 6	49	24
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.96	0.98
d(M,LT), Delay for stream 1 or 4	8.4	9.0
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.2

APPENDIX 5

CAPACITY ANALYSIS
(2016 DEVELOPED CONDITIONS)

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Eastbound			Westbound		
	Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume			562	59	57	565	
Peak-Hour Factor, PHF			0.92	0.75	0.72	0.91	
Hourly Flow Rate, HFR			610	78	79	620	
Percent Heavy Vehicles			--	--	0	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0	0	1	
Configuration				TR	LT		
Upstream Signal?			No			No	

Minor Street:	Approach	Northbound			Southbound		
	Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume		56	0	63			
Peak Hour Factor, PHF		0.71	1.00	1.00			
Hourly Flow Rate, HFR		78	0	63			
Percent Heavy Vehicles		0	0	0			
Percent Grade (%)			0			0	
Flared Approach:	Exists?/Storage			No	/		/
Lanes		0	1	0			
Configuration			LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		79		141				
C(m) (vph)		916		201				
v/c		0.09		0.70				
95% queue length		0.28		4.43				
Control Delay		9.3		56.6				
LOS		A		F				
Approach Delay				56.6				
Approach LOS				F				

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		562	59	57	565	
Peak-Hour Factor, PHF		0.92	0.75	0.72	0.91	
Peak-15 Minute Volume		153	20	20	155	
Hourly Flow Rate, HFR		610	78	79	620	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	56	0	63			
Peak Hour Factor, PHF	0.71	1.00	1.00			
Peak-15 Minute Volume	20	0	16			
Hourly Flow Rate, HFR	78	0	63			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		620
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			0	0	0	0			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		688	1427	1427	649			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	649	
Potential Capacity	473	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	473	
Probability of Queue free St.	0.87	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	688	
Potential Capacity	916	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	916	
Probability of Queue free St.	0.91	1.00
Maj L-Shared Prob Q free St.	0.87	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1427	
Potential Capacity	136	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	118	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1427	
Potential Capacity	150	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.87
Maj. L, Min T Adj. Imp Factor.		0.90
Cap. Adj. factor due to Impeding mvmnt	0.91	0.78
Movement Capacity	137	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1427	
Potential Capacity	136	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	118	

Result for 2 stage process:		
a		
y		
C t	118	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1427	
Potential Capacity	150	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.87
Maj. L, Min T Adj. Imp Factor.		0.90
Cap. Adj. factor due to Impeding mvmnt	0.91	0.78
Movement Capacity	137	

Results for Two-stage process:		
a		
y		
C t	137	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	78	0	63			
Movement Capacity (vph)	137	118	473			
Shared Lane Capacity (vph)		201				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	137	118	473			
Volume	78	0	63			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		201				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		79		141				
C(m) (vph)		916		201				
v/c		0.09		0.70				
95% queue length		0.28		4.43				
Control Delay		9.3		56.6				
LOS		A		F				
Approach Delay				56.6				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.91
v(il), Volume for stream 2 or 5		620
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.87
d(M,LT), Delay for stream 1 or 4		9.3
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.2

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		618	52	55	412	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Hourly Flow Rate, HFR		735	80	74	490	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	34	0	75			
Peak Hour Factor, PHF	0.86	1.00	0.78			
Hourly Flow Rate, HFR	39	0	96			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		74		135				
C(m) (vph)		821		260				
v/c		0.09		0.52				
95% queue length		0.30		2.75				
Control Delay		9.8		32.9				
LOS		A		D				
Approach Delay				32.9				
Approach LOS				D				

HCS2000: Unsignalized Intersections Release 4.1d

Phone:
E-Mail:
Fax:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381S
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381S
Intersection Orientation: EW
Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		618	52	55	412	
Peak-Hour Factor, PHF		0.84	0.65	0.74	0.84	
Peak-15 Minute Volume		184	20	19	123	
Hourly Flow Rate, HFR		735	80	74	490	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	34	0	75			
Peak Hour Factor, PHF	0.86	1.00	0.78			
Peak-15 Minute Volume	10	0	24			
Hourly Flow Rate, HFR	39	0	96			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		490
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1800
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1	6.5	6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			0	0	0	0			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70	0.00	0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.1	6.4	6.5	6.2			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		815	1413	1413	775			
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	775	
Potential Capacity	401	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	401	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	815	
Potential Capacity	821	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	821	
Probability of Queue free St.	0.91	1.00
Maj L-Shared Prob Q free St.	0.88	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1413	
Potential Capacity	139	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity	122	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1413	
Potential Capacity	153	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.88
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.91	0.69
Movement Capacity	139	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1413	
Potential Capacity	139	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity	122	

Result for 2 stage process:		
a		
y		
C t	122	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1413	
Potential Capacity	153	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.88
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.91	0.69
Movement Capacity	139	

Results for Two-stage process:		
a		
y		
C t	139	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	39	0	96			
Movement Capacity (vph)	139	122	401			
Shared Lane Capacity (vph)		260				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	139	122	401			
Volume	39	0	96			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		260				
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LTR				
v (vph)		74		135				
C(m) (vph)		821		260				
v/c		0.09		0.52				
95% queue length		0.30		2.75				
Control Delay		9.8		32.9				
LOS		A		D				
Approach Delay				32.9				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.91
v(il), Volume for stream 2 or 5		490
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1800
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.88
d(M,LT), Delay for stream 1 or 4		9.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.2

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Eastbound			Westbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		67	558			569	19
Peak-Hour Factor, PHF		0.88	0.92			0.91	0.85
Hourly Flow Rate, HFR		76	606			625	22
Percent Heavy Vehicles		0	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1			1	0
Configuration		LT				TR	
Upstream Signal?			No			No	

Minor Street:	Approach	Northbound			Southbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					46	0	53
Peak Hour Factor, PHF					0.71	1.00	0.68
Hourly Flow Rate, HFR					64	0	77
Percent Heavy Vehicles					0	0	0
Percent Grade (%)			0			0	
Flared Approach:	Exists?/Storage			/		No	/
Lanes					0	1	0
Configuration						LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	76						141	
C(m) (vph)	948						234	
v/c	0.08						0.60	
95% queue length	0.26						3.50	
Control Delay	9.1						41.3	
LOS	A						E	
Approach Delay							41.3	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	67	558			569	19
Peak-Hour Factor, PHF	0.88	0.92			0.91	0.85
Peak-15 Minute Volume	19	152			156	6
Hourly Flow Rate, HFR	76	606			625	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				46	0	53
Peak Hour Factor, PHF				0.71	1.00	0.68
Peak-15 Minute Volume				16	0	19
Hourly Flow Rate, HFR				64	0	77
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	606	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	647					1394	1394	636
s								
Px								
V c,u,x								
r,x								
plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		636
Potential Capacity		481
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		481
Probability of Queue free St.	1.00	0.84

Step 2: LT from Major St.	4	1
Conflicting Flows		647
Potential Capacity		948
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		948
Probability of Queue free St.	1.00	0.92
Maj L-Shared Prob Q free St.		0.88

Step 3: TH from Minor St.	8	11
Conflicting Flows		1394
Potential Capacity		143
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		126
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1394
Potential Capacity		158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	
Maj. L, Min T Adj. Imp Factor.	0.91	
Cap. Adj. factor due to Impeding mvmnt	0.76	0.92
Movement Capacity		145

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1394
Potential Capacity		143
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		126

Result for 2 stage process:		
a		
y		
C t		126
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1394
Potential Capacity		158
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	
Maj. L, Min T Adj. Imp Factor.	0.91	
Cap. Adj. factor due to Impeding mvmnt	0.76	0.92
Movement Capacity		145

Results for Two-stage process:		
a		
y		
C t		145

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				64	0	77
Movement Capacity (vph)				145	126	481
Shared Lane Capacity (vph)					234	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				145	126	481
Volume				64	0	77
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					234	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	76						141	
C(m) (vph)	948						234	
v/c	0.08						0.60	
95% queue length	0.26						3.50	
Control Delay	9.1						41.3	
LOS	A						E	
Approach Delay							41.3	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.92	1.00
v(il), Volume for stream 2 or 5	606	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.88	
d(M,LT), Delay for stream 1 or 4	9.1	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.1	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	89	604			413	62
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Hourly Flow Rate, HFR	97	719			491	79
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				44	0	54
Peak Hour Factor, PHF				0.70	1.00	0.77
Hourly Flow Rate, HFR				62	0	70
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	97						132	
C(m) (vph)	1013						223	
v/c	0.10						0.59	
95% queue length	0.32						3.36	
Control Delay	8.9						42.2	
LOS	A						E	
Approach Delay							42.2	
Approach LOS							E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SR 381N
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SR 381N
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	89	604			413	62
Peak-Hour Factor, PHF	0.91	0.84			0.84	0.78
Peak-15 Minute Volume	24	180			123	20
Hourly Flow Rate, HFR	97	719			491	79
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				44	0	54
Peak Hour Factor, PHF				0.70	1.00	0.77
Peak-15 Minute Volume				16	0	18
Hourly Flow Rate, HFR				62	0	70
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		/				No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	719	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	570					1443	1443	530
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		530
Potential Capacity		553
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		553
Probability of Queue free St.	1.00	0.87

Step 2: LT from Major St.	4	1
Conflicting Flows		570
Potential Capacity		1013
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1013
Probability of Queue free St.	1.00	0.90
Maj L-Shared Prob Q free St.		0.84

Step 3: TH from Minor St.	8	11
Conflicting Flows		1443
Potential Capacity		133
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		112
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1443
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.84	
Maj. L, Min T Adj. Imp Factor.	0.88	
Cap. Adj. factor due to Impeding mvmnt	0.77	0.90
Movement Capacity		133

