



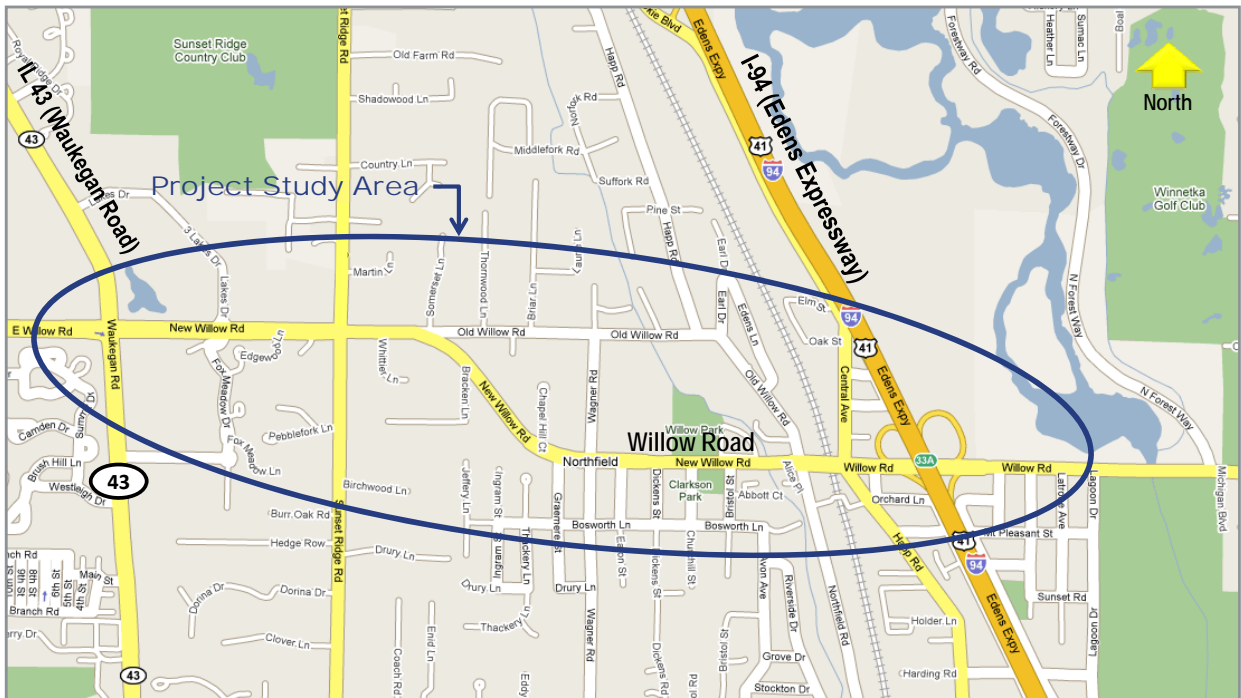
Draft

Traffic Analysis Summary

Existing ~~and~~, 2030 No-Build, and 2040 No-Build Traffic Volumes

Willow Road Study
Illinois Route 43 (Waukegan Road) to Interstate 94 (Edens Expressway)

Illinois Department of Transportation
Project Number: P-91-411-08



~~July 9, 2010~~ March 10, 2011

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All appendices have been provided on the companion CD.

Executive Summary

Willow Road is an east west Strategic Regional Arterial (SRA) that carries up to 32,000 vehicles per day within the study area. SRA's are a network of highways designed to accommodate long distance regional traffic, to complement the region's major highway and transit facilities, and to supplement the freeway system.

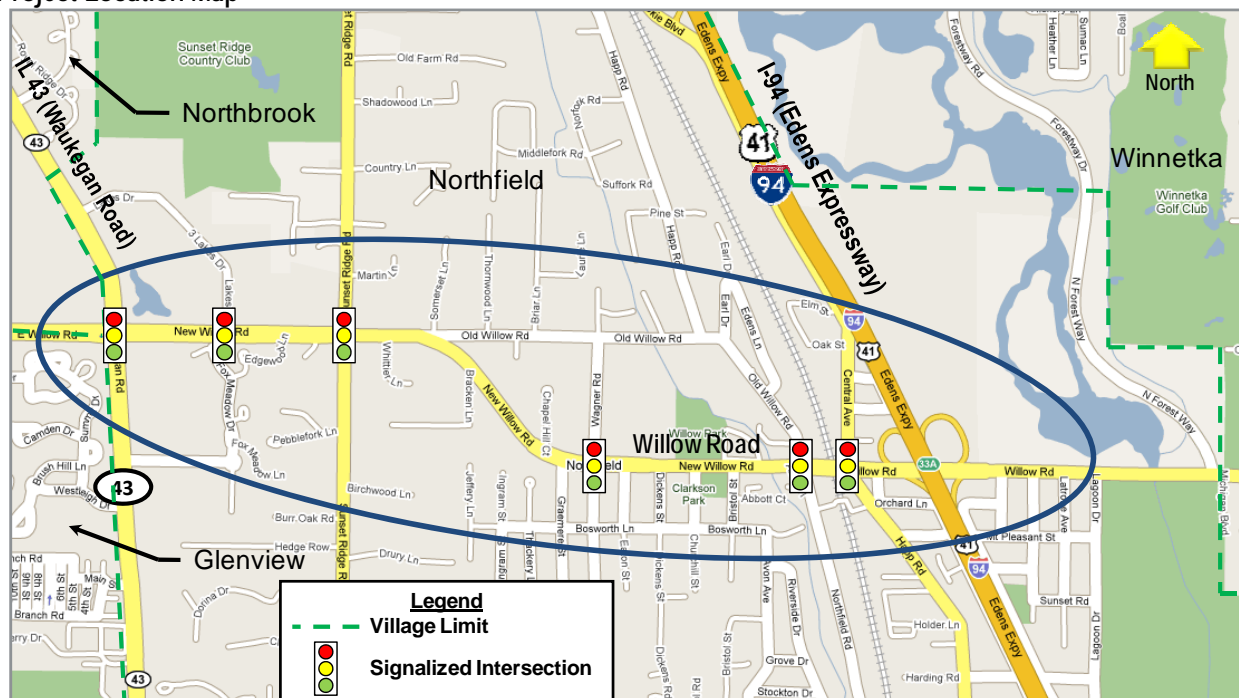
This report is one aspect of the overall Phase I study process and presents the findings of the existing conditions and 2030 No-Build and 2040 No-Build traffic analysis completed for the Willow Road Study. It should be noted that the Willow Road Study began in 2009, when long range forecasts were based upon the 2030 horizon. In the fall of 2010, the region adopted the 2040 plan. Therefore the 2030 No-Build traffic volumes are provided for information only. The 2040 No-Build traffic volumes and analyses will be utilized in the Purpose and Need and the alternatives development phase of the project.

The analysis includes Willow Road from Illinois Route 43 (Waukegan Road) to Interstate 94 (Edens Expressway). The corridor includes six signalized intersections and the Interstate 94 interchange which provides access to and from the south on Interstate 94. There are also numerous smaller cross streets and driveways that access Willow Road through the Study Area. The study area is shown in the figure below.

Traffic data is important in assessing how well a roadway is operating and accommodating the needs of its users. It is necessary to quantify how well a roadway is currently operating to have a basis for discussing possible improvement strategies and evaluating the benefits of potential improvements. These efforts are based on data regarding user demand and facility operations evaluated using approved analytical procedures.

In addition to evaluating existing conditions, the roadway will be evaluated based on forecasted traffic volumes (Design Hourly Volumes or DHV's). The traffic forecasts are done for a 20-year period and are developed by the Chicago Metropolitan Agency for Planning (CMAP) based on socio-economic forecast data for the region. CMAP is the official regional planning organization for the northeastern Illinois counties of Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will and is responsible for developing the comprehensive regional plan for the Chicago area.

Project Location Map

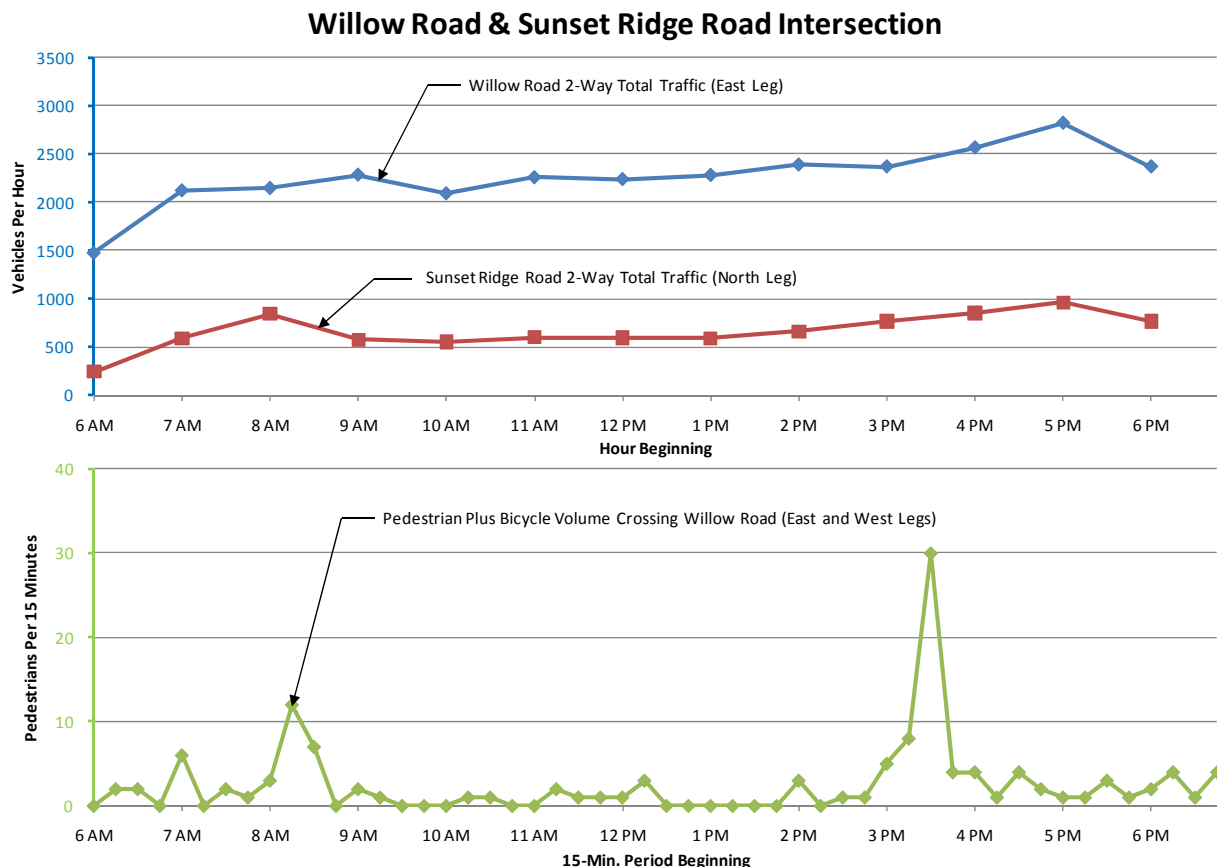


The evaluation of roadway operations occurs in a three-step process: 1) Data Collection, 2) Data Processing, and 3) Data Analysis. The following is a summary of those steps undertaken for the Willow Road Study. These steps will be completed for existing traffic volumes and for the forecasted 2030 and 2040 No-Build traffic volumes. The No-Build volumes maintain the existing street configuration for Willow Road but include other programmed roadway improvements in the Chicago region.

Data Collection

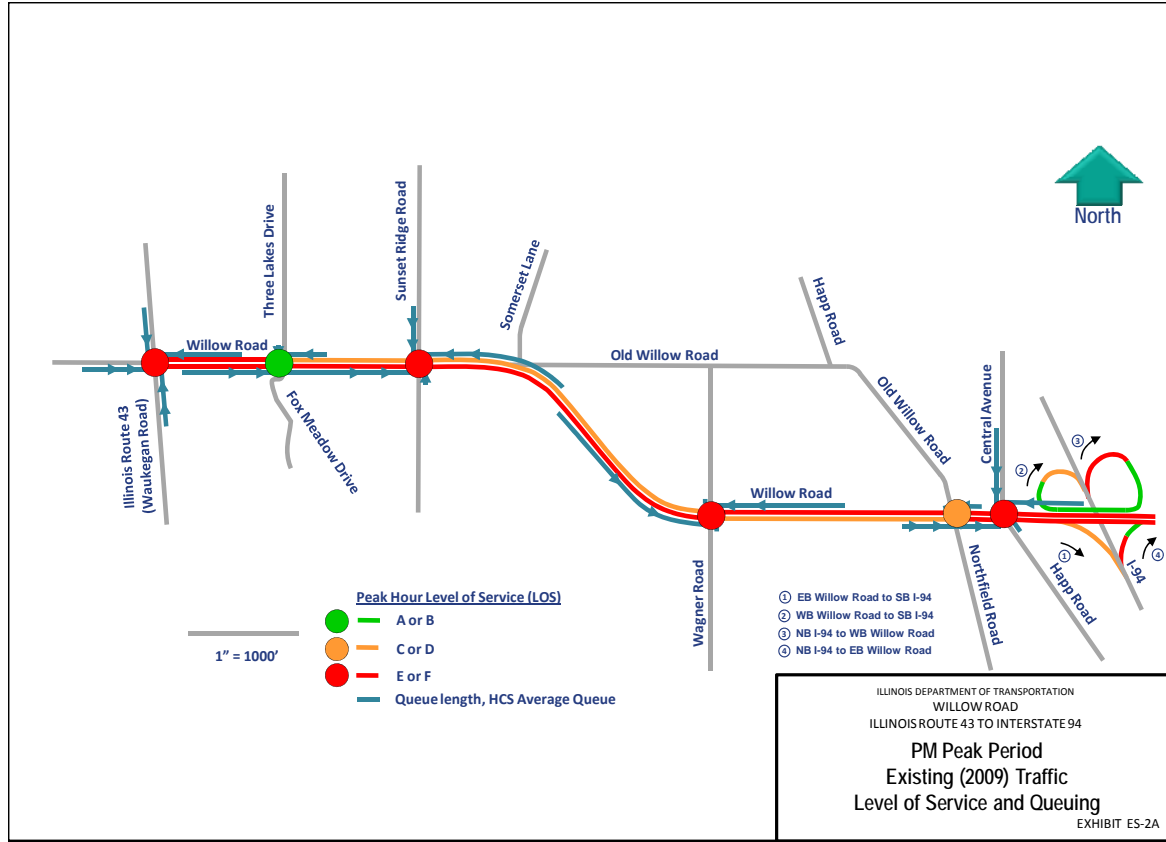
- **Existing Street Network** - An inventory of the existing street network in the vicinity of the study area was completed. This inventory included identifying the number of lanes on each segment of Willow Road and on the main cross streets in addition to collecting information on the intersection geometry and existing signal timings for the six signalized intersections.
- **Existing Traffic Counts** - Traffic counts were taken in the Spring of 2009. All signalized intersections and the Interstate 94 ramps were counted. Counts were taken at the unsignalized intersections of Willow Road at Bracken Lane, Churchill Street, Dickens Street, and Eaton Street as well as the Old Willow Road/Wagner Road intersection. These counts were conducted before construction began on Willow Road in July 2009. Peak hour counts were also taken at the Willow Road intersections with Bristol Avenue, Bristol Street, and Walnut Street and at Old Willow Road/Somerset Lane in Spring 2010. Staff members manually counted each car, truck, pedestrian, and bicycle entering or crossing a leg of an intersection. At the signalized intersections, 12-hour turning movement counts were taken while at the unsignalized intersections and the ramps, counts were taken during the peak two to three hour period in the morning and evening. An example plot of the data is shown in Figure ES-1 with all data included in Appendix B.