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1443
Potential Capacity		133
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		112

Result for 2 stage process:		
a		
y		
C t		112
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1443
Potential Capacity		147
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.84	
Maj. L, Min T Adj. Imp Factor.	0.88	
Cap. Adj. factor due to Impeding mvmnt	0.77	0.90
Movement Capacity		133

Results for Two-stage process:		
a		
y		
C t		133

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				62	0	70
Movement Capacity (vph)				133	112	553
Shared Lane Capacity (vph)					223	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				133	112	553
Volume				62	0	70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					223	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	97						132	
C(m) (vph)	1013						223	
v/c	0.10						0.59	
95% queue length	0.32						3.36	
Control Delay	8.9						42.2	
LOS	A						E	
Approach Delay							42.2	
Approach LOS							E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.90	1.00
v(il), Volume for stream 2 or 5	719	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.84	
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	23	581			411	41
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Hourly Flow Rate, HFR	34	631			451	62
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				41	0	46
Peak Hour Factor, PHF				0.62	1.00	0.66
Hourly Flow Rate, HFR				66	0	69
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						135	
C(m) (vph)	1063						307	
v/c	0.03						0.44	
95% queue length	0.10						2.14	
Control Delay	8.5						25.6	
LOS	A						D	
Approach Delay							25.6	
Approach LOS							D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	23	581			411	41
Peak-Hour Factor, PHF	0.66	0.92			0.91	0.66
Peak-15 Minute Volume	9	158			113	16
Hourly Flow Rate, HFR	34	631			451	62
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				41	0	46
Peak Hour Factor, PHF				0.62	1.00	0.66
Peak-15 Minute Volume				17	0	17
Hourly Flow Rate, HFR				66	0	69
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	631	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	513					1181	1181	482
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		482
Potential Capacity		588
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		588
Probability of Queue free St.	1.00	0.88

Step 2: LT from Major St.	4	1
Conflicting Flows		513
Potential Capacity		1063
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1063
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		1181
Potential Capacity		192
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		183
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1181
Potential Capacity		212
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.85	0.97
Movement Capacity		205

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1181
Potential Capacity		192
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		183

Result for 2 stage process:		
a		
y		
C t		183
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1181
Potential Capacity		212
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.85	0.97
Movement Capacity		205
Results for Two-stage process:		
a		
y		
C t		205

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				66	0	69
Movement Capacity (vph)				205	183	588
Shared Lane Capacity (vph)					307	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				205	183	588
Volume				66	0	69
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					307	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						135	
C(m) (vph)	1063						307	
v/c	0.03						0.44	
95% queue length	0.10						2.14	
Control Delay	8.5						25.6	
LOS	A						D	
Approach Delay							25.6	
Approach LOS							D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	631	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	28	649			400	23
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Hourly Flow Rate, HFR	35	772			476	39
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				21	0	15
Peak Hour Factor, PHF				0.79	1.00	0.58
Hourly Flow Rate, HFR				26	0	25
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	35						51	
C(m) (vph)	1061						253	
v/c	0.03						0.20	
95% queue length	0.10						0.74	
Control Delay	8.5						22.8	
LOS	A						C	
Approach Delay							22.8	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / HAWES ROAD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: HAWES ROAD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	28	649			400	23
Peak-Hour Factor, PHF	0.78	0.84			0.84	0.58
Peak-15 Minute Volume	9	193			119	10
Hourly Flow Rate, HFR	35	772			476	39
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				21	0	15
Peak Hour Factor, PHF				0.79	1.00	0.58
Peak-15 Minute Volume				7	0	6
Hourly Flow Rate, HFR				26	0	25
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	772	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	515					1338	1338	496
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		496
Potential Capacity		578
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		578
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		515
Potential Capacity		1061
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1061
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.94

Step 3: TH from Minor St.	8	11
Conflicting Flows		1338
Potential Capacity		154
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		145
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1338
Potential Capacity		170
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		164

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1338
Potential Capacity		154
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		145

Result for 2 stage process:		
a		
y		
C t		145
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1338
Potential Capacity		170
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		164

Results for Two-stage process:		
a		
y		
C t		164

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				26	0	25
Movement Capacity (vph)				164	145	578
Shared Lane Capacity (vph)					253	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				164	145	578
Volume				26	0	25
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					253	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	35						51	
C(m) (vph)	1061						253	
v/c	0.03						0.20	
95% queue length	0.10						0.74	
Control Delay	8.5						22.8	
LOS	A						C	
Approach Delay							22.8	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	772	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.94	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	31	591			427	15
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	34	656			474	16
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				14	0	28
Peak Hour Factor, PHF				0.90	0.90	0.90
Hourly Flow Rate, HFR				15	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						46	
C(m) (vph)	1084						359	
v/c	0.03						0.13	
95% queue length	0.10						0.44	
Control Delay	8.4						16.5	
LOS	A						C	
Approach Delay							16.5	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	31	591			427	15
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	9	164			119	4
Hourly Flow Rate, HFR	34	656			474	16
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				14	0	28
Peak Hour Factor, PHF				0.90	0.90	0.90
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				15	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	656	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	490					1206	1206	482
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		482
Potential Capacity		588
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		588
Probability of Queue free St.	1.00	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows		490
Potential Capacity		1084
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1084
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows		1206
Potential Capacity		185
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		176
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1206
Potential Capacity		205
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		199

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1206
Potential Capacity		185
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		176

Result for 2 stage process:		
a		
y		
C t		176
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1206
Potential Capacity		205
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.97
Movement Capacity		199
Results for Two-stage process:		
a		
y		
C t		199

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				15	0	31
Movement Capacity (vph)				199	176	588
Shared Lane Capacity (vph)					359	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				199	176	588
Volume				15	0	31
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					359	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	34						46	
C(m) (vph)	1084						359	
v/c	0.03						0.13	
95% queue length	0.10						0.44	
Control Delay	8.4						16.5	
LOS	A						C	
Approach Delay							16.5	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	656	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.95	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	34	636			484	17
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	37	706			537	18
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				15	0	30
Peak Hour Factor, PHF				0.90	0.90	0.90
Hourly Flow Rate, HFR				16	0	33
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	37						49	
C(m) (vph)	1026						312	
v/c	0.04						0.16	
95% queue length	0.11						0.55	
Control Delay	8.6						18.7	
LOS	A						C	
Approach Delay							18.7	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SEC. DRIVE
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SECONDARY DRIVEWAY
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	34	636			484	17
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	9	177			134	5
Hourly Flow Rate, HFR	37	706			537	18
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				15	0	30
Peak Hour Factor, PHF				0.90	0.90	0.90
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				16	0	33
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	706	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	555					1326	1326	546
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		546
Potential Capacity		541
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		541
Probability of Queue free St.	1.00	0.94

Step 2: LT from Major St.	4	1
Conflicting Flows		555
Potential Capacity		1026
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1026
Probability of Queue free St.	1.00	0.96
Maj L-Shared Prob Q free St.		0.94

Step 3: TH from Minor St.	8	11
Conflicting Flows		1326
Potential Capacity		157
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		148
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1326
Potential Capacity		173
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.90	0.96
Movement Capacity		167

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1326
Potential Capacity		157
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity		148

Result for 2 stage process:		
a		
y		
C t		148
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1326
Potential Capacity		173
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.94	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.90	0.96
Movement Capacity		167

Results for Two-stage process:		
a		
y		
C t		167

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				16	0	33
Movement Capacity (vph)				167	148	541
Shared Lane Capacity (vph)					312	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				167	148	541
Volume				16	0	33
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					312	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	37						49	
C(m) (vph)	1026						312	
v/c	0.04						0.16	
95% queue length	0.11						0.55	
Control Delay	8.6						18.7	
LOS	A						C	
Approach Delay							18.7	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.96	1.00
v(il), Volume for stream 2 or 5	706	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.94	
d(M,LT), Delay for stream 1 or 4	8.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

HCS2000: Signalized Intersections Release 4.1e

Analyst: RHH
Agency: McMILLEN ENGINEERING
Date: 12/5/2005
Period: WEEKDAY PM PEAK DEVELOPED
Project ID: 2005-319
E/W St: ROUTE 40

Inter.: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisd:
Year : 2016

N/S St: MAIN DRIVE/MARKER ROAD

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Volume	62	546	9	7	383	47	3	0	11	42	0	56
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			2			12			3			14

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
WB Left	A				SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	7.0	33.0					12.0			
Yellow	4.0	4.0					4.0			
All Red	2.0	2.0					2.0			

Cycle Length: 70.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	171	1710	0.40	0.10	31.1	C		
TR	831	1762	0.74	0.47	18.6	B	19.8	B
Westbound								
L	171	1710	0.05	0.10	28.6	C		
TR	823	1745	0.57	0.47	14.2	B	14.5	B
Northbound								
LTR	265	1545	0.05	0.17	24.3	C	24.3	C
Southbound								
L	244	1424	0.19	0.17	25.2	C		
TR	262	1530	0.18	0.17	25.1	C	25.2	C

Intersection Delay = 18.3 (sec/veh) Intersection LOS = B

HCS2000: Signalized Intersections Release 4.1e

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 12/5/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisdiction:
Analysis Year: 2016
Project ID: 2005-319

East/West Street: ROUTE 40
North/South Street: MAIN DRIVE/MARKER ROAD

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	62	546	9	7	383	47	3	0	11	42	0	56
% Heavy Veh	0	2	0	0	2	0	0	2	0	0	2	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PK 15 Vol	17	152	3	2	106	13	1	0	3	12	0	16
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800		1800	1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			2			12			3			14
Adj Flow	69	615		8	465			12		47	47	
%InSharedLn												
Prop LTs		0.000			0.000			0.250		1.000	0.000	
Prop RTs		0.013			0.084			0.750			1.000	
Peds Bikes		0			0			0			0	
Buses	0	0		0	0			0		0	0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Arriv. Type	3	3		3	3			3		3	3	
Unit Ext.	3.0	3.0		3.0	3.0			3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0			2.0		2.0	2.0	

Ped Min g	3.2	3.2	3.2	3.2

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A				NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
WB Left	A				SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds						Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	7.0	33.0					12.0			
Yellow	4.0	4.0					4.0			
All Red	2.0	2.0					2.0			

Cycle Length: 70.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	62	546	9	7	383	47	3	0	11	42	0	56
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj flow	69	607	8	8	426	39	3	0	9	47	0	47
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
Lane group	L	TR		L	TR			LTR		L	TR	
Adj flow	69	615		8	465			12		47	47	
Prop LTs		0.000			0.000			0.250		1.000	0.000	
Prop RTs		0.013			0.084			0.750			1.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR			LTR		L	TR	
So	1800	1800		1800	1800			1800		1800	1800	
Lanes	1	1	0	1	1	0	0	1	0	1	1	0
fW	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fHV	1.000	0.981		1.000	0.982			1.000		1.000	1.000	
fG	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fP	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fBB	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fA	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRT		0.998			0.987			0.899			0.850	
fLT	0.950	1.000		0.950	1.000			0.955		0.791	1.000	
Sec.												
fLpb	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1710	1762		1710	1745			1545		1424	1530	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	69	1710	# 0.04	0.10	171	0.40
Prot							
Perm							
Thru	TR	615	1762	# 0.35	0.47	831	0.74
Right							
Westbound							
Prot							
Perm							
Left	L	8	1710	0.00	0.10	171	0.05
Prot							
Perm							
Thru	TR	465	1745	0.27	0.47	823	0.57
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	12	1545	0.01	0.17	265	0.05
Right							
Southbound							
Prot							
Perm							
Left	L	47	1424	# 0.03	0.17	244	0.19
Prot							
Perm							
Thru	TR	47	1530	0.03	0.17	262	0.18
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.42
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.57

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.40	0.10	29.5	1.000	171	0.11	1.6	0.0	31.1	C		
TR	0.74	0.47	15.0	1.000	831	0.30	3.6	0.0	18.6	B	19.8	B
Westbound												
L	0.05	0.10	28.5	1.000	171	0.11	0.1	0.0	28.6	C		
TR	0.57	0.47	13.3	1.000	823	0.16	0.9	0.0	14.2	B	14.5	B
Northbound												
LTR	0.05	0.17	24.2	1.000	265	0.11	0.1	0.0	24.3	C	24.3	C
Southbound												
L	0.19	0.17	24.8	1.000	244	0.11	0.4	0.0	25.2	C		

```
  TR   0.18  0.17  24.8  1.000 262   0.11   0.3   0.0   25.1   C    25.2   C

        Intersection delay = 18.3  (sec/veh)   Intersection LOS = B

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for exclusive lefts
 Input
                                                        EB     WB     NB     SB
 Opposed by Single(S) or Multiple(M) lane approach                           S
 Cycle length, C                              70.0    sec
 Total actual green time for LT lane group, G (s)                            12.0
 Effective permitted green time for LT lane group, g(s)                      12.0
 Opposing effective green time, go (s)                                       12.0
 Number of lanes in LT lane group, N                                         1
 Number of lanes in opposing approach, No                                    1
 Adjusted LT flow rate, VLT (veh/h)                                          47
 Proportion of LT in LT lane group, PLT                                      1.000
 Proportion of LT in opposing flow, PLTo                                     0.25
 Adjusted opposing flow rate, Vo (veh/h)                                     12
 Lost time for LT lane group, tL                                             6.00
 Computation
 LT volume per cycle, LTC=VLTC/3600                                          0.91
 Opposing lane util. factor, fLUo                      1.000 1.000 1.000 1.000
 Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                         0.23
 gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                       0.0
 Opposing platoon ratio, Rpo (refer Exhibit 16-11)                           1.00
 Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                                0.83
 gq, (see Exhibit C16-4,5,6,7,8)                                             0.00
 gu=g-gq if gq>=gf, or = g-gf if gq<gf                                       12.00
 n=Max(gq-gf)/2,0)                                                           0.00
 PTHo=1-PLTo                                                                 0.75
 PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                          1.00
 EL1 (refer to Exhibit C16-3)                                                1.26
 EL2=Max((1-Ptho**n)/Plto, 1.0)                                              1.00
 fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                          0.33
 gdiff=max(gq-gf,0)                                                          0.00
 fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                         0.79
 flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
 or flt=[fm+0.91(N-1)]/N**
 Left-turn adjustment, fLT                                                   0.791

 For special case of single-lane approach opposed by multilane approach,
 see text.
 * If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
   left-turn lane and redo calculations.
 ** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
 For special case of multilane approach opposed by single-lane approach
 or when gf>gq, see text.

______________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                              for shared lefts
 Input
                                                        EB     WB     NB     SB
 Opposed by Single(S) or Multiple(M) lane approach                    M
 Cycle length, C                              70.0    sec
 Total actual green time for LT lane group, G (s)                     12.0
 Effective permitted green time for LT lane group, g(s)               12.0
 Opposing effective green time, go (s)                                12.0
```

Number of lanes in LT lane group, N			1	
Number of lanes in opposing approach, No			1	
Adjusted LT flow rate, VLT (veh/h)			3	
Proportion of LT in LT lane group, PLT	0.000	0.000	0.250	0.000
Proportion of LT in opposing flow, PLTo			0.00	
Adjusted opposing flow rate, Vo (veh/h)			47	
Lost time for LT lane group, tL			6.00	
Computation				
LT volume per cycle, LTC=VLTC/3600			0.06	
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			0.91	
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			4.7	
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.83	
gq, (see Exhibit C16-4,5,6,7,8)			0.00	
gu=g-gq if gq>=gf, or = g-gf if gq<gf			7.30	
n=Max(gq-gf)/2,0)			0.00	
PTHo=1-PLTo			1.00	
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.25	
EL1 (refer to Exhibit C16-3)			1.32	
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.21	
gdiff=max(gq-gf,0)			0.00	
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.96	
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT			0.955	

For special case of single-lane approach opposed by multilane approach, see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				

Vbicg
OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

			EBLT	WBLT	NBLT	SBLT
Cycle length, C	70.0	sec				
Adj. LT vol from Vol Adjustment Worksheet, v						
v/c ratio from Capacity Worksheet, X						
Protected phase effective green interval, g (s)						
Opposing queue effective green interval, gq						
Unopposed green interval, gu						
Red time r=(C-g-gq-gu)						
Arrival rate, qa=v/(3600(max[X,1.0]))						
Protected ph. departure rate, Sp=s/3600						
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)						
XPerm						
XProt						
Case						
Queue at beginning of green arrow, Qa						
Queue at beginning of unsaturated green, Qu						
Residual queue, Qr						
Uniform Delay, d1						

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
Westbound								
Northbound								
Southbound								

Intersection Delay 18.3 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR			LTR		L	TR	
Init Queue	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Flow Rate	69	615		8	465			12		47	47	
So	1800	1800		1800	1800			1800		1800	1800	
No.Lanes	1	1	0	1	1	0	0	1	0	1	1	0
SL	1710	1762		1710	1745			1545		1424	1530	
LnCapacity	171	831		171	823			265		244	262	
Flow Ratio	0.04	0.35		0.00	0.27			0.01		0.03	0.03	
v/c Ratio	0.40	0.74		0.05	0.57			0.05		0.19	0.18	
Grn Ratio	0.10	0.47		0.10	0.47			0.17		0.17	0.17	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3			3		3	3	
Pltn Ratio	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
PF2	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Q1	1.3	9.7		0.1	6.5			0.2		0.8	0.8	
kB	0.2	0.5		0.2	0.5			0.3		0.3	0.3	
Q2	0.1	1.4		0.0	0.7			0.0		0.1	0.1	
Q Average	1.4	11.1		0.2	7.2			0.2		0.8	0.8	
Q Spacing	25.0	25.0		25.0	25.0			25.0		25.0	25.0	
Q Storage	0	0		0	0			0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2			1.2		1.2	1.2	
BOQ	1.7	13.1		0.2	8.5			0.2		1.0	1.0	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5			1.6		1.6	1.6	
BOQ	2.2	16.8		0.2	11.0			0.3		1.3	1.3	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.6		1.8	1.7			1.8		1.8	1.8	
BOQ	2.5	18.2		0.3	12.1			0.4		1.5	1.5	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.8		2.1	1.9			2.1		2.1	2.1	
BOQ	2.9	20.3		0.3	13.7			0.4		1.7	1.7	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.1		2.7	2.3			2.7		2.6	2.6	
BOQ	3.6	23.7		0.4	16.4			0.6		2.2	2.2	
QSRatio												