Figure ES-1: Sample Existing Traffic and Pedestrian Volume Graph

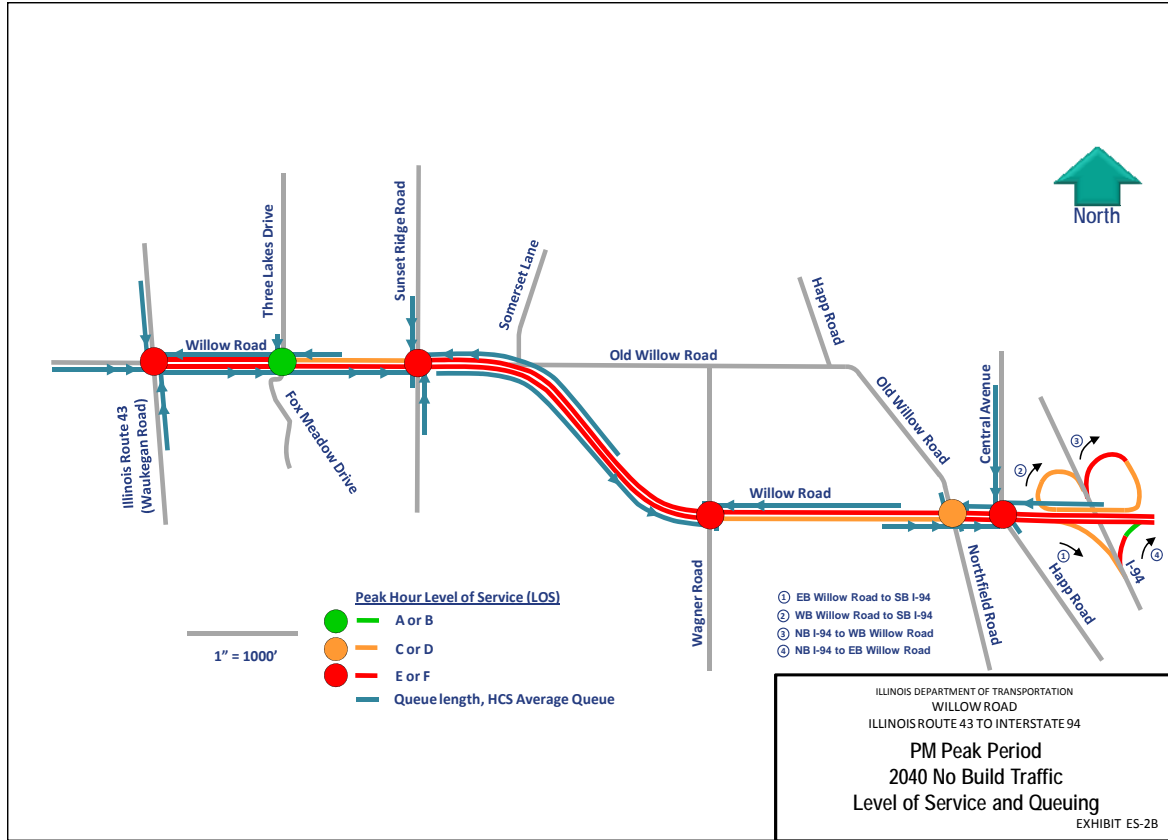


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- Vehicle Queues - During the peak hours long queues were observed which resulted in slow speeds. Figures ES-2A and ES-2B depicts the calculated average lengths of vehicles queued during the existing and 2040 P.M. peak hour. The teal lines with the arrows depict the average queues. Exhibits for both peak hours with existing and 2030 No-Build and 2040 No-Build traffic volumes are included as Exhibits 4, 5, 9 and 10, 14 and 15.



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- **Saturation Flow Rate Studies** - Saturation flow rate studies were completed at five locations. Saturation flow rate is defined as the equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times (time during which an intersection is not used effectively by any movement) are experienced. In other words, it is the maximum number of vehicles that can go through an intersection in one lane in one hour. Saturation flow rate is measured in passenger cars per hour per lane (pc/h/ln). The methodology in the *Highway Capacity Manual (HCM) 2000* assumes an ideal saturation flow rate of 1,900 pc/h/ln for capacity calculations. Based on the studies completed, the saturation flow rates varied from this ideal rate at most locations with the values ranging from a high of 1,985 to a low of 1,580 pc/h/ln. The measured rates were used in the capacity analyses completed for this analysis. The default saturation flow rate was used for the cross streets.

- **Lane Utilization Studies** - Lane utilization is defined as the distribution of vehicles among lanes when two or more lanes are available for a movement; however, as demand approaches capacity, uniform lane utilization develops. However, field conditions can create non uniform lane utilization, even at capacity conditions. Lane utilization studies were completed at three locations because of current conditions such as a lane drop immediately past the intersection or the presence of a heavily used facility such as the Edens Expressway ramp. The default value in the HCM 2000 assumes that 52.5 percent of the traffic is in the heavier travelled lane when there are two lanes on the approach. At the locations studied, this value ranged from a high of 72 percent to a low of 56 percent.

Data Processing

- **Balancing of Raw Traffic Counts** - Not all of the intersections in the Willow Road Study area were counted on the same day. Due to minor daily fluctuations in traffic volumes, counts taken on different days can result in variations in traffic volumes recorded at adjacent intersections. Traffic volumes were balanced between adjacent intersections to ensure that the volume of traffic leaving one intersection is approximately equal to the volume arriving at the next intersection unless local conditions suggest it should be otherwise.
- **Develop Annual Average Daily Traffic (AADT) Volumes** – Annual Average Daily Traffic is defined as the total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year. These volumes represent a total 24-hour volume of traffic traveling in both directions. Since 24-hour counts were not taken at any locations within the study limits, AADT volumes were developed using the peak hour and 12-hour counts which were adjusted as described in Section 3.2.
- **Comparison to Traffic Volumes from Previous Willow Road Study** - A comparison was made between the volumes used in the previously prepared Christopher B. Burke Engineering, Ltd. (CBBEL) *Project Report for Willow Road* and the AADT volumes developed from the peak hour and 12-hour counts. It was found that the existing (2000) AADT's from the CBBEL study were consistently higher than the AADT's developed for Willow Road but slightly lower than those along either Sunset Ridge or Wagner Roads. A comparison was also made between the 2009 peak hour traffic counts for this study and the existing (2000) peak hour volumes provided in the CBBEL report. This comparison showed that in general all of the turning movements and cross street traffic at the Sunset Ridge Road and Wagner Road intersections were similar between the two years. However, there was a substantial difference in the through movement traffic on Willow Road with the volumes in 2009 being 200 to 400 vehicles per hour less in each direction than the CBBEL volumes. These differences in AADT and peak hour volumes along Willow Road appear to be reasonable with the decrease in traffic volumes experienced in the last few years due to the economy. The minimal difference in AADT on the cross streets is also reasonable.
- **Develop 2030 and 2040 No-Build Annual Average Daily Traffic (AADT) and Design Hourly Volumes (DHV)** - The 2030 and 2040 No-Build AADT Volumes were provided by the Chicago Metropolitan Agency for Planning (CMAP). The 2030 and 2040 No-Build conditions assumes implementation of major projects contained in the Regional Transportation Plan outside the study area, and no widening of Willow Road. The 2030 and 2040 A.M. and P.M. peak hour traffic volumes were developed based upon the growth in traffic exhibited between the existing AADT and forecasted 2030 and 2040 No-Build AADT. Based on typical CMAP procedures and methodology, growth factors were determined for each leg of an intersection and then applied to the existing traffic volumes. These volumes were then balanced in the same manner as the existing traffic volumes. These Balanced 2030 and 2040 No-Build A.M. and P.M. Design Hourly Volumes were used in the traffic analyses for the intersections and interchange along Willow Road.

Data Analysis

Willow Road was analyzed using three different methodologies: Isolated Signalized Intersection Capacity Analysis, Urban Street Segment Capacity Analysis, and System Analysis (microsimulation). All three methodologies were used to provide a comparison in the operation and capacity of existing conditions to other conditions analyzed, such as the 2030 and 2040 No-Build conditions. Each methodology has a particular emphasis and primary purpose. Highway Capacity Software (HCS) provides detailed tools for intersection capacity and urban street segment capacity analyses. Microsimulation software (Synchro/SimTraffic) provides analysis and visualization tools. Capacity is defined as the maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions; usually expressed as vehicles per hour, passenger cars per hour, or persons per hour.

- Isolated Signalized Intersection Capacity Analyses** - The first methodology used was based on the *Highway Capacity Manual (HCM) 2000* which contains a collection of nationally recognized state-of-the-art techniques for estimating the capacity of different types of transportation facilities. Using the methodology contained in the HCM and the peak hour and AADT information developed for Willow Road, an analysis was undertaken to quantify the capacity and operation of the existing signalized intersections in the corridor. The HCM methodology calculates the capacity for an isolated signalized intersection, i.e., an intersection that is not influenced by adjacent intersections. When signalized intersections are fairly closely spaced (typically ½ mile or less between adjacent signals), a system analysis is also typically completed. The Highway Capacity Software (HCS), which is based on the HCM, is the primary software package required per the Illinois Department of Transportation (IDOT) Bureau of Design and Environment Manual for evaluating an intersection's operation.

The operation of an intersection is described by its Level of Service (LOS). Level of service is defined as a qualitative measure describing operation conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. The following table describes the six levels of service that are defined for a signalized intersection. Each level represents a range of operating conditions with LOS A representing the best operating conditions (an average delay of 10 seconds per vehicle or less) and LOS F representing the worst (80 seconds of delay or more). It is important to recognize that this delay is a snapshot in time for one vehicle, and the cumulative effects of delay are much greater. In practical terms, LOS F means that users may be stuck in long lines of traffic approaching an intersection and require multiple cycles to pass through it. The minimum level of service for a signalized intersection is LOS D on the SRA system. It is important to note that as part of the Alternatives Evaluation stage of the project, factors such as impacts and cost will be evaluated, and may or may not result in exceptions from the LOS standard.

Signalized Intersection Level of Service

Level of Service	General Description	Average Delay (seconds per vehicle)
A	Free flow traffic; many vehicles do not stop at all	≤10
B	Generally good traffic flow; more vehicles stop than with LOS A	>10-20
C	Fair traffic flow; the number of vehicles stopping is greater than LOS B although many still pass through without stopping	>20-35
D	Longer delays; many vehicles stop and the number passing through without stopping decreases	>35-55
E	Poor flow and progression; the number of vehicles stopping is very high	>55-80
F	Very high delays with long queues of vehicles	≥80

Intersection capacity analyses were completed using the existing conditions, e.g., number of lanes (through and turning), lane widths, and general terrain (shallow or steep grades); traffic conditions, e.g., demand volume by movement, saturation flow rate, and lane utilization; and signalization conditions, e.g., cycle time, green time, and phase plan.

- Urban Street Segment Capacity Analysis** - As was noted, the signalized intersection capacity analyses do not consider the effect of adjacent intersections on traffic flow through the system. The HCM 2000 Urban Street methodology is appropriate for analyzing suburban streets that have a traffic signal spacing of two miles or less. The HCM methodology assesses mobility on a street which is measured in terms of travel speed for the through-traffic stream. This methodology was used as a second tool for analysis of the operation of Willow Road.

As with signalized intersections, there are six levels of service for urban streets. These levels of service are based upon a free flow speed and range from LOS A the highest to LOS F the lowest (see table below). At LOS A, traffic moves freely ~~at or above the posted speed limit~~; all drivers have complete mobility to change lanes. At

LOS F, traffic flow is forced; every vehicle moves in lockstep with the vehicle in front of it. ~~Assuming a free-flow speed of 35 mph (which is the posted speed limit), LOS A would equate to an average travel speed greater than 30 mph while LOS F would be less than 10 mph (see the following table).~~ As with signalized intersections, the minimum street segment level of service for a suburban SRA is LOS D.

~~In addition, the HCM 2000 specifies four possible classifications of an urban street (I, II, III, IV) that each reflect a combination of street function and design. These vary from Class I roadways which have limited access points, relatively few signals, a posted speed of 45 mph or greater to Class IV urban arterials which have posted speeds of 35 mph or less, frequent access points and signals, and dense roadside development. Within the study limits, Willow Road functions as a Class II suburban arterial, given a posted speed that varies from 35 to 40 mph, relatively moderate access frequency, high volumes of daily traffic, and nearby interstate access at Interstate 94.~~

Urban Street Segment Level of Service (LOS) ~~35 mph Free-Flow Speed~~ for a Class II Suburban, Principal Arterial

Level of Service	General Description	Average travel speed
A	Traffic moves freely at or above the posted speed limit ; all drivers have complete mobility to change lanes	≥30 <u>>35</u> mph
B	Slightly more congested than LOS A; lane changes may be limited as motorists must occasionally drive side by side	>24-30 <u>>28-35</u> mph
C	More congestion than LOS B; the ability to pass or change lanes is not always assured	>18-24 <u>>22-28</u> mph
D	Speeds are somewhat reduced, motorists are hemmed in by other cars	>14-18 <u>>17-22</u> mph
E	Flow becomes irregular; road is approaching its design capacity	>10-14 <u>>13-17</u> mph
F	Flow is forced; every vehicle moves in lockstep with the vehicle in front of it	≤10 <u>13</u> mph

- **System Analysis** - Both the intersection and street capacity analyses discussed above are good tools for analyzing the performance of isolated or small-scale transportation facilities; however, they are not structured to analyze network or system performance. For system level analyses, a third tool such as traffic microsimulation models is used. Microsimulation models are designed to simulate the movement of individual vehicles within a transportation network over time as a means to evaluate system performance. This type of analysis takes into account the traffic flows and influence from adjacent intersections.

The system analysis undertaken for the Willow Road Study used the Synchro Studio 7 Software Suite. The two parts of the software package provide different types of analyses and serve different functions. Synchro is a macroscopic analysis and optimization program and is a beneficial tool since it also looks at queuing between intersections and the additional delay caused by the queues.

In addition to the visual representation of traffic operations, the simulation program also generates a variety of Measures of Effectiveness (MOE), i.e., statistics that describe system performance. One of the MOE's is Average Network Speed. This is total distance traveled by all vehicles on the network divided by total travel time for those vehicles. The network includes Willow Road from Illinois Route 43 through the Interstate 94 interchange. It also includes the intersecting legs of all of the signalized and unsignalized intersections except Chapel Hill Court and the Interstate 94 interchange ramps at Willow Road. Summaries of the remaining MOE's are provided in Appendices K and P.

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- **Summary of Analyses** - Each of the three types of analyses completed (signalized intersection, street segment and Synchro/SimTraffic) provide a means to evaluate the operation of Willow Road with existing traffic volumes and existing lane configurations as well as to compare that operation to the operation with 2030 and 2040 No-Build Traffic. Together these results provide an overall benchmark of corridor performance and a foundation upon which to base an analysis of possible alternative improvements.
- **Intersection Analyses** - The following tables present a comparison of the A.M. and P.M. peak hour signalized intersection capacity analyses for the existing and 2030 No-Build and 2040 No-Build traffic volumes. The Levels of Service for the existing P.M. peak hour traffic are graphically depicted in Figure ES-2 shown previously. The colored dots at each signalized intersection depict its level of service. Exhibits for both peak hours with existing and 2030 and 2040 traffic volumes are included as Exhibits 4, 5, 9 and 10, 10, 14 and 15. The results from the HCS analyses were also converted to total hourly delay for all vehicles using each of the signalized intersections. This delay was calculated by multiplying each movement delay (given in seconds/vehicle) by the number of vehicles making that movement, then summing up the seconds of delay for all movements and converting to hours.