ERROR MESSAGES

No errors to report.

```
                HCS2000: Signalized Intersections Release 4.1e

   Analyst: RHH                           Inter.: ROUTE 40/MAIN DRIVE
   Agency: McMILLEN ENGINEERING           Area Type: All other areas
   Date:    12/5/2005                     Jurisd:
   Period: SATURDAY AM PEAK DEVELOPED     Year  : 2016
   Project ID: 2005-319
   E/W St: ROUTE 40                       N/S St: MAIN DRIVE/MARKER ROAD

   ______________________SIGNALIZED INTERSECTION SUMMARY_______________________
               |  Eastbound     |  Westbound     |  Northbound    |  Southbound    |
               | L    T    R    | L    T    R    | L    T    R    | L    T    R    |
               |________________|________________|________________|________________|
   No. Lanes   |   1    1    0  |   1    1    0  |   0    1    0  |   1    1    0  |
   LGConfig    | L     TR       | L     TR       |      LTR       | L     TR       |
   Volume      |68   498   3    |6    346   51   |4    0    6     |45   0     60   |
   Lane Width  |12.0 12.0       |12.0 12.0       |     12.0       |12.0 12.0       |
   RTOR Vol    |           1    |           13   |          2     |           15   |
   ____________________________________________________________________________
   Duration     0.25      Area Type: All other areas
   ____________________________Signal Operations_______________________________
   Phase Combination 1     2     3     4 |           5     6     7     8
   EB  Left          A                   | NB  Left  A
       Thru                A             |     Thru  A
       Right               A             |     Right A
       Peds                              |     Peds
   WB  Left          A                   | SB  Left  A
       Thru                A             |     Thru  A
       Right               A             |     Right A
       Peds                              |     Peds
   NB  Right                             | EB  Right
   SB  Right                             | WB  Right
   Green            7.0   33.0                     12.0
   Yellow           4.0   4.0                      4.0
   All Red          2.0   2.0                      2.0
                                                Cycle Length: 70.0    secs
   ________________Intersection Performance Summary____________________________
   Appr/   Lane      Adj Sat    Ratios        Lane Group    Approach
   Lane    Group     Flow Rate  ___________   __________    __________
   Grp     Capacity   (s)       v/c    g/C    Delay LOS     Delay LOS
   ____________________________________________________________________________
   Eastbound
   L       171       1710       0.44   0.10   31.5   C
   TR      832       1764       0.67   0.47   16.3   B      18.1   B

   Westbound
   L       171       1710       0.04   0.10   28.6   C
   TR      821       1742       0.52   0.47   13.5   B      13.8   B

   Northbound

   LTR     263       1532       0.03   0.17   24.2   C      24.2   C

   Southbound
   L       245       1430       0.20   0.17   25.3   C
   TR      262       1530       0.19   0.17   25.2   C      25.3   C

        Intersection Delay = 17.2  (sec/veh)   Intersection LOS = B
   ____________________________________________________________________________
```

HCS2000: Signalized Intersections Release 4.1e

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 12/5/2005
Analysis Time Period: SATURDAY AM PEAK DEVELOPED
Intersection: ROUTE 40/MAIN DRIVE
Area Type: All other areas
Jurisdiction:
Analysis Year: 2016
Project ID: 2005-319

East/West Street: ROUTE 40
North/South Street: MAIN DRIVE/MARKER ROAD

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	68	498	3	6	346	51	4	0	6	45	0	60
% Heavy Veh	0	2	0	0	2	0	0	2	0	0	2	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
PK 15 Vol	19	138	1	2	96	14	1	0	2	13	0	17
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1800	1800		1800	1800			1800		1800	1800	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
LGConfig	L	TR		L	TR			LTR		L	TR	
Lane Width	12.0	12.0		12.0	12.0			12.0		12.0	12.0	
RTOR Vol			1			13			2			15
Adj Flow	76	555		7	426			8		50	50	
%InSharedLn												
Prop LTs		0.000			0.000			0.500		1.000	0.000	
Prop RTs		0.004			0.099			0.500			1.000	
Peds Bikes		0			0			0			0	
Buses	0	0		0	0			0		0	0	
%InProtPhase												

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Arriv. Type	3	3		3	3			3		3	3	
Unit Ext.	3.0	3.0		3.0	3.0			3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0			2.0		2.0	2.0	

Ped Min g	3.2	3.2	3.2	3.2	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A				NB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds						Peds				
WB	Left	A				SB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		7.0	33.0					12.0			
Yellow		4.0	4.0					4.0			
All Red		2.0	2.0					2.0			

Cycle Length: 70.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	68	498	3	6	346	51	4	0	6	45	0	60
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj flow	76	553	2	7	384	42	4	0	4	50	0	50
No. Lanes	1	1	0	1	1	0	0	1	0	1	1	0
Lane group	L	TR		L	TR			LTR		L	TR	
Adj flow	76	555		7	426			8		50	50	
Prop LTs		0.000			0.000			0.500		1.000	0.000	
Prop RTs		0.004			0.099			0.500			1.000	

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR			LTR		L	TR	
So	1800	1800		1800	1800			1800		1800	1800	
Lanes	1	1	0	1	1	0	0	1	0	1	1	0
fW	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fHV	1.000	0.980		1.000	0.982			1.000		1.000	1.000	
fG	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fP	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fBB	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fA	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
fRT		0.999			0.985			0.933			0.850	
fLT	0.950	1.000		0.950	1.000			0.912		0.794	1.000	
Sec.												
Lpb	1.000	1.000		1.000	1.000			1.000		1.000	1.000	
rRpb		1.000			1.000			1.000			1.000	
S	1710	1764		1710	1742			1532		1430	1530	
Sec.												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	76	1710	# 0.04	0.10	171	0.44
Prot							
Perm							
Thru	TR	555	1764	# 0.31	0.47	832	0.67
Right							
Westbound							
Prot							
Perm							
Left	L	7	1710	0.00	0.10	171	0.04
Prot							
Perm							
Thru	TR	426	1742	0.24	0.47	821	0.52
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	8	1532	0.01	0.17	263	0.03
Right							
Southbound							
Prot							
Perm							
Left	L	50	1430	# 0.03	0.17	245	0.20
Prot							
Perm							
Thru	TR	50	1530	0.03	0.17	262	0.19
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.39
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.53

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.44	0.10	29.7	1.000	171	0.11	1.8	0.0	31.5	C		
TR	0.67	0.47	14.3	1.000	832	0.24	2.1	0.0	16.3	B	18.1	B
Westbound												
L	0.04	0.10	28.5	1.000	171	0.11	0.1	0.0	28.6	C		
TR	0.52	0.47	12.9	1.000	821	0.12	0.6	0.0	13.5	B	13.8	B
Northbound												
LTR	0.03	0.17	24.2	1.000	263	0.11	0.0	0.0	24.2	C	24.2	C
Southbound												
L	0.20	0.17	24.9	1.000	245	0.11	0.4	0.0	25.3	C		

```
TR    0.19  0.17  24.8  1.000 262   0.11   0.4   0.0   25.2   C    25.3   C

______________________________________________________________________________
       Intersection delay = 17.2  (sec/veh)   Intersection LOS = B


____________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                           for exclusive lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach                         S
Cycle length, C                               70.0    sec
Total actual green time for LT lane group, G (s)                          12.0
Effective permitted green time for LT lane group, g(s)                    12.0
Opposing effective green time, go (s)                                     12.0
Number of lanes in LT lane group, N                                       1
Number of lanes in opposing approach, No                                  1
Adjusted LT flow rate, VLT (veh/h)                                        50
Proportion of LT in LT lane group, PLT                                    1.000
Proportion of LT in opposing flow, PLTo                                   0.50
Adjusted opposing flow rate, Vo (veh/h)                                   8
Lost time for LT lane group, tL                                           6.00
Computation
LT volume per cycle, LTC=VLTC/3600                                        0.97
Opposing lane util. factor, fLUo                      1.000 1.000 1.000 1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                       0.16
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                     0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)                         1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                              0.83
gq, (see Exhibit C16-4,5,6,7,8)                                           0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf                                     12.00
n=Max(gq-gf)/2,0)                                                         0.00
PTHo=1-PLTo                                                               0.50
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                        1.00
EL1 (refer to Exhibit C16-3)                                              1.26
EL2=Max((1-Ptho**n)/Plto, 1.0)                                            1.00
fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                        0.33
gdiff=max(gq-gf,0)                                                        0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                       0.79
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
or flt=[fm+0.91(N-1)]/N**
Left-turn adjustment, fLT                                                 0.794

For special case of single-lane approach opposed by multilane approach,
see text.
* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
  left-turn lane and redo calculations.
** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach
or when gf>gq, see text.

____________________SUPPLEMENTAL PERMITTED LT WORKSHEET______________________
                            for shared lefts
Input
                                                        EB    WB    NB    SB
Opposed by Single(S) or Multiple(M) lane approach                   M
Cycle length, C                               70.0    sec
Total actual green time for LT lane group, G (s)                    12.0
Effective permitted green time for LT lane group, g(s)              12.0
Opposing effective green time, go (s)                               12.0
```

```
  Number of lanes in LT lane group, N                                   1
  Number of lanes in opposing approach, No                              1
  Adjusted LT flow rate, VLT (veh/h)                                    4
  Proportion of LT in LT lane group, PLT                   0.000 0.000 0.500 0.000
  Proportion of LT in opposing flow, PLTo                               0.00
  Adjusted opposing flow rate, Vo (veh/h)                               50
  Lost time for LT lane group, tL                                       6.00
  Computation
  LT volume per cycle, LTC=VLTC/3600                                    0.08
  Opposing lane util. factor, fLUo                         1.000 1.000 1.000 1.000
  Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)                   0.97
  gf=G[exp(- a * (LTC ** b))]-tl, gf<=g                                 4.4
  Opposing platoon ratio, Rpo (refer Exhibit 16-11)                     1.00
  Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]                          0.83
  gq, (see Exhibit C16-4,5,6,7,8)                                       0.00
  gu=g-gq if gq>=gf, or = g-gf if gq<gf                                 7.58
  n=Max(gq-gf)/2,0)                                                     0.00
  PTHo=1-PLTo                                                           1.00
  PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]                                    0.50
  EL1 (refer to Exhibit C16-3)                                          1.32
  EL2=Max((1-Ptho**n)/Plto, 1.0)
  fmin=2(1+PL)/g  or  fmin=2(1+Pl)/g                                    0.25
  gdiff=max(gq-gf,0)                                                    0.00
  fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)                   0.91
  flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)],(fmin<=fm<=1.00)
  or flt=[fm+0.91(N-1)]/N**
  Left-turn adjustment, fLT                                             0.912

  For special case of single-lane approach opposed by multilane approach,
  see text.
  * If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto
    left-turn lane and redo calculations.
  ** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
  For special case of multilane approach opposed by single-lane approach
  or when gf>gq, see text.

____________SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET____________
 Permitted Left Turns
                                                          EB    WB    NB    SB
 Effective pedestrian green time, gp (s)
 Conflicting pedestrian volume, Vped (p/h)
 Pedestrian flow rate, Vpedg (p/h)
 OCCpedg
 Opposing queue clearing green, gq (s)
 Eff. ped. green consumed by opp. veh. queue, gq/gp
 OCCpedu
 Opposing flow rate, Vo (veh/h)
 OCCr
 Number of cross-street receiving lanes, Nrec
 Number of turning lanes, Nturn
 ApbT
 Proportion of left turns, PLT
 Proportion of left turns using protected phase, PLTA
 Left-turn adjustment, fLpb
 Permitted Right Turns
 Effective pedestrian green time, gp (s)
 Conflicting pedestrian volume, Vped (p/h)
 Conflicting bicycle volume, Vbic (bicycles/h)
 Vpedg
 OCCpedg
 Effective green, g (s)
```

Vbicg
OCCbicg
OCCr
Number of cross-street receiving lanes, Nrec
Number of turning lanes, Nturn
ApbT
Proportion right-turns, PRT
Proportion right-turns using protected phase, PRTA
Right turn adjustment, fRpb

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

			EBLT	WBLT	NBLT	SBLT
Cycle length, C	70.0	sec				
Adj. LT vol from Vol Adjustment Worksheet, v						
v/c ratio from Capacity Worksheet, X						
Protected phase effective green interval, g (s)						
Opposing queue effective green interval, gq						
Unopposed green interval, gu						
Red time r=(C-g-gq-gu)						
Arrival rate, qa=v/(3600(max[X,1.0]))						
Protected ph. departure rate, Sp=s/3600						
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)						
XPerm						
XProt						
Case						
Queue at beginning of green arrow, Qa						
Queue at beginning of unsaturated green, Qu						
Residual queue, Qr						
Uniform Delay, d1						

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
Westbound								
Northbound								
Southbound								

Intersection Delay 17.2 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR			LTR		L	TR	
Init Queue	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Flow Rate	76	555		7	426			8		50	50	
So	1800	1800		1800	1800			1800		1800	1800	
No.Lanes	1	1	0	1	1	0	0	1	0	1	1	0
SL	1710	1764		1710	1742			1532		1430	1530	
LnCapacity	171	832		171	821			263		245	262	
Flow Ratio	0.04	0.31		0.00	0.24			0.01		0.03	0.03	
v/c Ratio	0.44	0.67		0.04	0.52			0.03		0.20	0.19	
Grn Ratio	0.10	0.47		0.10	0.47			0.17		0.17	0.17	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3			3		3	3	
Pltn Ratio	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
PF2	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Q1	1.4	8.3		0.1	5.8			0.1		0.8	0.8	
kB	0.2	0.5		0.2	0.5			0.3		0.3	0.3	
Q2	0.2	1.0		0.0	0.6			0.0		0.1	0.1	
Q Average	1.6	9.4		0.1	6.4			0.1		0.9	0.9	
Q Spacing	25.0	25.0		25.0	25.0			25.0		25.0	25.0	
Q Storage	0	0		0	0			0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2			1.2		1.2	1.2	
BOQ	1.9	11.0		0.2	7.5			0.2		1.1	1.1	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5			1.6		1.6	1.6	
BOQ	2.5	14.2		0.2	9.8			0.2		1.4	1.4	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.7		1.8	1.7			1.8		1.8	1.8	
BOQ	2.8	15.4		0.2	10.8			0.2		1.6	1.6	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.9		2.1	1.9			2.1		2.1	2.1	
BOQ	3.2	17.4		0.3	12.2			0.3		1.9	1.9	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.2		2.7	2.3			2.7		2.6	2.6	
BOQ	4.0	20.5		0.4	14.7			0.4		2.4	2.4	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	18	610			435	9
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Hourly Flow Rate, HFR	26	648			462	13
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				13	0	29
Peak Hour Factor, PHF				0.75	0.90	0.93
Hourly Flow Rate, HFR				17	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	26						48	
C(m) (vph)	1098						363	
v/c	0.02						0.13	
95% queue length	0.07						0.45	
Control Delay	8.4						16.4	
LOS	A						C	
Approach Delay							16.4	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	18	610			435	9
Peak-Hour Factor, PHF	0.67	0.94			0.94	0.67
Peak-15 Minute Volume	7	162			116	3
Hourly Flow Rate, HFR	26	648			462	13
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				13	0	29
Peak Hour Factor, PHF				0.75	0.90	0.93
Peak-15 Minute Volume				4	0	8
Hourly Flow Rate, HFR				17	0	31
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	648	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	475					1168	1168	468
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		468
Potential Capacity		599
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		599
Probability of Queue free St.	1.00	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows		475
Potential Capacity		1098
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1098
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1168
Potential Capacity		195
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		188
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1168
Potential Capacity		216
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		211

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1168
Potential Capacity		195
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		188

Result for 2 stage process:		
a		
y		
C t		188
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1168
Potential Capacity		216
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		211

Results for Two-stage process:		
a		
y		
C t		211

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				17	0	31
Movement Capacity (vph)				211	188	599
Shared Lane Capacity (vph)					363	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				211	188	599
Volume				17	0	31
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					363	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	26						48	
C(m) (vph)	1098						363	
v/c	0.02						0.13	
95% queue length	0.07						0.45	
Control Delay	8.4						16.4	
LOS	A						C	
Approach Delay							16.4	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	648	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst:	RHH
Agency/Co.:	McMILLEN ENGINEERING
Date Performed:	11/23/2005
Analysis Time Period:	SATURDAY PEAK DEVELOPED
Intersection:	SR40 / SMITH SCHOOL
Jurisdiction:	WHARTON TOWNSHIP
Units: U. S. Customary	
Analysis Year:	2016
Project ID:	2005-319
East/West Street:	ROUTE 40
North/South Street:	SMITH SCHOOL HOUSE RD
Intersection Orientation:	EW

Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	15	534			426	11
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Hourly Flow Rate, HFR	30	613			489	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				9	0	13
Peak Hour Factor, PHF				0.40	0.90	0.60
Hourly Flow Rate, HFR				22	0	21
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/		No	/
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	30						43	
C(m) (vph)	1065						302	
v/c	0.03						0.14	
95% queue length	0.09						0.49	
Control Delay	8.5						18.9	
LOS	A						C	
Approach Delay							18.9	
Approach LOS							C	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / SMITH SCHOOL
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: SMITH SCHOOL HOUSE RD
Intersection Orientation: EW Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	15	534			426	11
Peak-Hour Factor, PHF	0.50	0.87			0.87	0.50
Peak-15 Minute Volume	8	153			122	6
Hourly Flow Rate, HFR	30	613			489	22
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				9	0	13
Peak Hour Factor, PHF				0.40	0.90	0.60
Peak-15 Minute Volume				6	0	5
Hourly Flow Rate, HFR				22	0	21
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	613	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1800	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0					0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1					6.4	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

omputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	511					1173	1173	500
s								
Px								
V c,u,x								
r,x								
C plat,x								

Two-Stage Process	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		500
Potential Capacity		575
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		575
Probability of Queue free St.	1.00	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows		511
Potential Capacity		1065
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1065
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows		1173
Potential Capacity		194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		186
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		1173
Potential Capacity		214
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		208

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1173
Potential Capacity		194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity		186

Result for 2 stage process:		
a		
y		
C t		186
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		1173
Potential Capacity		214
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.97
Movement Capacity		208

Results for Two-stage process:		
a		
y		
C t		208

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
volume (vph)				22	0	21
Movement Capacity (vph)				208	186	575
Shared Lane Capacity (vph)					302	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				208	186	575
Volume				22	0	21
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					302	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	30						43	
C(m) (vph)	1065						302	
v/c	0.03						0.14	
95% queue length	0.09						0.49	
Control Delay	8.5						18.9	
LOS	A						C	
Approach Delay							18.9	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	613	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1800	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.96	
d(M,LT), Delay for stream 1 or 4	8.5	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.4	

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Eastbound			Westbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		29	555	52	15	398	42
Peak-Hour Factor, PHF		0.81	0.94	0.78	0.58	0.94	0.79
Hourly Flow Rate, HFR		35	590	66	25	423	53
Percent Heavy Vehicles		0	--	--	0	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1	0	0	1	0
Configuration			LTR			LTR	
Upstream Signal?			No			No	

Minor Street:	Approach	Northbound			Southbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		29	8	18	40	3	17
Peak Hour Factor, PHF		0.81	0.58	0.67	0.75	0.38	0.63
Hourly Flow Rate, HFR		35	13	26	53	7	26
Percent Heavy Vehicles		0	0	0	0	0	0
Percent Grade (%)			0			0	
Flared Approach:	Exists?/Storage			No /			No /
Lanes		0	1	0	0	1	0
Configuration			LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1097	941		194			178	
v/c	0.03	0.03		0.38			0.48	
95% queue length	0.10	0.08		1.67			2.33	
Control Delay	8.4	8.9		34.6			42.8	
LOS	A	A		D			E	
Approach Delay				34.6			42.8	
Approach LOS				D			E	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: WEEKDAY PM PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	29	555	52	15	398	42
Peak-Hour Factor, PHF	0.81	0.94	0.78	0.58	0.94	0.79
Peak-15 Minute Volume	9	148	17	6	106	13
Hourly Flow Rate, HFR	35	590	66	25	423	53
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	29	8	18	40	3	17
Peak Hour Factor, PHF	0.81	0.58	0.67	0.75	0.38	0.63
Peak-15 Minute Volume	9	3	7	13	2	7
Hourly Flow Rate, HFR	35	13	26	53	7	26
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	590	423
Shared ln volume, major rt vehicles:	66	53
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0	0	0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	476	656	1209	1219	623	1212	1226	450
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	623	450
Potential Capacity	490	613
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	490	613
Probability of Queue free St.	0.95	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	656	476
Potential Capacity	941	1097
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	941	1097
Probability of Queue free St.	0.97	0.97
Maj L-Shared Prob Q free St.	0.96	0.95