NOTE: These changes were made in July 2010.

Signalized Intersection Capacity Analyses Summary – Existing Traffic

Intersection	Existing Traffic					
	A.M. Peak Hour			P.M. Peak Hour		
	Delay (sec/veh)	Delay (hours)	LOS	Delay (sec/veh)	Delay (hours)	LOS
Willow Road at Illinois Route 43 (Waukegan Road)	57.0 <u>55.9</u>	68.4 <u>66.9</u>	E	69.9 <u>74.6</u>	123.6 <u>121.0</u>	E
Willow Road at Three Lakes/Fox Meadow Drive	26.0 <u>15.1</u>	47.8 <u>9.3</u>	C <u>B</u>	20.7 <u>10.2</u>	47.1 <u>8.7</u>	B <u>G</u>
Willow Road at Sunset Ridge Road	82.4	57.9	F	112.9	93.1	F
Willow Road at Wagner Road	65.9	39.2	E	146.6 <u>149.3</u>	101.9	F
Willow Road at Old Willow Road/Northfield Road	26.5 <u>28.6</u>	45.6 <u>17.5</u>	C	22.7 <u>26.4</u>	46.9 <u>20.1</u>	C
Willow Road at Central Avenue/ Happ Road	54.7 <u>47.9</u>	46.9 <u>36.7</u>	D	69.8 <u>67.7</u>	70.2 <u>70.0</u>	E

Signalized Intersection Capacity Analyses Summary – 2030 No-Build Traffic

Intersection	2030 No-Build Traffic					
	A.M. Peak Hour			P.M. Peak Hour		
	Delay (sec/veh)	Delay (hours)	LOS	Delay (sec/veh)	Delay (hours)	LOS
Willow Road at Illinois Route 43 (Waukegan Road)	79.3 <u>78.0</u>	107.3 <u>105.3</u>	E	109.5 <u>108.0</u>	195.0 <u>192.1</u>	F
Willow Road at Three Lakes/Fox Meadow Drive	33.2 <u>217.3</u>	21.4 <u>12.4</u>	C <u>B</u>	27.6 <u>18.3</u>	25.0 <u>16.1</u>	C <u>B</u>
Willow Road at Sunset Ridge Road	107.7	88.3	F	168.8	166.7	F
Willow Road at Wagner Road	115.7	79.5	F	229.1 <u>225.2</u>	177.6	F
Willow Road at Old Willow Road/ Northfield Road	32.9 <u>36.0</u>	23.2 <u>25.5</u>	C <u>D</u>	26.1 <u>30.3</u>	22.6 <u>26.4</u>	C
Willow Road at Central Avenue/ Happ Road	77.5	67.6	E	106.3 <u>106.4</u>	128.3 <u>122.7</u>	F

Signalized Intersection Capacity Analyses Summary – 2040 No-Build Traffic

Intersection	<u>2040 No-Build Traffic</u>					
	<u>A.M. Peak Hour</u>			<u>P.M. Peak Hour</u>		
	<u>Delay (sec/veh)</u>	<u>Delay (hours)</u>	<u>LOS</u>	<u>Delay (sec/veh)</u>	<u>Delay (hours)</u>	<u>LOS</u>
<u>Willow Road at Illinois Route 43 (Waukegan Road)</u>	<u>90.9</u>	<u>130.3</u>	<u>F</u>	<u>122.3</u>	<u>235.1</u>	<u>F</u>
<u>Willow Road at Three Lakes/Fox Meadow Drive</u>	<u>17.6</u>	<u>12.9</u>	<u>B</u>	<u>18.5</u>	<u>16.7</u>	<u>B</u>
<u>Willow Road at Sunset Ridge Road</u>	<u>139.9</u>	<u>118.9</u>	<u>F</u>	<u>192.0</u>	<u>195.3</u>	<u>F</u>
<u>Willow Road at Wagner Road</u>	<u>110.8</u>	<u>80.6</u>	<u>F</u>	<u>217.5</u>	<u>178.2</u>	<u>F</u>
<u>Willow Road at Old Willow Road/ Northfield Road</u>	<u>39.7</u>	<u>28.8</u>	<u>D</u>	<u>31.2</u>	<u>27.6</u>	<u>C</u>
<u>Willow Road at Central Avenue/ Happ Road</u>	<u>85.0</u>	<u>77.6</u>	<u>F</u>	<u>126.0</u>	<u>152.0</u>	<u>F</u>

During the A.M. peak hour with the existing traffic volumes, the HCS signalized intersection capacity analysis showed three of the six signalized intersections to be operating below the minimum level of service, i.e., LOS D. These intersections are Willow Road at Illinois Route 43, Sunset Ridge Road, and Wagner Road. With the 2030 No-Build traffic volumes, four of the six intersections are operating below the minimum level of service, with Wagner Road changing to LOS F and Central Avenue/Happ Road changes to LOS E. With the 2040 No-Build traffic, four of the six intersections also operate below LOS D, with Illinois Route 43 and Central Avenue/Happ Road changing to LOS F. All intersections experienced increased delay in the A.M. peak hour with the 2030 2040 No-Build traffic over the existing traffic.

During the P.M. peak hour with the existing traffic volumes, the HCS capacity analysis showed four of the six signalized intersections to be operating below the minimum level of service. These were the intersections of Willow Road at Illinois Route 43, Sunset Ridge Road, Wagner Road, and Central Avenue/Happ Road. Overall

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the delay in the P.M. peak hour is worse than the A.M. peak hour. This follows the general tendency for the P.M. peak to be the busier of the two times of day based on the results of the traffic counts conducted for this study. With the 2030 No-Build traffic volumes, the Level of Service for both the Illinois Route 43 and Central Avenue/Happ Road intersections change to LOS F and delay increases at all six intersections. For 2040 traffic, there is no change in level of service from 2030 although the intersection delay increased for all six intersections.

These analyses show that four of the six signalized intersections on Willow Road between Illinois Route 43 and Central Avenue/Happ Road are operating over capacity with ~~either~~ existing traffic volumes ~~or and with~~ forecasted 2030 and 2040 No Build traffic volumes ~~and~~. The analyses also show that the levels of service will continue to decline with the projected No-Build future travel demand. A substantial increase in delay will also occur as a result of the increase in traffic, particularly at the Illinois Route 43, Sunset Ridge Road and Wagner Road intersections.

- **Street Segment Analysis** - The following tables presents a comparison of the street segment capacity analyses results between existing, ~~and~~ 2030 No-Build and 2040 No-Build traffic volumes. The street segment levels of service for the existing P.M. peak hour traffic are shown in Figure ES-2.

Street Segment Capacity Analysis – Existing and 2030 No-Build Traffic

Eastbound	Existing Traffic Volumes				2030 No-Build Traffic Volumes			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Arterial Speed (mph)	Arterial Level of Service	Arterial Speed (mph)	Arterial Level of Service	Arterial Speed (mph)	Arterial Level of Service	Arterial Speed (mph)	Arterial Level of Service
IL Route 43 to Three Lakes Drive/Fox Meadow Drive	13.221. <u>2</u>	E <u>D</u>	15.427. <u>2</u>	E <u>C</u>	12.420. <u>4</u>	F <u>D</u>	14.626. <u>7</u>	E <u>C</u>
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	15.7	E	6.7	F	12.0	F	4.1	F
Sunset Ridge Road to Wagner Road	13.5	E	7.9	F	9.3	F	5.7	F
Wagner Road to Old Willow Road/Northfield Road	20.1	D	20.7	D	18.6	D	19.9	D
Old Willow Road/Northfield Road to Central Avenue/Happ Road	3.9	F	3.5	F	2.1	F	1.9	F
Westbound								
Central Avenue/Happ Road to Old Willow Road/ Northfield Road	12.49.4	F	12.98.9	F	13.29.2	E <u>F</u>	12.48.4	F
Old Willow Road/Northfield Road to Wagner Road	17.416. <u>5</u>	D <u>E</u>	8.9	F	11.3	F	6.0	F
Wagner Road to Sunset Ridge Road	26.3	C	24.9	C	24.5	C	15.9	E
Sunset Ridge Road to Three Lakes Drive/Fox Meadow Drive	18.7	D	21.3	D	18.3	D	20.8	D
Three Lakes Drive/Fox Meadow Drive to IL Route 43	13.1	E	6.1	F	12.6	F	3.8	F

Street Segment Capacity Analysis – 2040 No-Build Traffic

<u>Eastbound</u>	<u>2040 No-Build Traffic Volumes</u>			
	<u>AM Peak Hour</u>		<u>PM Peak Hour</u>	
	<u>Arterial Speed (mph)</u>	<u>Arterial Level of Service</u>	<u>Arterial Speed (mph)</u>	<u>Arterial Level of Service</u>
<u>IL Route 43 to Three Lakes Drive/Fox Meadow Drive</u>	<u>20.4</u>	<u>D</u>	<u>26.7</u>	<u>C</u>
<u>Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road</u>	<u>12.0</u>	<u>F</u>	<u>4.0</u>	<u>F</u>
<u>Sunset Ridge Road to Wagner Road</u>	<u>9.3</u>	<u>F</u>	<u>5.7</u>	<u>F</u>
<u>Wagner Road to Old Willow Road/Northfield Road</u>	<u>17.5</u>	<u>D</u>	<u>19.7</u>	<u>D</u>
<u>Old Willow Road/Northfield Road to Central Avenue/Happ Road</u>	<u>1.9</u>	<u>F</u>	<u>2.0</u>	<u>F</u>
<u>Westbound</u>	-	-	-	-
<u>Central Avenue/Happ Road to Old Willow Road/ Northfield Road</u>	<u>9.2</u>	<u>F</u>	<u>8.4</u>	<u>F</u>
<u>Old Willow Road/Northfield Road to Wagner Road</u>	<u>11.3</u>	<u>F</u>	<u>6.0</u>	<u>F</u>
<u>Wagner Road to Sunset Ridge Road</u>	<u>24.5</u>	<u>C</u>	<u>15.9</u>	<u>E</u>
<u>Sunset Ridge Road to Three Lakes Drive/Fox Meadow Drive</u>	<u>18.1</u>	<u>D</u>	<u>20.6</u>	<u>D</u>
<u>Three Lakes Drive/Fox Meadow Drive to IL Route 43</u>	<u>12.4</u>	<u>F</u>	<u>3.4</u>	<u>F</u>

This-These tables shows that the arterial levels of service with existing traffic volumes are currently below the minimum LOS D for all segments except westbound Willow Road between Wagner Road and Sunset Ridge Road and between Sunset Ridge Road and Three Lakes Drive/Fox Meadow Drive as well as eastbound Willow Road between Illinois Route 43 and Three Lakes Drive/Fox Meadow Drive and between Wagner Road and Old Willow Road/Northfield Road. With the future travel demand estimated for the 2030 and 2040 No-Build conditions, arterial speeds will decline and levels of service will worsen.

The volume-to-capacity (V/C) ratio relates the demand on a roadway, in terms of vehicles, to the roadway's ability to carry traffic, i.e., its capacity. It is a measure of congestion. As the value of the ratio approaches 1.00 a roadway is becoming more congested. Values at or above 1.00 indicate a congested roadway operating above capacity. Note that the capacity is only that of the through traffic lanes and does not consider any turn lanes that may be present. This does not account for turning vehicles that either because of the lack of turn lanes or because turn lanes are operating above capacity themselves, add additional delay for the through traffic.

The following table shows the calculated V/C ratios with existing and, 2030 No-Build and 2040 No-Build traffic volumes. Under existing traffic conditions during peak hours, all segments have a V/C greater than 1.0 except between Central Avenue/Happ Road and Interstate 94. The other segments have ratios over 1.00 indicating congested conditions with the highest values on the segments between Three Lakes Drive/Fox Meadow Drive

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and Old Willow Road/Northfield Road. ~~In comparison, under the 2030 No-Build condition, all segments in either the A.M. or P.M. peak hour have V/C ratios equal to or greater than 1.00. In addition, the V/C ratios in the 2030 and 2040 No-Build conditions are all higher than the corresponding ratios under the existing condition indicating greater congestion levels. Finally, the highest values are once again on the segments between Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road.~~

Street Segment Volume-to-Capacity (V/C) Ratio – Existing and 2030 No-Build and 2040 No-Build

Segment	Existing Traffic Volumes		2030 No-Build Traffic Volumes		2040 No-Build Traffic Volumes	
	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
	V/C Ratio	V/C Ratio	V/C Ratio	V/C Ratio	V/C Ratio	V/C Ratio
IL Route 43 to Three Lakes Drive/Fox Meadow Drive	1.11	1.29 1.45	1.45 1.29	1.68	1.31	1.71
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	1.39	1.64 1.81	1.84 1.61	2.09	1.64	2.14
Sunset Ridge Road to Wagner Road	1.55	1.84	1.84 1.80	2.13	1.80	2.14
Wagner Road to Old Willow Road/Northfield Road	1.45	1.67 1.69	1.69 1.67	1.95	1.70	1.97
Old Willow Road/Northfield Road to Central Avenue/Happ Road	1.04	1.49 1.26	1.26 1.19	1.44	1.22	1.46
Central Avenue/Happ Road through Interstate 94 Interchange	0.81	0.89 1.00	1.00 0.89	1.10	0.94	1.14

Based on both the street segment capacity analyses using the HCS and the street segment volume-to-capacity ratios, most segments of Willow Road are over capacity but by 2030 under the No-Build condition, all segments will be over capacity as they will be with 2040 No-Build traffic.

- System Analysis - For both the A.M. and P.M. peak hours, the Synchro/SimTraffic simulation showed a reasonable representation of observed traffic conditions. The following table provides the existing and 2030 No-Build and 2040 No-Build system travel speeds for the A.M. and P.M. peak hours. For comparison purposes, a level of service value has been assigned based on the HCM values given previously for segment level of service based on average travel speed.

Traffic Simulation Network Travel Speed – Existing and 2030 and 2040 No-Build Traffic

	Existing Traffic Volumes		2030 No-Build Traffic Volumes		2040 No-Build Traffic Volumes	
	A.M. Peak Hour	P.M. Peak Hour	A.M. Peak Hour	P.M. Peak Hour	A.M. Peak Hour	P.M. Peak Hour
Network Travel Speed	14 mph	9 mph	12 mph	7 mph	10 mph	7 mph
Level of Service	E	F	E	F	F	F

- Interchange Analysis - Three types of analyses were completed to evaluate the operation of the Willow Road interchange with Interstate 94. These include two-way stop control; weaving section; and ramp merge/diverge analyses.

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Along Willow Road, the northbound Interstate 94 to eastbound Willow Road ramp terminal is under stop control. With existing traffic volumes it operates at LOS B in both peak hours. With 2030 or 2040 No-Build traffic, it still operates at LOS B.

The northbound Interstate 94 to westbound Willow Road and westbound Willow Road to southbound Interstate 94 ramps have a weaving section between them on Willow Road. A Freeway Weaving Operational Analysis using HCM 2000 procedures as implemented in the HCS was used to analyze this section. Based on existing traffic volumes, this weaving section operates at LOS B for both peak hours and with 2030 or 2040 No-Build traffic volumes it operates at LOS C for both peak hours.

The eastbound Willow Road to southbound Interstate 94 ramp diverge cannot be analyzed using the HCM 2000 procedure. The procedure requires the mainline facility to operate at a speed at or above 55 mph. Because this section of Willow Road has a speed limit of only 35 mph, the methodology is not applicable.

Along Interstate 94, the eastbound and westbound Willow Road to southbound Interstate 94 ramp terminals operate as merge sections with Interstate 94. With existing ~~or~~ 2030 No-Build traffic or 2040 No-Build volumes, the eastbound Willow Road to southbound Interstate 94 ramp terminal operates at LOS D in both peak hours. With ~~either set of existing or 2030 No-Build~~ traffic volumes, the westbound Willow Road to southbound Interstate 94 operates at LOS C in both peak hours. With 2040 No-Build traffic, it operates at LOS D in both peak hours.

The northbound Interstate 94 to eastbound and westbound Willow Road ramps operate as diverge sections with Interstate 94. With ~~either set of existing, 2030 No-Build or 2040 No-Build~~ traffic volumes, both ramps operate at LOS F in the A.M. peak hour and LOS E in the P.M. peak hour.

Conclusion

Based upon the analysis of existing traffic conditions, much of Willow Road from Illinois Route 43 (Waukegan Road) to Central Avenue/Happ Road is operating at or above capacity with existing (2009) traffic volumes. There are capacity problems on both the four lane and two lanes sections of Willow Road. Therefore, alternatives should be evaluated to address these deficiencies. With expected traffic growth estimated in the ~~2030~~2040 No-Build condition, this operation will only worsen. As demand continues to grow, drivers will experience decreased levels of service at intersections and along street segments, increased congestion, and longer queues, further increasing the need to address deficiencies. The interchange at Interstate 94 operates at LOS D for existing and future traffic conditions.



Draft

Traffic Analysis Summary

Existing ~~and~~, 2030 No-Build and 2040 No-Build Traffic Volumes

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1 Introduction

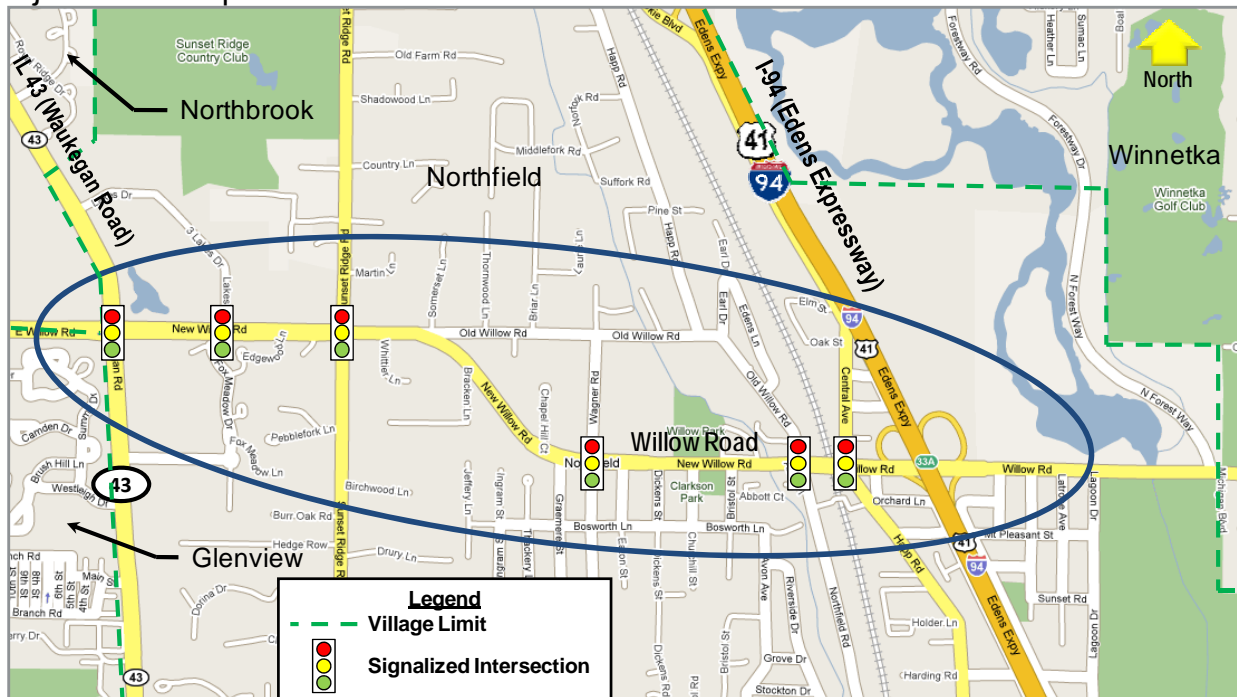
Willow Road is an east west Strategic Regional Arterial (SRA) that carries up to 32,000 vehicles per day within the study area. SRA's are a network of highways designed to accommodate long distance regional traffic, to complement the region's major highway and transit facilities and to supplement the freeway system.

This report is one aspect of the overall Phase I study process and presents the findings of the existing conditions and 2030 No-Build and 2040 No-Build traffic analysis completed for the Willow Road Study. It should be noted that the Willow Road Study began in 2009, when long range forecasts were based upon the 2030 horizon. In the fall of 2010, the region adopted the 2040 plan. Therefore the 2030 No-Build traffic volumes are provided for information only. The 2040 No-Build traffic volumes and analyses will be utilized in the Purpose and Need and the alternatives development phase of the project.

The analysis includes Willow Road from Illinois Route 43 (Waukegan Road) to Interstate 94 (Edens Expressway). The corridor includes six signalized intersections and the Interstate 94 interchange which provides access to and from the south on Interstate 94. There are also numerous smaller cross streets and driveways that access Willow Road through the Study Area. The study area is shown in the figure below.

The evaluation of roadway operations occurs in a three-step process: 1) Data Collection, 2) Data Processing, and 3) Data Analysis. The following is a summary of those steps undertaken for the Willow Road Study. These steps will be completed for existing traffic volumes and for the forecasted 2030 and 2040 No-Build traffic volumes. This methodology is detailed in the *Methodology for Evaluating Existing and Future Traffic Conditions* which is included in Appendix A. The No-Build volumes maintain the existing street configuration for Willow Road within the study area but include other improvements in the Chicago region that are included in CMAP's 2030 GO TO 2040 plan.

Project Location Map



2 Data Collection

2.1 Existing Street Network

Willow Road Corridor

Willow Road is an arterial that consists of two-lane and four-lane segments within the study limits. The corridor provides regional connections with Interstate 94, Illinois Route 43 and Interstate 294 (3.5 miles west of the study area). Willow Road is classified as an east-west Strategic Regional Arterial (SRA). Within the study area, Willow Road also provides access to residential streets and driveways, some commercial uses, local schools, parks, and churches.

The cross section on Willow Road widens near signalized intersections to accommodate turn lanes and at the east and west ends of the study area to transition to the existing four-lane cross sections. Within the study area, the roadway has a four-lane cross section with a center barrier median from Illinois Route 43 to just west of Sunset Ridge Road and from just west of Northfield Road through the Interstate 94 interchange. Willow Road has a two-lane cross section between Sunset Ridge Road and just west of Northfield Road.

There are six signalized intersections within the Willow Road Study limits. Those include Illinois Route 43, Sunset Ridge Road, Wagner Road, Old Willow Road/Northfield Road and Central Avenue/Happ Road. All of the signals are under the jurisdiction ~~of the~~of the Illinois Department of Transportation (IDOT). The only signals of these six which IDOT maintains (routinely checks for proper operation and provides service on when equipment malfunctions) are the signals at Illinois Route 43 and Three Lakes Drive/Fox Meadow Drive. The other four are maintained by the Village of Northfield under a maintenance agreement between the State and the Village.

The signals at Illinois Route 43 and Three Lakes Drive/Fox Meadow Drive are part of a larger traffic signal interconnect system which IDOT maintains and provides signal timings. The system extends west along Willow Road to Old Willow Road in Glenview. It also extends north along Illinois Route 43 to Founders Drive and south to Chestnut Avenue. This is a system in which the controllers are connected through fiber optic cable to a master controller which provides communications to all the signals in the system. IDOT is able to connect to the master controller to monitor system operations and provide updates to signal timings as necessary.

The traffic signals at Sunset Ridge Road and Wagner Road are older signals and are not interconnected or coordinated with any of the other signals along Willow Road. In order to monitor or modify the signal operation, IDOT must be physically present at the intersection.

The signals at Old Willow Road/Northfield Road and at Central Avenue/Happ Road are also older signals but do have a hard-wire connection between the two signal controllers. This connection allows some coordination to be provided between the signals, although as with Sunset Ridge and Wagner Roads, IDOT must be physically present at the intersection to monitor or modify the signal operation.

The goal of traffic signal coordination is to establish platoons or tight groups of vehicles that can move easily from one intersection through another without stopping. Two lane roads make it difficult to maintain platoons because of ~~they~~lack channelization for turning vehicles and tend to provide random arrival at the adjacent signalized intersection. Even when geometric conditions do not provide ideal traffic signal coordination, it is at times beneficial to interconnect traffic signals to remotely monitor signal performance and improve maintenance.

Illinois Route 43 (Waukegan Road)

Illinois Route 43 is a north-south Strategic Regional Arterial. The cross section includes two through lanes in each direction which widen to accommodate an exclusive left turn lane in each direction at its intersection with Willow Road. There are also right turn lanes for the eastbound, westbound and southbound approaches to this intersection.

Three Lakes Drive/Fox Meadow Drive

Three Lakes Drive provides access to Kraft Foods, Inc. to the north of Willow Road. Fox Meadow Drive provides access to the residential development to the south which includes single family homes and Fox Meadow Park with three soccer fields. Both are median divided local roadways. The Three Lakes Drive approach has a combined left turn/through lane and a right turn lane. The Fox Meadow Drive approach has one wide lane with no marked channelization for turns.

Sunset Ridge Road

Sunset Ridge Road is a north-south two-lane collector roadway that widens to provide an exclusive northbound left turn lane and southbound exclusive right and left turn lanes at Willow Road.

Old Willow Road

Old Willow Road is a local street that intersects Willow Road at two locations within the study area. The two-lane roadway intersects Willow Road at a skewed unsignalized intersection just east of Sunset Ridge Road. Left turns are restricted from eastbound Willow Road onto Old Willow Road between the hours of 7:00 a.m. and 10:00 a.m. and 3:00 p.m. and 7:00 p.m.

Old Willow Road is also the north leg of the signalized intersection with Northfield Road in the eastern portion of the study area. Old Willow Road widens at this signalized intersection to provide an exclusive southbound left turn lane.

Wagner Road

Wagner Road is a north-south, two-lane local roadway that widens to accommodate an exclusive left turn lane in each direction at Willow Road.

Northfield Road

Northfield Road is a north-south, two-lane local roadway which provides access to mostly commercial uses south of Willow Road in the eastern portion of the study area. The roadway widens to accommodate an exclusive left turn lane at Willow Road.

Central Avenue/Happ Road

Central Avenue to the north and Happ Road to the south of Willow Road are both north-south, two-lane collector roadways. Central Avenue operates with one lane in each direction and a center two-way left turn lane north of Willow Road. It widens to include left and right turn lanes on the southbound approach to Willow Road. Happ Road is a two lane roadway that widens to accommodate left and right turn lanes at Willow Road.

Interstate 94

Interstate 94 is generally oriented north-south within the study area and intersects Willow Road with a partial interchange that provides access to and from the south on Interstate 94. At this interchange, the interstate is a six-lane divided freeway. The interchange ramps are all single lane ramps and include:

- Northbound Interstate 94 to Eastbound Willow Road Exit Ramp
- Northbound Interstate 94 to Westbound Willow Road Exit Ramp
- Eastbound Willow Road to Southbound Interstate 94 Entrance Ramp
- Westbound Willow Road to Southbound Interstate 94 Entrance Ramp

2.2 Traffic Counts

The traffic count data collected for the Willow Road Study represented the first step in evaluating roadway operations along Willow Road between Illinois Route 43 and Interstate 94 (I-94 or Edens Expressway). These counts were

conducted manually with staff counting each car, truck, pedestrian, and bicycle entering or crossing a leg of an intersection. Normally at a minimum the busiest two to three hours of the day, during the morning and evening rush hours, are counted to ensure that traffic volumes during the busiest hour of the day are counted¹. For the Willow Road Traffic Study the following counts were completed:

- 1) 12-hour (minimum) turn-movement counts at all signalized intersections.
- 2) Peak period counts (two to three hours in duration) taken during the morning and evening at all non-signalized intersections with public streets.

Procedures that were followed for these manual traffic counts include:

- 1) All vehicle movements at the intersection were counted (left turn, through, and right turn).
- 2) All pedestrians and bicyclists that cross the main road or side street were counted.
- 3) Trucks were counted in addition to cars.
- 4) Counts were taken on Tuesday, Wednesday, Thursday, or Friday (Friday counts occurred only in the morning and only at three of the intersections).
- 5) Counts were not taken on days immediately before or after a holiday.
- 6) Counts were not taken during inclement weather (rain or snow).
- 7) Local conditions were considered that may have influence the count (e.g., school not in session).
- 8) Closely spaced intersections were counted on the same day when possible.

Counts were conducted at the following signalized intersections:

- 1) Willow Road at Illinois Route 43 (Waukegan Road);
- 2) Willow Road at Three Lakes Drive/Fox Meadow Drive;
- 3) Willow Road at Sunset Ridge Road;
- 4) Willow Road at Wagner Road;
- 5) Willow Road at Old Willow Road/Northfield Road; and,
- 6) Willow Road at Central Avenue/Happ Road

Peak Period Counts were taken at the following unsignalized intersections:

- 1) Willow Road at Old Willow Road/Somerset Lane;
- 2) Willow Road at Bracken Lane;
- 3) Willow Road at Eaton Street;
- 4) Willow Road at Dickens Street;
- 5) Willow Road at Churchill Street;
- 6) Willow Road at Bristol Avenue (north) and Bristol Street (south);
- 7) Willow Road at Walnut Street; and,
- 8) Old Willow Road at Wagner Road.

Counts were also taken at the Interstate 94 ramp terminals with Willow Road:

- 1) Eastbound Willow Road to Southbound Interstate 94 Entrance Ramp (12-hour count);
- 2) Northbound Interstate 94 to Eastbound Willow Road Exit Ramp (peak period count);
- 3) Northbound Interstate 94 to Westbound Willow Road Exit Ramp (peak period count); and,
- 4) Westbound Willow Road to Southbound Interstate 94 Entrance Ramp (12-hour count).

¹ For this study, the majority of the traffic counts were collected by Regina Webster & Associates (RWA) during May and June 2009. These were taken prior to the Willow Road resurfacing west of Illinois Route 43 which began in July 2009.

Appendix B contains the following information:

- Graphical representation of the hourly two-way traffic volumes for the east and north legs of signalized intersections throughout the count period. The total pedestrian plus bicycle volume crossing the east and west legs of Willow Road are also graphed.

Appendix C contains the following information:

- Raw traffic count sheets showing the 15-minute totals for each movement at the intersection for cars, single unit trucks, multi-unit trucks, pedestrians and bicyclists.
- For the unsignalized intersections and ramp intersections, where morning and evening peak period counts were taken, only the raw traffic count sheets have been provided.

2.3 Saturation Flow Studies

The saturation flow rate is defined as the equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times² are experienced, in vehicles per hour or vehicles per hour per lane (HCM 2000, p. 5-14). In other words, it is the maximum number of vehicles that can go through an intersection in one lane in one hour.