Step 3: TH from Minor St.	8	11
Conflicting Flows	1219	1226
Potential Capacity	182	180
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity	167	165
Probability of Queue free St.	0.92	0.96

Step 4: LT from Minor St.	7	10
Conflicting Flows	1209	1212
Potential Capacity	161	160
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	0.84
Maj. L, Min T Adj. Imp Factor.	0.91	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	140	133

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1219	1226
Potential Capacity	182	180
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity	167	165

Result for 2 stage process:		
a		
y		
C t	167	165
Probability of Queue free St.	0.92	0.96

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1209	1212
Potential Capacity	161	160
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.88	0.84
Maj. L, Min T Adj. Imp Factor.	0.91	0.88
Cap. Adj. factor due to Impeding mvmnt	0.87	0.83
Movement Capacity	140	133

Results for Two-stage process:		
a		
y		
C t	140	133

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	35	13	26	53	7	26
Movement Capacity (vph)	140	167	490	133	165	613
Shared Lane Capacity (vph)		194			178	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	140	167	490	133	165	613
Volume	35	13	26	53	7	26
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		194			178	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	35	25		74			86	
C(m) (vph)	1097	941		194			178	
v/c	0.03	0.03		0.38			0.48	
95% queue length	0.10	0.08		1.67			2.33	
Control Delay	8.4	8.9		34.6			42.8	
LOS	A	A		D			E	
Approach Delay				34.6			42.8	
Approach LOS				D			E	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	0.97
v(il), Volume for stream 2 or 5	590	423
v(i2), Volume for stream 3 or 6	66	53
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.95	0.96
d(M,LT), Delay for stream 1 or 4	8.4	8.9
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.4	0.3

HCS2000: Unsignalized Intersections Release 4.1d

TWO-WAY STOP CONTROL SUMMARY

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	534	31	10	360	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Hourly Flow Rate, HFR	28	613	49	14	413	24
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1134	936		207			218	
v/c	0.02	0.01		0.55			0.31	
95% queue length	0.08	0.05		2.94			1.25	
Control Delay	8.3	8.9		41.8			28.7	
LOS	A	A		E			D	
Approach Delay				41.8			28.7	
Approach LOS				E			D	

HCS2000: Unsignalized Intersections Release 4.1d

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: RHH
Agency/Co.: McMILLEN ENGINEERING
Date Performed: 11/23/2005
Analysis Time Period: SATURDAY PEAK DEVELOPED
Intersection: SR40 / DINNER BELL RD
Jurisdiction: WHARTON TOWNSHIP
Units: U. S. Customary
Analysis Year: 2016
Project ID: 2005-319
East/West Street: ROUTE 40
North/South Street: DINNER BELL ROAD
Intersection Orientation: EW   Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	21	534	31	10	360	17
Peak-Hour Factor, PHF	0.75	0.87	0.63	0.68	0.87	0.70
Peak-15 Minute Volume	7	153	12	4	103	6
Hourly Flow Rate, HFR	28	613	49	14	413	24
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	59	2	17	18	3	17
Peak Hour Factor, PHF	0.84	0.50	0.42	0.50	0.75	0.62
Peak-15 Minute Volume	18	1	10	9	1	7
Hourly Flow Rate, HFR	70	4	40	36	4	27
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
RT Channelized?						
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	613	413
Shared ln volume, major rt vehicles:	49	24
Sat flow rate, major th vehicles:	1800	1800
Sat flow rate, major rt vehicles:	1800	1800
Number of major street through lanes:	1	1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

'ovement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0	0	0	0	0
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Grade/100				0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

›mputation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	437	662	1162	1159	638	1169	1171	425
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500		1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	638	425
Potential Capacity	480	634
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	480	634
Probability of Queue free St.	0.92	0.96

Step 2: LT from Major St.	4	1
Conflicting Flows	662	437
Potential Capacity	936	1134
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	936	1134
Probability of Queue free St.	0.99	0.98
Maj L-Shared Prob Q free St.	0.98	0.96

Step 3: TH from Minor St.	8	11
Conflicting Flows	1159	1171
Potential Capacity	197	194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	186	183
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10
Conflicting Flows	1162	1169
Potential Capacity	174	172
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	157	148

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1159	1171
Potential Capacity	197	194
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	186	183

Result for 2 stage process:		
a		
y		
C t	186	183
Probability of Queue free St.	0.98	0.98

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1162	1169
Potential Capacity	174	172
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	0.92
Maj. L, Min T Adj. Imp Factor.	0.94	0.94
Cap. Adj. factor due to Impeding mvmnt	0.90	0.86
Movement Capacity	157	148

Results for Two-stage process:		
a		
y		
C t	157	148

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	70	4	40	36	4	27
Movement Capacity (vph)	157	186	480	148	183	634
Shared Lane Capacity (vph)		207			218	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	157	186	480	148	183	634
Volume	70	4	40	36	4	27
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		207			218	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LTR	LTR		LTR			LTR	
v (vph)	28	14		114			67	
C(m) (vph)	1134	936		207			218	
v/c	0.02	0.01		0.55			0.31	
95% queue length	0.08	0.05		2.94			1.25	
Control Delay	8.3	8.9		41.8			28.7	
LOS	A	A		E			D	
Approach Delay				41.8			28.7	
Approach LOS				E			D	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	0.99
v(il), Volume for stream 2 or 5	613	413
v(i2), Volume for stream 3 or 6	49	24
s(il), Saturation flow rate for stream 2 or 5	1800	1800
s(i2), Saturation flow rate for stream 3 or 6	1800	1800
P*(oj)	0.96	0.98
d(M,LT), Delay for stream 1 or 4	8.3	8.9
N, Number of major street through lanes	1	1
d(rank,1) Delay for stream 2 or 5	0.3	0.2

APPENDIX 6

PEAK HOUR FACTOR CALCULATIONS

Route 40/Route 381

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	13	13	17	17	60	**0.88**
Through	112	129	126	136	503	**0.92**
Right Turn	11	18	18	7	54	**0.75**
Route 40 West Bound						
Left Turn	11	10	18	13	52	**0.72**
Through	133	142	107	133	515	**0.91**
Right Turn	3	5	4	5	17	**0.85**
Route 381 North Bound						
Left Turn	18	7	13	13	51	**0.71**
Through						**N/A**
Right Turn	14	14	14	14	56	**1**
Route 381 South Bound						
Left Turn	6	9	16	17	48	**0.71**
Through						**N/A**
Right Turn	15	13	10	3	41	**0.68**

Route 40/Route 381

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	16	26	16	22	80	**0.91**
Through	142	120	140	171	573	**0.84**
Right Turn	12	8	9	18	47	**0.65**
Route 40 West Bound						
Left Turn	12	9	18	14	53	**0.74**
Through	114	118	80	85	397	**0.84**
Right Turn	16	19	14	10	59	**0.78**
Route 381 North Bound						
Left Turn	4	9	9	9	31	**0.86**
Through						**N/A**
Right Turn	14	21	12	22	69	**0.78**
Route 381 South Bound						
Left Turn	8	15	11	8	42	**0.70**
Through						**N/A**
Right Turn	13	11	9	16	49	**0.77**

Route 40/Hawes Road

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	8	5	5	3	21	**0.66**
Through						**0.92**
Right Turn						**N/A**
Route 40 West Bound						
Left Turn						**N/A**
Through						**0.91**
Right Turn	4	11	14	8	37	**0.66**
Hawes Road South Bound						
Left Turn	8	15	7	7	37	**0.62**
Through						**N/A**
Right Turn	11	16	10	5	42	**0.66**

Route 40/Hawes Road

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	8	2	7	8	25	**0.78**
Through						**0.84**
Right Turn						**N/A**
Route 40 West Bound						
Left Turn						**N/A**
Through						**0.84**
Right Turn	9	1	6	5	21	**0.58**
Hawes Road South Bound						
Left Turn	5	5	6	3	19	**0.79**
Through						**N/A**
Right Turn	2	6	4	2	14	**0.58**

Route 40/Secondary Driveway

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						**0.90**
Through						**0.90**
Right Turn						**N/A**
Route 40 West Bound						
Left Turn						**N/A**
Through						**0.90**
Right Turn						**0.90**
Secondary Driveway South Bound						
Left Turn						**0.90**
Through						**N/A**
Right Turn						**0.90**

Route 40/Secondeary Driveway

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						**0.90**
Through						**0.90**
Right Turn						**N/A**
Route 40 West Bound						
Left Turn						**N/A**
Through						**0.90**
Right Turn						**0.90**
Secondary Driveway South Bound						
Left Turn						**0.90**
Through						**N/A**
Right Turn						**0.90**

Route 40/Marker Road - Main Driveway

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						**0.90**
Through	127	138	145	148	558	**0.94**
Right Turn	2	1	3	2	8	**0.67**
Route 40 West Bound						
Left Turn	1	2	3	0	6	**0.50**
Through						**0.94**
Right Turn						**0.9**
Marker Road North Bound						
Left Turn	1	0	1	1	3	**0.75**
Through						**0.90**
Right Turn	2	4	1	3	10	**0.63**
Main Driveway South Bound						
Left Turn						**0.90**
Through						**0.90**
Right Turn						**0.90**