Field saturation flow studies were performed at five locations along the corridor to directly measure the saturation flow rate. The studies were performed according to the procedures listed in the Highway Capacity Manual. (HCM 2000, pp. 16-158-160) Data collection started at an intersection when a minimum of eight vehicles were queued in a given lane at the beginning of a signal cycle. Then, when the signal changed and traffic started moving, the times when the front axle of the fourth vehicle and the front axle of the last vehicle in the queue crossed the stop bar were recorded. (Note that the initial three vehicles in queue are not included in order to eliminate start up loss time from the calculation. It is assumed that by the time the fourth vehicle reaches the stop bar, the traffic is operating in a steady state.)

The saturation flow rate was measured during the morning and evening peak hours eastbound and westbound on Willow Road at Illinois Route 43 (Waukegan Road), Sunset Ridge Road, and Wagner Road, eastbound at Old Willow Road/Northfield Road, and westbound at Central Avenue/Happ Road. These sites were chosen because the methodology requires a minimum of eight vehicles in the queue at an intersection. These were all the locations along Willow Road that reliably had a sufficient queue.

The dates of the flow rate studies along Willow Road were:

- April 8, 2010 at Illinois Route 43 (Waukegan Road) and Wagner Road during the A.M. and P.M. Peak;
- April 12, 2010 at Sunset Ridge Road, Old Willow Road/Northfield Road, and Central Avenue/Happ Road during the P.M. Peak; and,
- April 13, 2010 at Sunset Ridge Road, Old Willow Road/Northfield Road, and Central Avenue/Happ Road during the A.M. Peak.

For the most part the weather was good, with little or no precipitation, on the day these studies were conducted.

Although data for three locations was collected on a Monday afternoon, this did not make a significant difference in

² The time, in seconds, during which an intersection is not used effectively by any movement; it is the sum of clearance lost time plus start-up lost time. (HCM 2000, p. 5-9) Clearance lost time is the time, in seconds, between signal phases during which an intersection is not used by any traffic. (HCM 2000, p. 5-3) Start-up lost time is the additional time, in seconds, consumed by the first few vehicles in a queue at a signalized intersection above and beyond the saturation headway, because of the need to react to the initiation of the green phase and to accelerate. (HCM 2000, p. 5-15)

the results obtained. Saturation flow studies are not affected by conditions such as rerouted traffic from adjacent road closures unless traffic flow through the intersections is affected. It was noted that Old Willow Road was closed between Wagner Road and Happ Road due to bridge construction when the studies were being completed.

The field measured saturation flow rate at each location for each direction was determined by averaging the results of all of the morning and evening cycles. The observed average saturation flow rates, expressed in vehicle per lane per hour (vplph) along the Willow Road corridor are presented in Table 1. For reference, the methodology in the HCM 2000 assumes an ideal saturation flow rate of 1,900 pc/h/ln (passenger cars per hour per lane). Adjustment factors which account for lane width, percent of heavy vehicles, percent grade, existence of on-street parking, number of buses stopping, area type, lane utilization, percent of right turns or left turns using a shared lane, and the number of conflicting bicycles and pedestrians are applied to the ideal saturation flow rate to develop a rate which would be comparable to the field measured rate. Using those factors, the field rates were adjusted to back into an “ideal” rate for each location. Those are also shown in Table 1.

Table 1 – Saturation Flow Study Results

Willow Road at:	Field Measured Rate (vplph)		Calculated “Ideal” Rate (pc/h/l)	
	Eastbound	Westbound	Eastbound	Westbound
Illinois Route 43	1800	1720	1955	1930
Sunset Ridge Road	1855	1780	1985	1900
Wagner Road	1890	2095	1580	1675
Old Willow Road/Northfield Road	1490	--	1740	--
Central Avenue/Happ Road	--	1460	--	1680

A comparison of these rates shows that for the intersections in the west half of the project, the calculated ideal saturation flow rate is similar to that assumed by the HCM. The intersections from Wagner Road east have a much lower calculated ideal rate. The intersections east of Wagner Road are more closely spaced and therefore the queuing between them has more effect on traffic flow. This is likely due to the queuing at adjacent intersections which results in drivers starting up from the intersection at a slower pace since they know there are usually delays as they continue their trip on this section of Willow Road. Because actual saturation flow rates were measured for these locations and it was shown that they varied from the assumed ideal rate, the measured rates were used in the intersection capacity analyses. Default saturation flow rates (1900 pc/h/ln) were used for the cross roads.

A summary of the individual Saturation Flow Studies and the saturation flow rate calculations isare presented in Appendix D.

2.4 Lane Utilization Studies

Lane utilization is defined as the distribution of vehicles among lanes when two or more lanes are available for a movement; however, as demand approaches capacity, uniform lane utilization develops. (HCM 2000, p. 5-8) The methodology involved counting the number of vehicles using each lane of a two lane approach for a fifteen minute period. Based on these data, the percentage of traffic traveling in the most heavily used lane was calculated.

Lane utilization studies were performed at three locations along the project corridor. These three locations were chosen because the commonly used default values may not apply due to circumstances such as a lane drop immediately past the intersection or the presence of a heavily used facility such as the Edens Expressway ramp. The locations were:

- Eastbound along Willow Road at Three Lakes Drive/Fox Meadow Lane just west of the lane reduction approaching Sunset Ridge Road;

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- Eastbound along Willow Road at Central Avenue/Happ Road just west of the southbound entrance ramp to Interstate 94; and
- Westbound along Willow Road at Old Willow Road/Northfield Road just east of the lane reduction approaching Bristol Street.

The HCM 2000 lane utilization default is 52.5 percent for a through or shared lane group³ with two lanes in the group, i.e., the percentage of the traffic in the most heavily traveled lane is 52.5 percent. (HCM 2000 p. 10-26 Ex 10-23) The results of the lane utilization studies are presented in Table 2.

Table 2 – Lane Utilization Study Results

Location	AM Peak Hour	PM Peak Hour
Eastbound Willow Road at Three Lakes Drive/Fox Meadow Drive	72%	65%
Eastbound Willow Road at Central Avenue/Happ Road	56%	65%
Westbound Willow Road at Old Willow Road/Northfield Road	65%	56%

Based on these results, it can be seen that the using the default lane utilization value is not appropriate for these three locations, therefore the values shown in the table above were used for the analyses.

Summaries of the lane utilization studies and calculations are presented in Appendix E.

³ The word “shared” in this context refers to vehicular movements from a lane, e.g., a lane from which a driver may go through an intersection as well as make a left turn is considered a shared lane.

3 Data Processing

3.1 Balancing of Raw Traffic Counts

Not all of the intersections in the Willow Road Study Area were counted on the same day. Due to daily fluctuations in traffic volumes, counts taken on different days can result in minor variations in the traffic volumes recorded at adjacent intersections. Standard practice is for counts collected over several days to be adjusted to represent a typical traffic day. In order to facilitate the analyses to be completed as part of this study, traffic volumes were balanced between adjacent intersections. The objective of this balancing is to ensure that the volume of traffic leaving one intersection is approximately equal to the volume arriving at the next intersection unless local conditions suggest it should be otherwise.

In order to balance the raw traffic data, the following steps are completed for both the morning and evening periods:

- 1) Determine the common peak hour
 - a. Identify the peak hour for each intersection. This is the one-hour period during the morning and evening that has the most traffic passing through the intersection.
 - b. Identify which peak hour in the morning and in the evening occurs most often at all intersections.
 - c. For the Willow Road Study, the common peak hours were 7:45 A.M. to 8:45 A.M. and 5:00 P.M. to 6:00 P.M.
- 2) Determine a starting point
 - a. Using the common peak hour, compare arriving and departing volumes at adjacent intersections to evaluate the variations in traffic between the intersections.
 - b. Choose a starting point at which to begin the balancing giving consideration to the variations in traffic between adjacent intersections and any especially important or sensitive intersections.
 - c. For the Willow Road Study, the starting point was the intersection of Willow Road and Sunset Ridge Road.
- 3) Balance the raw traffic counts
 - a. Balance traffic eastward and westward from Sunset Ridge Road.
 - b. During the balancing, give consideration to mid-block driveways and cross streets which may generate traffic and create an imbalance in volumes between two adjacent intersections.

| The final balanced existing peak hour traffic volumes are illustrated in Exhibits 1aA and 1bB. Appendix F contains Peak Hour Diagrams showing the balanced traffic volumes, truck percentages, lane configurations, as well as bicycle and pedestrian traffic.

3.2 Develop Annual Average Daily Traffic (AADT) Volumes

Annual Average Daily Traffic is defined as the total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year (HCM 2000, p. 5-1). These volumes represent a total 24-hour volume of traffic traveling in both directions. In short, AADT is a measure of how busy a road is.

Since 24-hour counts were not taken at any locations within the project limits, it was necessary to develop the existing AADT volumes using the peak hour and 12-hour counts. Two different methods were utilized based on accepted engineering practice.

Method 1. This method recognizes that the peak hour volume is generally about eight to ten percent of the total 24-hour volume on urban arterial roadways. The method utilizes a K-factor, defined as the proportion of total daily traffic that occurs during the peak hour, applied to peak hour volumes to estimate AADT. (HCM 2000, p. 9-8) Based on the *HCM 2000*, a nine-percent K-factor is representative of what would be expected in an urbanized area such as

the Willow Road Study area. However, the true K-factor can vary depending on the overall AADT (the higher the volume, the lower the K-factor because the traffic peak spreads out over several hours). It can also vary depending on the type of road and surrounding land use (a road that serves peak hour commuters would have a different K-factor than one that has many shopping areas). To apply this method, the A.M. and P.M. two-way peak hour volumes were averaged and then divided by 0.09 (equivalent to saying 9.0 percent of AADT occurs during the peak hour) to estimate the AADT's. The results of the AADT calculations for the signalized intersections and the ramps using Method 1 are summarized in Appendix G.

Method 2. The second method converted the 12-hour counts to a 24-hour AADT using seasonal adjustment and expansion factors developed by the Illinois Department of Transportation. Traffic volumes vary throughout the year based on the month, type of roadway, and character of adjacent land use, e.g., residential or recreational. The Seasonal Adjustment Factors (SAF) are based on historical data and applied to traffic counts to adjust the counts to a seasonally adjusted 12-hour count. The weekday SAF for urban/rural and interstate/other roads are shown in Appendix G. The roadway classification of "Other Urban Arterial" was chosen to represent Willow Road and, since the counts were taken primarily in May of 2009, a factor of 1.15 corresponding to the month of May was used from the table.

Traffic volumes can vary throughout the day, but have a relatively consistent percentage of the AADT occurring during a 12-hour period. The Expansion Factor (EF), as with the SAF, can vary based on type of roadway and adjacent land use. The EF, which like the SAF is based on historical data, is used to expand the 12-hour seasonally adjusted counts to a 24-hour total, i.e., AADT. The Expansion Factor tables are shown in Appendix G. The EF classification chosen for the Willow Road legs of each intersection and the north and south legs of Waukegan Road was "Other Principal Arterial; Urban". For all the other signalized cross streets within the project limits, the classification "Collector, Urban" was chosen. For both types of roadways these tables give a factor of 1.36 for counts taken in the month of May.

Finally, to apply this method, the two-way 12-hour count total for each leg of an intersection is first divided by the seasonal factor and then multiplied by the expansion factor to develop the AADT. The Method 2 calculations for the six signalized intersections are also presented in Appendix G. (Note that since the ramps and unsignalized intersections were not counted for a 12-hour period, Method 2 could not be used at those locations.)

After application of the two methods for calculating AADT, the study team compared the data to each other and to the AADT data from the IDOT website. AADT's for 2000 were also available at the Sunset Ridge Road and Wagner Road intersections from the Christopher B. Burke Engineering, Ltd. (CBBEL) *Project Report for Willow Road*. Exhibit G-1, which summarizes these data for the entire corridor, is provided in Appendix G.

In a comparison of the data on Exhibit G-1, it could be noted that generally the AADT's developed using Method 1 were about 3,000 vehicles per day lower along Willow Road than either those developed using Method 2 or those available from the IDOT website. On the cross streets Method 1 produced consistently higher AADT's than either Method 2 or those shown on the IDOT website. A comparison was also made between the CBBEL AADT data and both the IDOT and Method 2 AADT's. It was found that the AADT's from 2000 were consistently higher than either the IDOT or Method 2 AADT's along Willow Road but slightly lower than the Method 2 AADT's along either Sunset Ridge or Wagner Roads. Finally, a comparison was made between the 2009 peak hour traffic counts for this study and the existing (2000) peak hour volumes provided in the CBBEL report. This comparison showed that in general all of the turning movements and cross street traffic at the Sunset Ridge Road and Wagner Road intersections were similar between the two years. However, there was a substantial difference in the through movement traffic on Willow Road with the volumes in 2009 being 200 to 400 vehicles per hour less in each direction than the CBBEL volumes. These differences in AADT and peak hour volumes along Willow Road appear to be reasonable with the decrease in traffic volumes experienced in the last few years due to the economy in addition to many other factors. The minimal difference in AADT on the cross streets is also reasonable. Therefore, for the purposes of the Willow Road Study, and where they were available, the Method 2 AADT data were used for the project AADT because:

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- They are based on more recent (2009) traffic counts rather than the 2006 data available from IDOT's website;
- They consider 12 hours of traffic data instead of just two as in Method 1; and,
- The comparison of the Method 2 AADT's with the 2000 AADT's showed a general decrease from 2000 to 2009 in volumes along Willow Road with a slight increase on Sunset Ridge Road and Wagner Road which is a reasonable expectation.

At two of the Interstate 94 ramps, 12-hour counts were taken while the other two ramps had peak period counts. For the available data that was collected for the ramps, Method 1 was appropriate for developing the AADT. Exhibit 2 shows the final existing AADT volumes to be used for the Willow Road Study.

4 Data Analysis – Existing Traffic Volumes

4.1 Isolated Signalized Intersection Capacity Analyses

The *Highway Capacity Manual (HCM) 2000* contains a collection of nationally recognized state-of-the-art techniques for estimating the capacity of different types of transportation facilities. Capacity is defined as the maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions; usually expressed as vehicles per hour, passenger cars per hour, or persons per hour. (HCM 2000, p. 5-2-3) Using the methodology contained in the HCM and the peak hour and AADT information developed for Willow Road, an analysis was undertaken to quantify the capacity and operation of the existing signalized intersections in the corridor.

The capacity analyses contained in this report were calculated using the Highway Capacity Software (HCS). This software was developed by the University of Florida for the Federal Highway Administration (FHWA) and is designed to be a faithful implementation of the HCM procedures. The HCM methodology calculates the capacity for an isolated signalized intersection, i.e., an intersection that is not influenced by adjacent intersections. When signalized intersections are fairly closely spaced (typically ½ mile or less between adjacent signals) a system analysis is also normally completed. The system analysis undertaken for the Willow Road Corridor under existing traffic conditions is discussed in Section 4.3.

The data needed for an intersection capacity analysis includes information on geometric conditions, e.g., number of lanes (through and turning), lane widths, and general terrain (shallow or steep grades); traffic conditions, e.g., demand volume by movement, saturation flow rate, and lane utilization; and signalization conditions, e.g., cycle time, green time, and phase plan. While values for some of the input data can only be based on local conditions, e.g., the actual turning volumes at an intersection, there are default values for many other input data. For this evaluation the default values for saturation flow rate and lane utilization were modified based on actual field measurement discussed in Sections 2.3 and 2.4.