Route 40/Marker Road - Main Driveway

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn						**0.90**
Through	129	111	137	170	547	**0.80**
Right Turn	1	0	1	1	3	**0.75**
Route 40 West Bound						
Left Turn	0	2	2	1	5	**0.63**
Through						**0.87**
Right Turn						**0.90**
Marker Road North Bound						
Left Turn	1	1	1	1	4	**1.00**
Through						**0.90**
Right Turn	0	1	1	3	5	**0.42**
Main Driveway South Bound						
Left Turn						**0.90**
Through						**0.90**
Right Turn						**0.90**

Route 40/Smith School House Road

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	1	4	5	6	16	**0.67**
Through						**0.94**
Right Turn						**N/A**
Route 40 West Bound						
Left Turn						**N/A**
Through	104	89	101	96	390	**0.94**
Right Turn	2	2	1	3	8	**0.67**
Smith School House Road South Bound						
Left Turn	3	2	3	4	12	**0.75**
Through						**N/A**
Right Turn	7	6	6	7	26	**0.93**

Route 40/Smith School House Raod

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	1	2	4	7	14	**0.50**
Through						**0.87**
Right Turn						**N/A**
Route 40 West Bound						
Left Turn						**N/A**
Through	114	109	89	86	398	**0.87**
Right Turn	2	2	1	5	10	**0.50**
Smith School House Road South Bound						
Left Turn	3	5	0	0	8	**0.40**
Through						**N/A**
Right Turn	5	1	3	3	12	**0.60**

Route 40/Dinner Bell Road

Weekday PM 4:45-5:45

	4:45	5:00	5:15	5:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	6	8	5	7	26	**0.81**
Through						**0.94**
Right Turn	7	14	15	11	47	**0.78**
Route 40 West Bound						
Left Turn	2	6	2	4	14	**0.58**
Through						**0.94**
Right Turn	11	10	5	12	38	**0.79**
Dinner Bell Road North Bound						
Left Turn	3	8	7	8	26	**0.81**
Through	3	1	1	2	7	**0.58**
Right Turn	5	2	6	3	16	**0.67**
Dinner Bell Road South Bound						
Left Turn	9	7	12	8	36	**0.75**
Through	0	0	1	2	3	**0.38**
Right Turn	6	2	6	1	15	**0.63**

Route 40/Dinner Bell Road

Saturday AM 10:45-11:45

	10:45	11:00	11:15	11:30	TOTAL	PHF
Route 40 East Bound						
Left Turn	1	3	3	2	9	**0.75**
Through						**0.87**
Right Turn	1	6	5	3	15	**0.63**
Route 40 West Bound						
Left Turn	7	3	2	7	19	**0.68**
Through						**0.87**
Right Turn	10	6	5	7	28	**0.70**
Dinner Bell Road North Bound						
Left Turn	16	11	13	14	54	**0.84**
Through	0	1	0	1	2	**0.50**
Right Turn	2	0	4	9	15	**0.42**
Dinner Bell Road South Bound						
Left Turn	3	2	3	8	16	**0.50**
Through	1	1	1	0	3	**0.75**
Right Turn	6	6	0	3	15	**0.63**

APPENDIX 7

QUEUE ANALYSIS

QUEUE ANALYSIS –

Route 40 / Main Driveway – Marker Road
Eastbound Left Turn Lane

Turning Volume V = 68
C = 70.0 seconds
T = 2%

Table 7 Lane Length = 100'

Route 40 / Main Driveway – Marker Road
Westbound Left Turn Lane

Turning Volume V = 6
C = 70.0 seconds
T = 2%

Table 7 Lane Length = 100'

Route 40 / Main Driveway – Marker Road
Southbound Left Turn Lane

Turning Volume V = 45
C = 70.0 seconds
T = 2%

Table 7 Lane Length = 100'

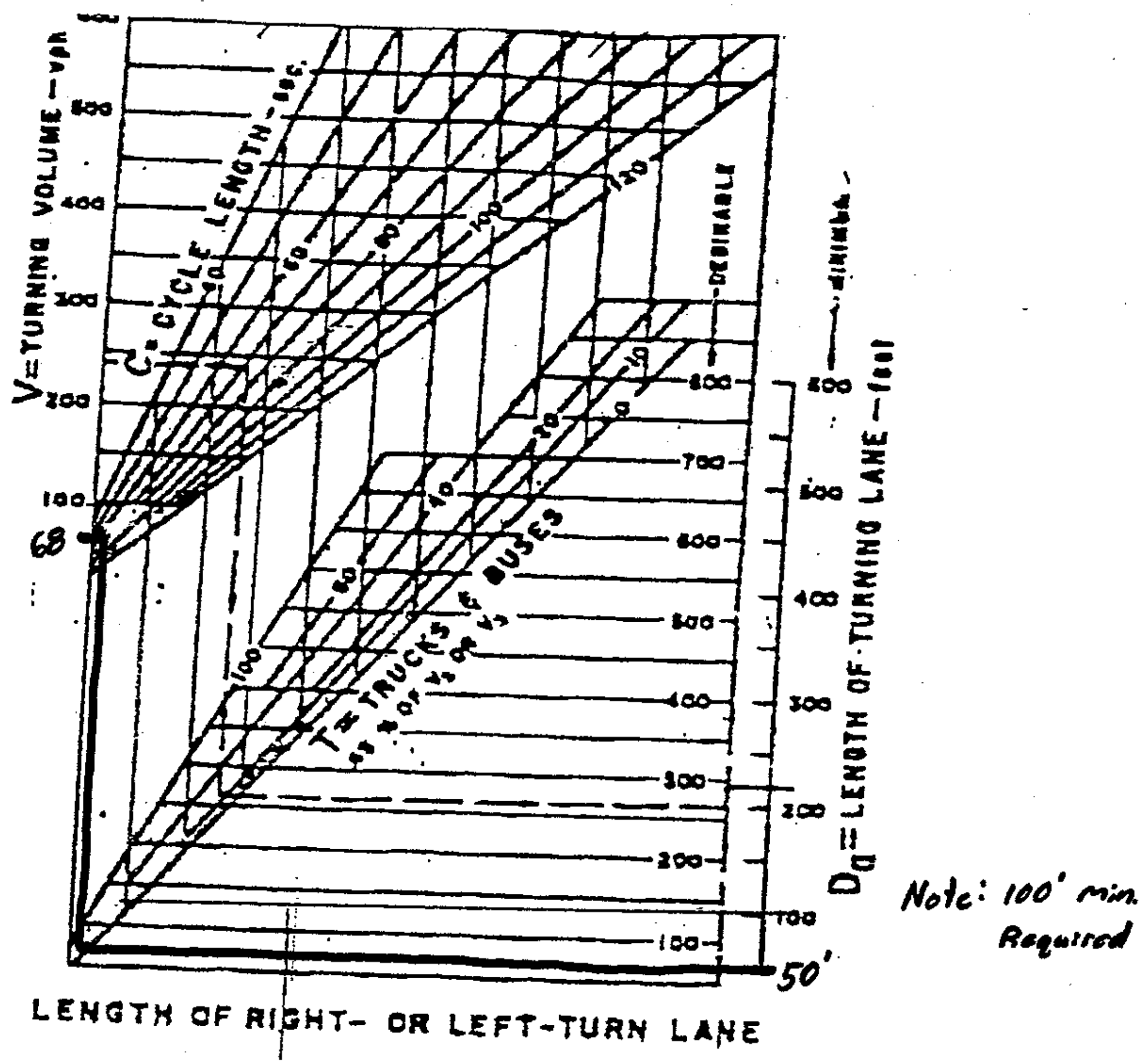


FIGURE 7. Guidelines for Design Lengths of Left-Turn Lanes to Provide for Vehicle Storage

(1) Required storage length determined using Intersection Channelization Guide, NCHRP Report Number 279, published by the Transportation Research Board.