The operation of an intersection is described by its Level of Service (LOS). Level of service is defined as a qualitative measure describing operation conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (HCM 2000, p. 5-8). Table 3 describes the six levels of service that are defined for a signalized intersection. Each level represents a range of operating conditions with LOS A representing the best operating conditions (an average delay of 10 seconds per vehicle or less) and LOS F representing the worst (80 seconds of delay or more). It is important to recognize that this delay is a snapshot in time for one vehicle and the cumulative effects of delay are much greater. In practical terms, LOS F means that users may be stuck in long lines of traffic approach an intersection, and require multiple cycles to pass through it. The minimum level of service for a signalized intersection is LOS D on the SRA system.

Summary results from the signalized intersection capacity analyses are presented in Table 4; detailed information from the intersection capacity analyses is presented in Appendix H. In addition to an overall intersection level of service, a level of service and associated delay in seconds per vehicle for each movement is calculated. The level of service for each movement at each signalized intersection in the Willow Road Corridor is shown on Exhibits 3aA and 3bB.

Table 3 – Signalized Intersection Level of Service

Level of Service	General Description	Average Delay (seconds per vehicle)
A	Free flow traffic; many vehicles do not stop at all	≤10
B	Generally good traffic flow; more vehicles stop than with LOS A	>10-20
C	Fair traffic flow; the number of vehicles stopping is greater than LOS B although many still pass through without stopping	>20-35
D	Longer delays; many vehicles stop and the number passing through without stopping decreases	>35-55
E	Poor flow and progression; the number of vehicles stopping is very high	>55-80
F	Very high delays with long queues of vehicles	≥80

Table 4 – Signalized Intersection Capacity Analyses Summary – Existing Traffic

Intersection	Existing Traffic					
	A.M. Peak Hour			P.M. Peak Hour		
	Delay (sec/veh)	Delay (hours)	LOS	Delay (sec/veh)	Delay (hours)	LOS
Willow Road at Illinois Route 43 (Waukegan Road)	57.0 <u>55.9</u>	68.4 <u>66.9</u>	E	69.9 <u>74.6</u>	123.6 <u>121.0</u>	E
Willow Road at Three Lakes/Fox Meadow Drive	26.0 <u>15.1</u>	17.8 <u>9.3</u>	C <u>B</u>	20.7 <u>10.2</u>	17.1 <u>8.7</u>	C <u>B</u>
Willow Road at Sunset Ridge Road	82.4	57.9	F	112.9	93.1	F
Willow Road at Wagner Road	65.9	39.2	E	146.6 <u>149.3</u>	101.9	F
Willow Road at Old Willow Road/ Northfield Road	26.5 <u>28.6</u>	15.6 <u>17.5</u>	C	22.7 <u>26.4</u>	16.9 <u>20.1</u>	C
Willow Road at Central Avenue/ Happ Road	51.7 <u>47.9</u>	16.9 <u>36.7</u>	D	69.8 <u>67.7</u>	70.2 <u>70.0</u>	E

During the A.M. peak hour, three of the six intersections in the corridor are operating below LOS D. These are the intersections of Willow Road at Illinois Route 43, Sunset Ridge Road and Wagner Road. In addition to these intersections, during the P.M. peak hour the intersection of Willow Road and at Central Avenue/Happ Road is also operating below LOS D.

The results from the HCS analyses were also converted to total hourly delay for all vehicles using each of the signalized intersections. This delay was calculated by multiplying each movement delay (given in seconds/vehicle) by the number of vehicles making that movement, then summing up the seconds of delay for all movements and converting to hours. Table 4 also summarizes the estimated delay in hours for each intersection. The calculations for these delays are shown on Exhibits H-1 and H-2 in Appendix H. This analysis demonstrates the large amount of delay to traffic which results from the existing congestion, particularly at the Illinois Route 43, Sunset Ridge Road and Wagner Road intersections.

The other performance measure used to analyze a signalized intersection is the back of queue. The back of the queue is the distance between the stop line of a signalized intersection and the farthest reach of an upstream queue, expressed as a number of vehicles (HCM p. 5-2). The length of the queue depends upon the arrival patterns of vehicles and vehicles that do not clear the intersection during a given green phase (HCM 2000 p. 10-16). Exhibits 4 and 5 illustrate the average length of queued vehicles for the A.M. and P.M. peak hours respectively. For these

exhibits, the length of queued vehicles was estimated by multiplying the number of queued vehicles from the HCS output by 25 feet (assumed vehicle length).

- **Illinois Route 43/Willow Road** – This intersection is operating at LOS E overall in both peak hours with existing traffic volumes. As shown on Exhibit 3A, for the P.M. peak hour all of the left turn movements except the westbound to southbound left turn operate at LOS F. The westbound through movement also operates at LOS F during the P.M. peak hour. There is extensive vehicle queuing on all legs of the intersection but the east leg often backs up to or beyond Three Lakes Drive.
- **Three Lake Drive/Fox Meadow Drive/Willow Road** – This intersection operates at LOS C in both peak hours. Based on field observations, traffic from the cross street normally clears during a single signal cycle. However, HCS evaluates intersections as “isolated” and does not consider the influence from adjacent intersections. This intersection provides an everyday example of the impact of vehicle queues on level of service. Queues are an indication of vehicles waiting to be served by the facility. Typically, longer queues result in greater delay and may be indicative of congestion problems. As noted above, this intersection operates at LOS C during both time periods. This is due to the relatively low volumes on the minor legs of the intersection. Drivers along Willow Road experience queuing as unmet demand builds up. As vehicles from the minor legs attempt to access Willow Road, there is often no space for them, as Willow Road is filled with vehicles and has backed up into the intersection.
- **Sunset Ridge Road/Willow Road** – The overall level of service for this intersection is LOS F in both peak hours. There are extensive queues on both the east and west legs during both peak hours, on the south leg during the morning peak hour and on the north leg during the evening peak hour. Cars also often stack beyond the available storage length in all of the turn lanes, blocking the through traffic. The lack of left turn arrows for the northbound and southbound direction compound the difficulty of making those movements.
- **Wagner Road/Willow Road** – This intersection operates at LOS E in the morning peak hour and LOS F in the evening. There are no left turn arrows for any of the left turn lanes. Because traffic volumes are fairly low on Wagner Road, those legs are able to operate at LOS B/C and clear during every cycle. In the eastbound and westbound directions, there are extensive queues which reach 1,000 to 2,000 feet from the intersection. Because all of the left turn volumes are fairly low (most are less than 50 vehicles per hour), the left turning vehicles typically do not back up beyond the available storage. With the long queues though, they have to wait to be able to get into the lanes to make their turns.
- **Old Willow Road/Northfield Road/Willow Road** – The overall level of service for this intersection is LOS C. As discussed with the Three Lakes Drive/Fox Meadow Drive intersection, the HCS analysis does not account for the influence of adjacent intersections. Traffic often backs up from Central Avenue/Happ Road through this intersection, primarily because there is not good traffic progression through the two intersections. The cross street volumes are fairly low, therefore traffic from the cross street is normally able to make their turns onto Willow Road in a single signal cycle.
- **Central Avenue/Happ Road/Willow Road** – This intersection operates at LOS D in the A.M. peak hour and LOS E in the P.M. peak hour. There is queuing in both directions although because there are two through lanes in each direction, the queues are not as long as at the intersections to the west. Left turning traffic also sometimes backs up beyond the available left turn storage length, resulting in the adjacent through lane being blocked. Cross street traffic typically clears each cycle.

4.2 Urban Street Segment Capacity Analyses

The HCM 2000 Urban Street methodology is appropriate for analyzing suburban streets that have a traffic signal spacing of two miles or less. The HCM methodology assesses mobility on a street which is measured in terms of travel speed for the through-traffic stream. (HCM 2000, p. 15-1) As with intersections, the street analysis was undertaken using the Highway Capacity Software (HCS).

A street segment capacity analysis is based upon the street’s functional and design categories as well as vehicle running time and control delay at intersections. A road’s functional category, e.g., principal arterial, is based upon its role in the roadway network and the type of trips it serves. Its design category is determined by such factors as driveway/ access density, number of lanes, signal density, pedestrian activity, and level of adjacent development. Running time is influenced by free flow speed and segment length while control delay results from traffic signal operation and the response of traffic to the signal operation. The street segment capacity analysis procedure only considers street segments between signalized intersections, therefore the segment of Willow Road between Central Avenue/Happ Road and Interstate 94 is not included in this analysis.

~~As with signalized intersections, there are six levels of service for urban streets. These levels of service are based upon a free flow speed and range from LOS A the highest to LOS F the lowest (see Table 5). At LOS A, traffic moves freely at or above the posted speed limit; all drivers have complete mobility to change lanes. At LOS F, traffic flow is forced; every vehicle moves in lockstep with the vehicle in front of it. Assuming a free flow speed of 35 mph (the posted speed limit), LOS A would equate to an average travel speed greater than 30 mph while LOS F would be less than 10 mph (see Table 5). The minimum level of service for a signalized intersection street segment is LOS D.~~

In addition, the HCM 2000 specifies four possible classifications of an urban street (I, II, III, IV) that each reflect a combination of street function and design. These vary from Class I roadways which have limited access points, relatively few signals, a posted speed of 45 mph or greater to Class IV urban arterials which have posted speeds of 35 mph or less, frequent access points and signals, and dense roadside development. Within the study limits, Willow Road functions as a Class II suburban arterial, given a posted speed that varies from 35 to 40 mph, relatively moderate access frequency, high volumes of daily traffic, and nearby interstate access at Interstate 94.

Table 5 - Urban Street Segment Level of Service (LOS) 35-mph Free Flow Speed for a Class II Suburban, Principal Arterial

Level of Service	General Description	Average travel speed
A	Traffic moves freely at or above the posted speed limit ; all drivers have complete mobility to change lanes	≥30 <u>>35</u> mph
B	Slightly more congested than LOS A; lane changes may be limited as motorists must occasionally drive side by side	>24-30 <u>28-35</u> mph
C	More congestion than LOS B; the ability to pass or change lanes is not always assured	>18-24 <u>22-28</u> mph
D	Speeds are somewhat reduced, motorists are hemmed in by other cars	>14-18 <u>17-22</u> mph
E	Flow becomes irregular; road is approaching its design capacity	>10-14 <u>13-17</u> mph
F	Flow is forced; every vehicle moves in lockstep with the vehicle in front of it	≤10 <u>13</u> mph

A summary of the street segment capacity analysis results is presented in Table 6; detailed information from the capacity analyses is presented in Appendix I. These levels of service are also shown graphically on Exhibits 4 and 5 for the A.M. and P.M. peak hours respectively.

The relationship between demand and capacity on a roadway segment may also be assessed in terms of a volume-to-capacity ratio. This ratio relates to the demand on a roadway, in terms of vehicles, to the roadway’s ability to carry traffic, i.e., its capacity. It is a measure of congestion. As the value of the ratio approaches 1.00 a roadway is becoming more congested. Values at or above 1.00 indicate a congested roadway. Further, the capacity is only that of the through traffic lanes and does not consider any turn lanes that may be present. While V/C ratios of 1.00 or greater imply delay the ratios do not measure delay and, for example, do not account for turning vehicles that, because of the lack of turn lanes or turn lanes that are operating above capacity themselves, add additional delay for the through traffic.

Table 6 – Street Segment Capacity Analyses – Existing Traffic

	A.M. Peak Hour		P.M. Peak Hour	
	Arterial Speed (mph)	Arterial Level of Service	Arterial Speed (mph)	Arterial Level of Service
Eastbound				
IL Route 43 (Waukegan Road) to Three Lakes Drive/Fox Meadow Drive	13.221.2	E D	15.427.2	E C
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	15.7	E	6.7	F
Sunset Ridge Road to Wagner Road	13.5	E	7.9	F
Wagner Road to Old Willow Road/Northfield Road	20.1	D	20.7	D
Old Willow Road/Northfield Road to Central Avenue/Happ Road	3.9	F	3.5	F
Westbound				
Central Avenue/Happ Road to Old Willow Road/Northfield Road	12.49.4	E F	12.98.9	F
Old Willow Road/Northfield Road to Wagner Road	17.416.5	E E	8.9	F
Wagner Road to Sunset Ridge Road	26.3	C	24.9	C
Sunset Ridge Road to Three Lakes Drive/Fox Meadow Drive	18.7	D	21.3	D
Three Lakes Drive/Fox Meadow Drive to IL Route 43 (Waukegan Road)	13.1	E	6.1	F

Table 7 shows the volume-to-capacity ratios for the existing condition. During either peak hour, the segment between Central Avenue/Happ Road and Interstate 94 is the only segment with a V/C ratio below 1.00. All other segments have ratios that suggest congested conditions with the highest values on the segments between Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road. Appendix I contains detailed information on the calculation of the volume-to-capacity ratios.

Table 7 – Volume-to-Capacity Ratios – Existing Traffic

Segment	A.M. Peak Hour			P.M. Peak Hour		
	Volume ₁	Capacity ₂	V/C	Volume ₁	Capacity ₂	V/C
Illinois Route 43 to Three Lakes Drive/Fox Meadow Drive	2155	2050	1.11	2825	2050	1.45
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	2180	1650	1.39	2830	1650	1.81
Sunset Ridge Road to Wagner Road	1838	1250	1.55	2185	1250	<u>1.94</u> <u>4</u>
Wagner Road to Old Willow Road/Northfield Road	1728	1250	1.45	2010	1250	1.69
Old Willow Road/Northfield Road to Central Avenue/Happ Road	2035	2050	1.04	2460	2050	1.26
Central Avenue/Happ Road through Interstate 94 Interchange	1583	2050	0.81	1950	2050	1.00

- Notes: ¹ Traffic volumes are an average of the two-way traffic leaving either end of the road segment.
² Capacities are design hour volumes (DHV) taken from Figure 48-6A in Chapter 48 of the Illinois Department of Transportation's Bureau of Design and Environmental Manual 2002 Edition.
³ The design hour volumes were divided by a peak hour factor of 0.95 to convert to peak hour volumes.
⁴ Capacities for segments with variable numbers of lanes were based on the fewest number of lanes in the segment.

Based on both the street segment capacity analyses and the volume-to-capacity ratios, it should be noted that both the four/five lane segments and the two/three lane segments on Willow Road are operating at poor levels of service and have V/C ratios greater than 1.0.

4.3 System Analysis

The intersection and street capacity analyses discussed above are good tools for analyzing the performance of isolated or small-scale transportation facilities; however, they are not structured to analyze network or system performance in detail. For system level analyses, tools such as traffic microsimulation models are used. Microsimulation models are designed to simulate the movement of individual vehicles within a transportation network over time as a means to evaluate system performance. This type of analysis takes into account the traffic flows and influence from adjacent intersections.

The system analysis undertaken for the Willow Road Study used the Synchro Studio 7 Software Suite. The two parts of the software package provide different types of analyses and serve different functions. Synchro is a macroscopic analysis and optimization program. It is used to input system and intersection information and can be used for isolated intersection analyses. The program can use either existing signal timings to evaluate existing operation or can optimize signal operation and coordination between signals to improve traffic flow. SimTraffic performs microsimulation and animation of vehicular traffic. Visualization will be used as part of the alternative evaluation process. Individual vehicles are modeled and displayed traversing a street network. To analyze the Willow Road operation as a system between Illinois Route 43 and the Interstate 94 interchange, Synchro is a beneficial tool since it also looks at queuing between intersections and the additional delay caused by the queues.

In general, microsimulation models rely upon three processes to simulate traffic. These processes generate traffic into the system; assign driver and vehicle characteristics; and model vehicle movement. Traffic is generated into the system based upon such factors as arrival pattern and vehicle headway. When a vehicle enters the network it is assigned driver and vehicle characteristics, e.g., driver aggressiveness, destination, vehicle type, and vehicle turning radius. As a vehicle moves through the network it interacts with the network and other vehicles. These interactions are modeled using car-following, lane-changing, and queue-discharge algorithms. Vehicles are tracked through the

network over small time intervals, e.g., 1 second, for a period of 15-minutes or longer. SimTraffic assumptions and sample data input are presented in Appendix J.

In addition to the visual representation of traffic operations, the simulation program also generates a variety of Measures of Effectiveness (MOE), i.e., statistics that describe system performance. One such MOE is Average Network Speed. This is total distance traveled by all vehicles on the network divided by total travel time for those vehicles. The network includes Willow Road from Illinois Route 43 through the Interstate 94 interchange. It also includes the intersecting legs of all of the signalized and unsignalized intersections except Chapel Hill Court and the Interstate 94 interchange ramps at Willow Road. Summaries of the remaining MOE's for the existing traffic simulations are provided in Appendix K.

Table 8 provides the existing system travel speeds for the A.M. and P.M. peak hours. For comparison purposes, a level of service value has been assigned based on the HCM values given in Table 5 for segment level of service based on average travel speed. The Existing Conditions SimTraffic Simulation Performance Report appears in Appendix K.

Table 8 - Traffic Simulation Network Travel Speed – Existing Traffic

	Existing Traffic Volumes	
	A.M. Peak Hour	P.M. Peak Hour
Network Travel Speed	14 mph	9 mph
Level of Service	E	F

4.4. Interstate 94 Interchange Capacity Analyses

Three types of analyses were completed to evaluate the operation of the Willow Road interchange with Interstate 94. These include two-way stop control; weaving section and ramp merge/diverge analyses. Detailed information for the interchange capacity analyses is presented in Appendix L. These are also shown on Exhibits 3aA and 3bB.

Willow Road Ramp Terminals - The northbound Interstate 94 to eastbound Willow Road ramp terminal at Willow Road is under stop sign control with Willow Road having the right-of-way. An Unsignalized Intersection Two-Way Stop Control analysis using HCM 2000 procedures as implemented in the Highway Capacity Software (HCS) was performed for this location. Similar to signalized intersections and urban street segments, the level of service for this type of intersection is ranked A through F. This ranking is based on the calculated delay to the vehicles entering from the cross street which is under stop control. It is based on the estimated number of acceptable gaps in which that vehicle can make a turn onto the main road. For both the A.M. and P.M. peak hours, this intersection operates at LOS B with existing traffic volumes.

The northbound Interstate 94 to westbound Willow Road and westbound Willow Road to southbound Interstate 94 ramps have a weaving section between them. This weaving section allows movements between Willow Road and either of these two ramps and also from ramp to ramp. A Freeway Weaving Operational Analysis using HCM 2000 procedures as implemented in the HCS was used to analyze this section. The level of service for a weaving section is evaluated through calculations which determine the average speed of vehicles in the weaving section and the density (passenger cars per mile per lane) within the weaving section. Based on the analyses with existing traffic volumes, this weaving section operates at LOS B for both peak hours.

The eastbound Willow Road to southbound Interstate 94 ramp diverge cannot be analyzed using the HCM 2000 procedure. The procedure requires the mainline facility to operate at a speed at or above 55 mph. Because this section of Willow Road has a speed limit of only 35 mph, the methodology is not applicable.

Interstate 94 Ramp Terminals - The eastbound and westbound Willow Road to southbound Interstate 94 ramp terminals operate as merge sections with Interstate 94. The Ramps and Ramp Junctions Merge Analysis module of the HCS was used for the analyses. The LOS for the ramp influence area is determined from the computed density as compared to the thresholds defined in HCM. The eastbound Willow Road to southbound Interstate 94 ramp operates at LOS D in both peak hours while the westbound Willow Road to southbound Interstate 94 ramp operates at LOS C in both peak hours.

The northbound Interstate 94 to eastbound and to westbound Willow Road ramps operate as diverge sections with Interstate 94. The Ramps and Ramp Junctions Diverge Analysis module of the HCS was used for these ramps. Again, the level of service for the ramp influence area is determined from the computed density. Both ramps operate at LOS F in the A.M. peak hour and LOS E in the P.M. peak hour.

5 Data Analysis – 2030 No-Build Traffic Volumes

5.1 2030 No-Build Traffic Volumes

The 2030 No-Build Annual Average Daily Traffic (AADT) Volumes were provided by the Chicago Metropolitan Agency for Planning (CMAP). The letter from CMAP is included in Appendix M. The AADT volumes are presented in Exhibit 6. The 2030 A.M. and P.M. peak hour traffic volumes were developed based upon the growth in traffic exhibited between the existing AADT and forecasted 2030 No-Build AADT. Growth factors were determined for each leg of an intersection and then applied to the Existing Traffic volumes. These volumes were then balanced in the same manner of the existing traffic volumes. The Balanced 2030 No-Build A.M. and P.M. Design Hourly Volumes (DHV's) are presented in Exhibit 7Aa and 7bB. The peak hour diagrams for the 2030 No-Build traffic are presented in Appendix M.

5.2 Isolated Signalized Intersection Capacity Analyses

Using the same HCM methodology that was applied to the existing traffic data and the 2030 No-Build DHV's, an analysis was undertaken to quantify the capacity and operation of the signalized intersections in the corridor under 2030 No-Build conditions. A 2030 No-Build system analysis was also undertaken and is discussed in Section 5.3.

As was the case for the Existing Condition Analysis the default values for saturation flow rate and lane utilization were modified based on actual field measurement as discussed in Sections 2.3 and 2.4. Summary results from the signalized intersection capacity analyses are presented in Table 9; detailed information from the intersection capacity analyses is presented in Appendix N. The individual movement level of service for each intersection under 2030 No-Build traffic conditions is presented in Exhibits 8aA and 8bB. The queue analyses for the A.M. and P.M. 2030 No-Build traffic are presented in Exhibits 9 and 10 as are the intersection levels of service.

Table 9 – Signalized Intersection Capacity Analyses Summary - 2030 No-Build Traffic

Willow Road Intersection at	A.M. Peak Hour			P.M. Peak Hour		
	Delay (sec/veh)	Delay (hours)	LOS	Delay (sec/veh)	Delay (hours)	LOS
Illinois Route 43 (Waukegan Road)	79.3 <u>78.0</u>	107.3 <u>105.3</u>	E	109.5 <u>108.0</u>	195.0 <u>192.1</u>	F
Three Lakes/Fox Meadow Drive	33.2 <u>27.2</u>	24.4 <u>21.4</u>	CB	27.6 <u>18.3</u>	25.0 <u>16.1</u>	CB
Sunset Ridge Road	107.7	88.3	F	168.8	166.7	F
Wagner Road	115.7	79.5	F	229.1 <u>225.2</u>	177.6	F
Old Willow Road/Northfield Road	32.9 <u>36.0</u>	23.2 <u>25.5</u>	CD	26.4 <u>30.3</u>	22.6 <u>26.4</u>	C
Central Avenue/Happ Road	77.5	67.6	E	106.4 <u>106.3</u>	128.3 <u>122.7</u>	F

Table 9 also summarizes the estimated delay in hours for each intersection. The calculations for this delay are shown on Exhibits N-1 and N-2 in Appendix N. These values, when compared to the existing delay values, demonstrate the substantial increase which will occur, particularly at the Sunset Ridge Road and Wagner Road intersections.

~~Overall, at most~~Overall the operations at the signalized intersections with the 2030 No-Build traffic volumes, ~~the operations~~ deteriorate. ~~The exceptions to this being Willow Road at Three Lakes Drive/Fox Meadow Drive and Old~~

~~Willow Road/Northfield Road~~-In addition, the queues along Willow Road at all of the signalized intersections increase with the 2030 No-Build condition.

5.3 Urban Street Segment Capacity Analyses

In the same fashion as done for the Existing Condition, the HCM 2000 Urban Street methodology was applied to the 2030 No-Build traffic. A summary of the street segment capacity analysis results is presented in Table 10. Table 11 presents the 2030 volume-to-capacity ratios. The levels of service are shown graphically on Exhibits 9 and 10. Detailed information from the capacity analyses and the calculation of the volume-to-capacity ratios is presented in Appendix O.

Table 10 – Street Segment Capacity Analyses – 2030 No-Build Traffic

	AM Peak Hour		PM Peak Hour	
	Arterial Speed (mph)	Arterial Level of Service	Arterial Speed (mph)	Arterial Level of Service
Eastbound				
Illinois Route 43 to Three Lakes Drive/Fox Meadow Drive	12.4 <u>20.4</u>	F <u>FD</u>	4.1 <u>26.7</u>	F <u>EC</u>
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	12.0	F	4.1	F
Sunset Ridge Road to Wagner Road	9.3	F	5.7	F
Wagner Road to Old Willow Road/Northfield Road	18.6	D	19.9	D
Old Willow Road/Northfield Road to Central Avenue/Happ Road	2.1	F	1.9	F
Westbound				
Central Avenue/Happ Road to Old Willow Road/Northfield Road	13.3 <u>29.2</u>	F <u>EF</u>	12.4 <u>48.4</u>	F
Old Willow Road/Northfield Road to Wagner Road	11.3	F	6.0	F
Wagner Road to Sunset Ridge Road	24.5	C	15.9	E
Sunset Ridge Road to Three Lakes Drive/Fox Meadow Drive	18.3	D	20.8	D
Three Lakes Drive/Fox Meadow Drive to Illinois Route 43	12.6	F	3.8	F

Table 11 – Volume-to-Capacity Ratios – 2030 No-Build Traffic

Segment	AM Peak Hour			PM Peak Hour		
	Volume ¹	Capacity ²	V/C	Volume ¹	Capacity ²	V/C
Illinois Route 43 to Three Lakes Drive/Fox Meadow Drive	2515	2050	1.29	3265	2050	1.68
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	2525	1650	1.61	3270	1650	2.09
Sunset Ridge Road to Wagner Road	2133	1250	1.80	2533	1250	2.13
Wagner Road to Old Willow Road/Northfield Road	1983	1250	1.67	2310	1250	1.95
Old Willow Road/Northfield Road to Central Avenue/Happ Road	2325	2050	1.19	2795	2050	1.44
Central Avenue/Happ Road through Interstate 94 Interchange	1728	2050	0.89	2143	2050	1.10

Notes: ¹ Traffic volumes are an average of the two-way traffic leaving either end of the road segment.

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2. Capacities are design hour volumes (DHV) taken from Figure 48-6A in Chapter 48 of the Illinois Department of Transportation's Bureau of Design and Environmental Manual 2002 Edition.
3. The design hour volumes were divided by a peak hour factor of 0.95 to convert to peak hour volumes.
4. Capacities for segments with variable numbers of lanes were based on the fewest number of lanes in the segment.

In the existing condition, a majority of the street segments in the corridor are operating below the minimum level of service during both the A.M. and P.M. peak hours. Most of these segments are operating at LOS E or F. Again this situation is expected to worsen by 2030 with many segments moving to LOS F (average speed less than 10 mph) and average travel speeds declining on all segments.

In addition, under the 2030 No-Build condition, all segments in either peak hour have V/C ratios equal to or greater than 1.00 except the Central Avenue/Happ Road to Interstate 94 segment in the A.M. peak hour. In addition, the V/C ratios in the 2030 No-Build are all higher indicating greater congestion than the corresponding values under existing conditions. Finally, the highest V/C values are once again on the segments between Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road.

5.4 System Analyses

Just as was done for the existing condition, SimTraffic was used to evaluate Willow Road as a system under 2030 No-Build traffic conditions. The Average Network Speed is provided in Table 12. For comparison purposes, the HCM level of service value has again been assigned based on the values given in Table 6 for segment level of service based on average travel speed. The 2030 No-Build SimTraffic Simulation Performance Report which gives all of the MOE's appears in Appendix P.

Table 12 - Traffic Simulation Network Travel Speed –2030 No-Build Traffic

	2030 No-Build Traffic Volumes	
	A.M. Peak Hour	P.M. Peak Hour
Network Travel Speed	12 mph	7 mph
Level of Service	E	F

5.5 Interstate 94 Interchange Capacity Analyses

Three types of analyses were completed to evaluate the operation of the Willow Road interchange with Interstate 94 under the 2030 No-Build traffic condition. These include two-way stop control; weaving section; and ramp merge/diverge analyses. Detailed information for the interchange capacity analyses is presented in Appendix Q. These are also shown on Exhibits 8aA and 8bB.

Willow Road Ramp Terminals - The northbound Interstate 94 to eastbound Willow Road ramp terminal operates at LOS B during both the A.M. and P.M. peak hour with 2030 No-Build traffic volumes.

The northbound Interstate 94 to westbound Willow Road and westbound Willow Road to southbound Interstate 94 ramps have a weaving section between them. A Freeway Weaving Operational Analysis using HCM 2000 procedures as implemented in the HCS was used to analyze this section. Based on the analyses with 2030 Traffic volumes, this weaving section operates at LOS C for both peak hours.

The eastbound Willow Road to southbound Interstate 94 ramp diverge cannot be analyzed using the HCM 2000 procedure. The procedure requires the mainline facility to operate at a speed at or above 55 mph. Because this section of Willow Road has a speed limit of only 35 mph, the methodology is not applicable.

Interstate 94 Ramp Terminals - The eastbound and westbound Willow Road to southbound Interstate 94 ramp terminals operate as merge sections with Interstate 94. The Ramps and Ramp Junctions Merge Analysis module of the HCS was used for the analyses. The eastbound Willow Road to southbound Interstate 94 ramp operates at LOS D during both peak hours while the westbound Willow Road to southbound Interstate 94 ramp operates at LOS C during both peak hours.

The northbound Interstate 94 to eastbound and to westbound Willow Road ramps operate as diverge sections with Interstate 94. The Ramps and Ramp Junctions Diverge Analysis module of the HCS was used for these ramps. Both ramps operate at LOS F in the A.M. peak hour and LOS E in the P.M. peak hour under the 2030 No-Build traffic conditions.

6 Data Analysis – 2040 No-Build Traffic Volumes

6.1 2040 No-Build Traffic Volumes

The 2040 No-Build Annual Average Daily Traffic (AADT) Volumes were provided by the Chicago Metropolitan Agency for Planning (CMAP). The letter from CMAP is included in Appendix R. The AADT volumes are presented in Exhibit 11. The 2040 A.M. and P.M. peak hour traffic volumes were developed based upon the growth in traffic exhibited between the existing AADT and forecasted 2040 No-Build AADT. Growth factors were determined for each leg of an intersection and then applied to the Existing Traffic volumes. These volumes were then balanced in the same manner as the existing traffic volumes. The Balanced 2040 No-Build A.M. and P.M. Design Hourly Volumes (DHV's) are presented in Exhibits 12A and 12B. The peak hour diagrams for the 2040 No-Build traffic are presented in Appendix R.

6.2 Isolated Signalized Intersection Capacity Analyses

Using the same HCM methodology that was applied to the existing and 2030 No-Build traffic data and using the 2030 No-Build DHV's, an analysis was undertaken to quantify the capacity and operation of the signalized intersections in the corridor under 2040 No-Build conditions. A 2040 No-Build system analysis was also undertaken and is discussed in Section 6.3.