Route 40 / Main Driveway - Marker Road

Eastbound Left Turn Lane

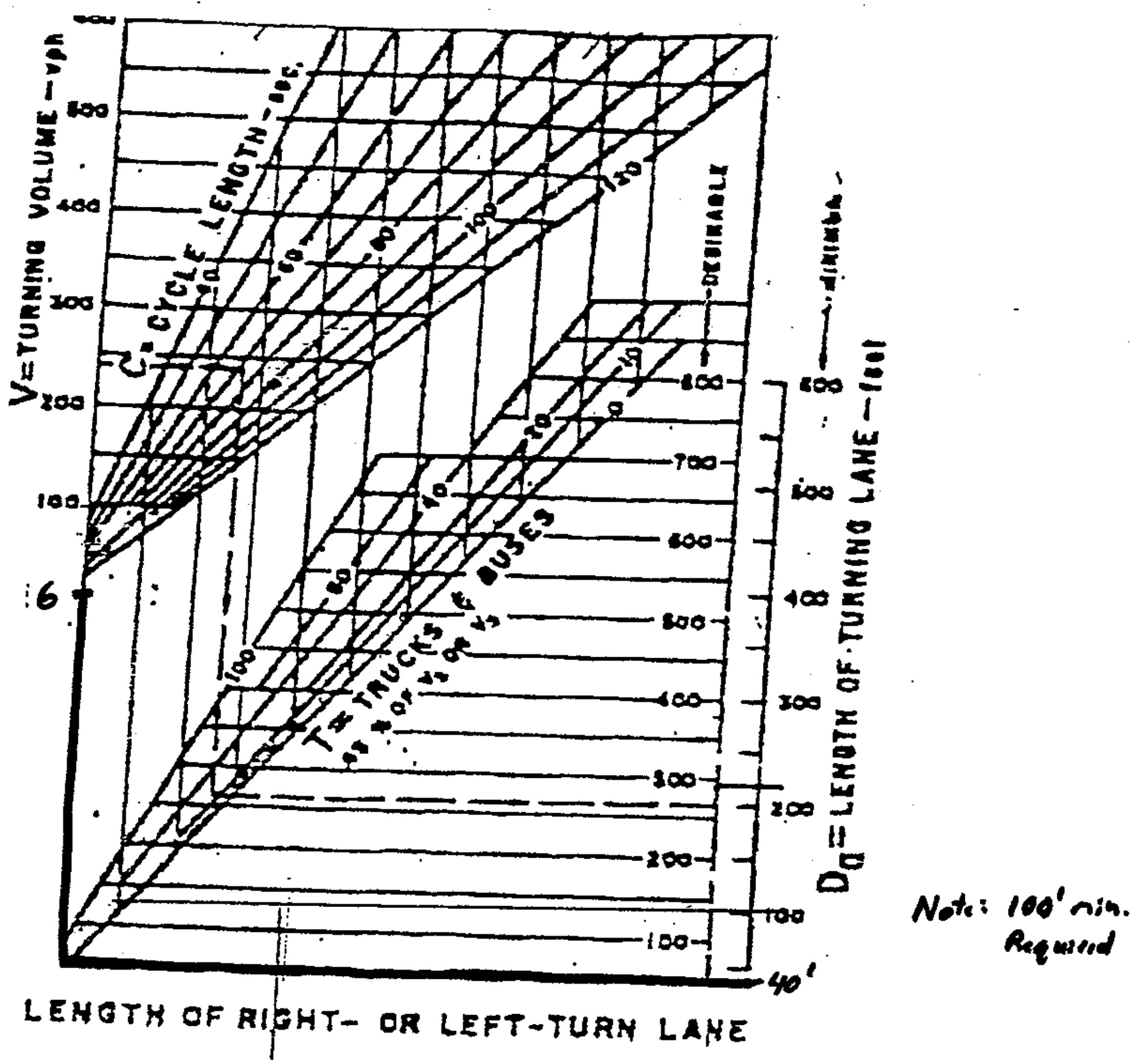
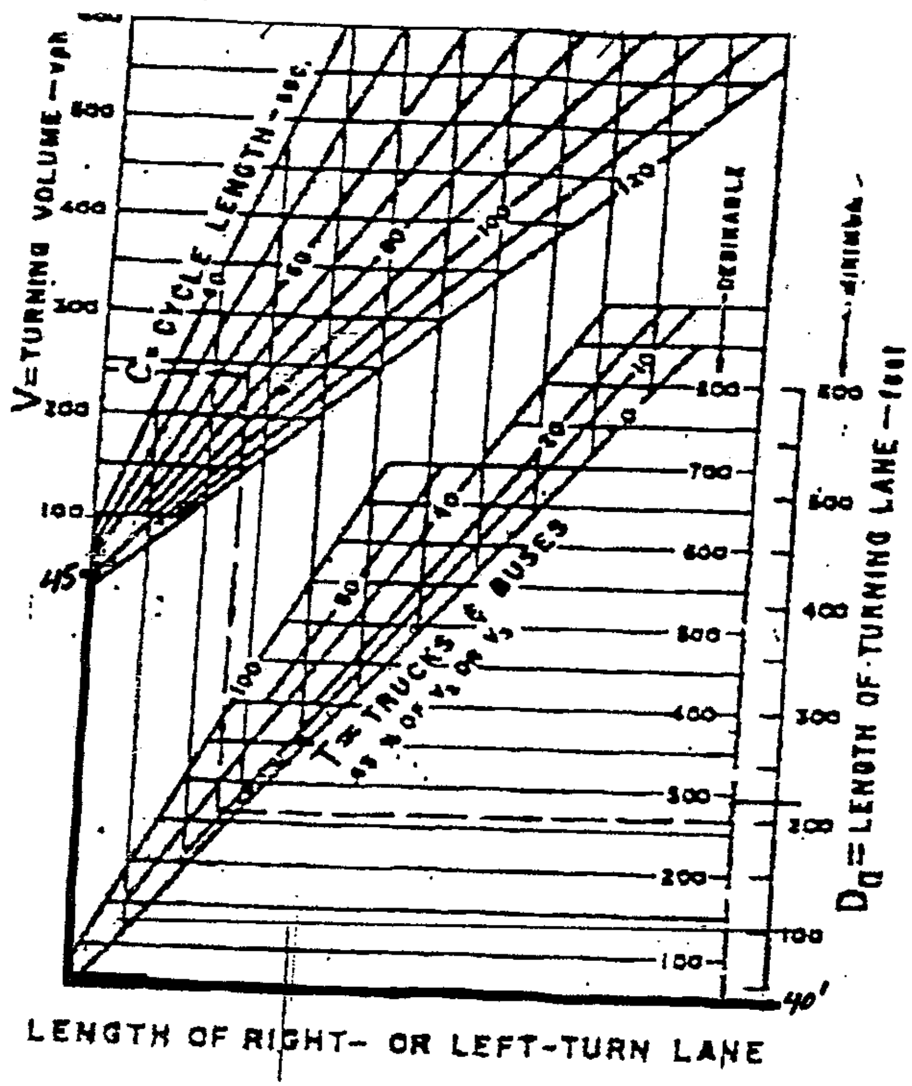


FIGURE 7. Guidelines for Design Lengths of Left-Turn Lanes to Provide for Vehicle Storage

(1) Required storage length determined using Intersection Channelization Guide, NCHRP Report Number 279, published by the Transportation Research Board.

Route 40 / Main Driveway - Marker Road

Westbound Left Turn Lane



Note: 100' min. Required

FIGURE 7. Guidelines for Design Lengths of Left-Turn Lanes to Provide for Vehicle Storage

(1) Required storage length determined using Intersection Channelization Guide, NCHRP Report Number 279, published by the Transportation Research Board.

Route 40 / Main Driveway - Marker Road

Southbound Left Turn Lane

APPENDIX 8

SIGNAL WARRANT ANALYSIS

SIGNAL WARRANT ANALYSIS

Route 40 / Main Driveway – Marker Road
2016 Developed Conditions

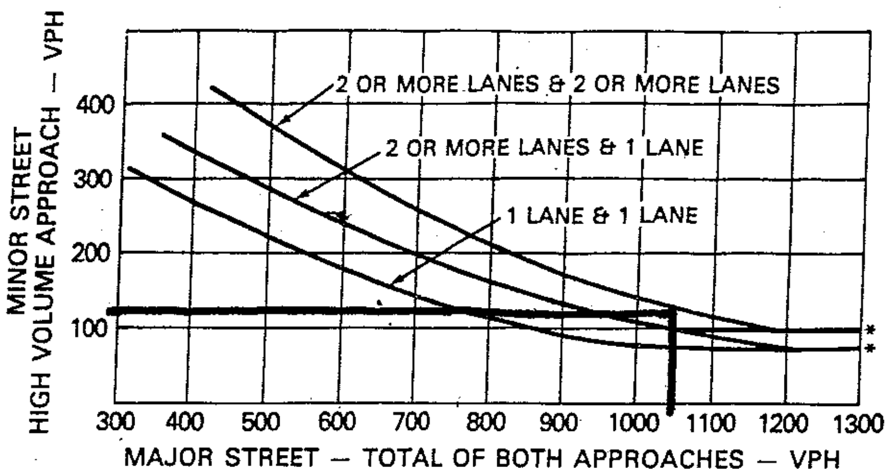
xi. Peak Hour Volumes - meets

	Major	Minor
2016	1054	112

*see attached warrant chart

PEAK HOUR VOLUME WARRANT

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)

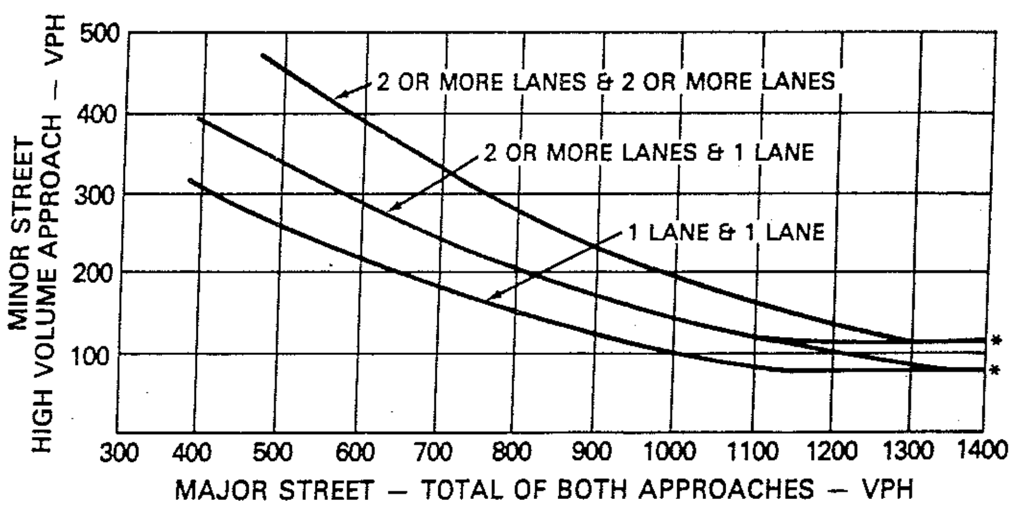


*NOTE: 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 75 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

(xii) Four-hour volume. This warrant is satisfied when the following requirements exist:

(A) For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor street approach (one direction only), all fall above the curve in the following graph for the existing combination of approach lanes:

FOUR HOUR VOLUME WARRANT



*NOTE: 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.