As was the case for the previous analyses, the default values for saturation flow rate and lane utilization were modified based on actual field measurement as discussed in Sections 2.3 and 2.4. Summary results from the signalized intersection capacity analyses are presented in Table 13; detailed information from the intersection capacity analyses is presented in Appendix S. The individual movement level of service for each intersection under 2040 No-Build traffic conditions is presented in Exhibits 13A and 13B. The queue analyses for the A.M. and P.M. 2040 No-Build traffic are presented in Exhibits 14 and 15 as are the intersection levels of service.

Table 13 – Signalized Intersection Capacity Analyses Summary - 2040 No-Build Traffic

<u>Willow Road Intersection at</u>	<u>A.M. Peak Hour</u>			<u>P.M. Peak Hour</u>		
	<u>Delay (sec/veh)</u>	<u>Delay (hours)</u>	<u>LOS</u>	<u>Delay (sec/veh)</u>	<u>Delay (hours)</u>	<u>LOS</u>
<u>Illinois Route 43 (Waukegan Road)</u>	<u>90.9</u>	<u>130.3</u>	<u>F</u>	<u>122.3</u>	<u>235.1</u>	<u>F</u>
<u>Three Lakes/Fox Meadow Drive</u>	<u>17.6</u>	<u>12.9</u>	<u>B</u>	<u>18.5</u>	<u>16.7</u>	<u>B</u>
<u>Sunset Ridge Road</u>	<u>139.9</u>	<u>118.9</u>	<u>F</u>	<u>192.0</u>	<u>195.3</u>	<u>F</u>
<u>Wagner Road</u>	<u>110.8</u>	<u>80.6</u>	<u>F</u>	<u>217.1</u>	<u>170.2</u>	<u>F</u>
<u>Old Willow Road/Northfield Road</u>	<u>39.7</u>	<u>28.8</u>	<u>D</u>	<u>31.2</u>	<u>27.9</u>	<u>C</u>
<u>Central Avenue/Happ Road</u>	<u>85.0</u>	<u>97.6</u>	<u>F</u>	<u>126.0</u>	<u>152.0</u>	<u>F</u>

Table 13 also summarizes the estimated delay in hours for each intersection. The calculations for this delay are shown on Exhibits S-1 and S-2 in Appendix S. These values, when compared to the existing delay values, demonstrate the substantial increase which will occur, particularly at the Sunset Ridge Road and Wagner Road intersections.

At all intersections except the Wagner Road intersection, with the 2040 No-Build traffic volumes, the operations deteriorate compared to existing and 2030 No-Build traffic. The Willow Road/Wagner Road intersection shows a slight improvement in level of service, only because the timings were held constant but the volumes increased on the Wagner Road movements which had less delay. Since the overall intersection delay is a weighted average based on

the sum of the approach volume multiplied by the movement delay for each approach divided by the total of the approach volumes, this results in a slight decrease in intersection delay. In addition, the queues along Willow Road at all of the signalized intersections increase with the 2040 No-Build condition.

6.3 Urban Street Segment Capacity Analyses

In the same fashion as done for the existing and 2030 No-Build conditions, the HCM 2000 Urban Street methodology was applied to the 2040 No-Build traffic. A summary of the street segment capacity analysis results is presented in Table 14. Table 15 presents the 2040 volume-to-capacity ratios. The levels of service are shown graphically on Exhibits 14 and 15. Detailed information from the capacity analyses and the calculation of the volume-to-capacity ratios is presented in Appendix T.

Table 14 – Street Segment Capacity Analyses – 2040 No-Build Traffic

	AM Peak Hour		PM Peak Hour	
	Arterial Speed (mph)	Arterial Level of Service	Arterial Speed (mph)	Arterial Level of Service
Eastbound				
Illinois Route 43 to Three Lakes Drive/Fox Meadow Drive	20.4	D	26.7	C
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	12.0	F	4.0	F
Sunset Ridge Road to Wagner Road	9.3	F	5.7	F
Wagner Road to Old Willow Road/Northfield Road	17.5	D	19.7	D
Old Willow Road/Northfield Road to Central Avenue/Happ Road	1.9	F	2.0	F
Westbound				
Central Avenue/Happ Road to Old Willow Road/Northfield Road	9.2	F	8.4	F
Old Willow Road/Northfield Road to Wagner Road	11.3	F	6.0	F
Wagner Road to Sunset Ridge Road	24.5	C	15.9	E
Sunset Ridge Road to Three Lakes Drive/Fox Meadow Drive	18.1	D	20.6	D
Three Lakes Drive/Fox Meadow Drive to Illinois Route 43	12.4	F	3.4	F

Table 15 – Volume-to-Capacity Ratios – 2040 No-Build Traffic

Segment	AM Peak Hour			PM Peak Hour		
	Volume ¹	Capacity ²	V/C	Volume ¹	Capacity ²	V/C
Illinois Route 43 to Three Lakes Drive/Fox Meadow Drive	2560	2050	1.31	3335	2050	1.71
Three Lakes Drive/Fox Meadow Drive to Sunset Ridge Road	2575	1650	1.64	3350	1650	2.14
Sunset Ridge Road to Wagner Road	2142	1250	1.80	2540	1250	2.14
Wagner Road to Old Willow Road/Northfield Road	2022	1250	1.70	2340	1250	1.97
Old Willow Road/Northfield Road to Central Avenue/Happ Road	2385	2050	1.22	2845	2050	1.46
Central Avenue/Happ Road through Interstate 94 Interchange	1822	2050	0.94	2228	2050	1.14

Notes: ¹ Traffic volumes are an average of the two-way traffic leaving either end of the road segment.

- ² Capacities are design hour volumes (DHV) taken from Figure 48-6A in Chapter 48 of the Illinois Department of Transportation's Bureau of Design and Environmental Manual 2002 Edition.
- ³ The design hour volumes were divided by a peak hour factor of 0.95 to convert to peak hour volumes.
- ⁴ Capacities for segments with variable numbers of lanes were based on the fewest number of lanes in the segment.

In the existing condition, a majority of the street segments in the corridor are operating below the minimum level of service during both the A.M. and P.M. peak hours. Most of these segments are operating at LOS E or F. As with the 2030 No-Build traffic, this situation is expected to worsen by 2040 with average travel speeds declining on many of the segments.

In addition, under the 2040 No-Build condition with one exception, all segments in either peak hour have V/C ratios equal to or greater than 1.00. That exception is Central Avenue/Happ Road through the Interstate 94 interchange in the A.M. peak hour. In addition, the V/C ratios in the 2040 No-Build are all higher than existing indicating greater congestion than the corresponding values under existing conditions. Finally, the highest V/C values are once again on the segments between Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road.

6.4 System Analyses

Just as was done for the existing and 2030 No-Build conditions, SimTraffic was used to evaluate Willow Road as a system under 2040 No-Build traffic conditions. The Average Network Speed is provided in Table 16. For comparison purposes, the HCM level of service value has again been assigned based on the values given in Table 5 for segment level of service based on average travel speed. The 2040 No-Build SimTraffic Simulation Performance Report which gives all of the MOE's appears in Appendix U.

Table 16 - Traffic Simulation Network Travel Speed –2040 No-Build Traffic

	<u>2040 No-Build Traffic Volumes</u>	
	<u>A.M. Peak Hour</u>	<u>P.M. Peak Hour</u>
<u>Network Travel Speed</u>	<u>10 mph</u>	<u>7 mph</u>
<u>Level of Service</u>	<u>E</u>	<u>E</u>

6.5 Interstate 94 Interchange Capacity Analyses

The same three types of analyses as used for existing and 2030 No-Build conditions were completed to evaluate the operation of the Willow Road interchange with Interstate 94 under the 2040 No-Build traffic condition. These include two-way stop control; weaving section; and ramp merge/ diverge analyses. Detailed information for the interchange capacity analyses is presented in Appendix V. These are also shown on Exhibits 13A and 13B.

Willow Road Ramp Terminals - The northbound Interstate 94 to eastbound Willow Road ramp terminal operates at LOS B during both the A.M. and P.M. peak hour with 2040 No-Build traffic volumes.

The northbound Interstate 94 to westbound Willow Road and westbound Willow Road to southbound Interstate 94 ramps have a weaving section between them. A Freeway Weaving Operational Analysis using HCM 2000 procedures as implemented in the HCS was used to analyze this section. Based on the analyses with 2040 Traffic volumes, this weaving section operates at LOS C for both peak hours.

The eastbound Willow Road to southbound Interstate 94 ramp diverge cannot be analyzed using the HCM 2000 procedure. The procedure requires the mainline facility to operate at a speed at or above 55 mph. Because this section of Willow Road has a speed limit of only 35 mph, the methodology is not applicable.

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Interstate 94 Ramp Terminals - The eastbound and westbound Willow Road to southbound Interstate 94 ramp terminals operate as merge sections with Interstate 94. The Ramps and Ramp Junctions Merge Analysis module of the HCS was used for the analyses. Both the eastbound Willow Road and the westbound Willow Road to southbound Interstate 94 ramps operate at LOS D during both peak hours.

The northbound Interstate 94 to eastbound and to westbound Willow Road ramps operate as diverge sections with Interstate 94. The Ramps and Ramp Junctions Diverge Analysis module of the HCS was used for these ramps. Both ramps operate at LOS F in the A.M. peak hour and LOS E in the P.M. peak hour under the 2040 No-Build traffic conditions.

76 Conclusions

Based upon the analysis of existing traffic conditions presented in this report, much of Willow Road is operating at or above capacity. There are capacity problems in both the four lane and two lane sections. With expected traffic growth assumed in the ~~2030~~ 2040 No-Build condition, this operation will only worsen. As demand continues to grow, drivers will experience decreased levels of service at intersections and along street segments, increased congestion, and longer queues. In support of these conclusions consider the following results from the analysis of the traffic conditions along Willow Road between Illinois Route 43 (Waukegan Road) and Interstate 94 for the existing (2009), ~~and~~ 2030 No-Build and 2040 No-Build conditions.

Volume-to-Capacity Ratio

Demand relative to capacity is measured by the volume-to-capacity (V/C) ratio. As this measure of congestion approaches 1.0 a facility is becoming congested; values at 1.0 or above indicate a congested roadway. Existing demand exceeds capacity on all segments but one during the A.M. peak hour and meets or exceeds capacity on all segments during the P.M. peak hour. Congestion is especially prevalent between Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road. Here, in the center of the corridor, V/C ratios range between 1.39 and 1.59 during the A.M. peak hour. During the P.M. peak hour, the range is between 1.69 and 1.91.

Given the expected increase in demand, this situation will only worsen. Between 2009 and 2030 No-Build, the Annual Average Daily Traffic (AADT) on Willow Road is forecasted to increase approximately 14 percent. The increase between 2009 and 2040 No-Build is expected to be approximately 17 percent. The impact of this growth as measured by the V/C ratio will be significant. For example, under the 2030 No-Build condition V/C ratios in the center of the corridor are expected to range from 1.61 and 1.85 during the A.M. peak hour and 1.95 and 2.23 during the P.M. peak hour. With the 2040 No-Build condition, the V/C ratios in the center of the corridor will range from 1.95 to 2.13 during the P.M. peak hour. This increasing congestion will be evident to drivers as they experience declining levels of service at intersections, along street segments, and lengthening queues.

Level of Service and Queuing - Intersections

The operation of an intersection is described by its level of service (LOS), i.e., which measures average delay per vehicle in seconds. The minimum desired level of service for signalized intersections is LOS D. In the existing condition, during both the A.M. and P.M. peak hours, three and four of the six signalized intersections respectively in the corridor are operating below LOS D for either the A.M. or P.M. peak or both. These are the intersections of Willow Road at Illinois Route 43 (Waukegan Road), Sunset Ridge Road, Wagner Road, and Central Avenue/Happ Road (P.M. only). At most all intersections, the exceptions being Willow Road at Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road, this situation under the 2030 No-Build or the 2040 No-Build condition further deteriorates.

The calculated average queues at the intersections in the study area are over two thousand feet in length with existing traffic volumes and will increase to almost three thousand feet with 2030 and 2040 No-Build volumes. This results in motorists today requiring multiple cycles to pass through an intersection with access to left turn lanes frequently being blocked. The resultant delay increases driver frustration as they travel on this segment of Willow Road. This situation will become increasingly worse as traffic volumes grow.

The intersections of Willow Road at Three Lakes Drive/Fox Meadow Drive and Old Willow Road/Northfield Road provide an everyday example of the impact of vehicle queues on level of service. Queues are an indication of vehicles waiting to be served by the facility. Typically, longer queues result in greater delay and may be indicative of congestion problems. ~~As noted above, these two~~ The Three Lakes Drive/Fox Meadow Drive intersections, despite the increase in volumes on Willow Road, operates at LOS C-B during ~~both years and existing and both No-Build~~ time periods. This is due to the relatively low volumes on the minor legs of each the intersection. Drivers along Willow Road at each of these this intersections experience queuing as unmet demand builds up. As vehicles from the

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minor legs attempt to access Willow Road, there is often no space for them, as Willow Road is filled with vehicles and has backed up into the intersection.

Level of Service - Segments

The operation of a street segment can also be described by its level of service. As is the case with intersections, the minimum level of service for a street segment is LOS D. In the existing condition, ~~three-six~~ of the ten street segments in the corridor are operating below the minimum level of service during both the A.M. and P.M. peak hours. Most of these segments are operating at LOS E or F. Again this situation is expected to worsen by ~~2030-2040~~ with additional segments moving to LOS F (average speed less than ~~40-13~~ mph) and average travel speeds declining on all ~~but one~~ segments.

In the existing condition, long queues are seen at many places along the corridor during the A.M. and P.M. peak hours, e.g., Willow Road in the eastbound direction from Wagner Road to west of Illinois Route 43 (Waukegan Road); Willow Road in the westbound direction at Wagner Road, Sunset Ridge Road, and Illinois Route 43 (Waukegan Road). Long queues can also be seen on Sunset Ridge Road (northbound during the A.M. peak) and Central Avenue (southbound during the P.M. peak). Also note that these queues frequently occur along segments or at intersections that are operating at a poor level of service. The pattern of queuing under 2030 No-Build ~~and 2040 No-Build~~ conditions ~~is-are~~ very similar to that observed for the existing condition except that the queues are longer.

Interstate 94 Interchange

Finally, three types of analyses were completed to evaluate the operation of the Willow Road interchange with Interstate 94. These include two-way stop control; weaving section; and ramp merge/diverge analyses. The LOS letter grades reported here have the same interpretation as the LOS for signalized intersections and urban street segments. The two-way stop control and weaving section analysis showed that the interchange ramps, at the stop sign and in the Willow Road weaving section, are operating and are expected to continue to operate at no worse than LOS C. With existing or 2030 No-Build traffic volumes, the eastbound to southbound Interstate 94 ramp operates at LOS D and the westbound to southbound Interstate 94 ramp operates at LOS C during either peak hour. With 2040 No-Build traffic, this will drop to LOS D in both peak hours. Under ~~either~~ existing ~~or~~ 2030 No-Build ~~and 2040 No-Build~~ conditions, the northbound Interstate 94 to eastbound and westbound Willow Road ramps operate at LOS F in the A.M. peak hour and LOS E in the P.M. peak hour.

In summary, Willow Road between Illinois Route 43 and Interstate 94 is experiencing congestion, delays and queuing with existing traffic in both the two/three lane sections and the four/five lane sections. ~~and t~~hese will continue to worsen as traffic grows to 20~~34~~0 No-Build volumes. Alternatives should be evaluated to address these deficiencies.

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