PRELIMINARY DRAFT

Traffic Study for the Intersection of S. 51st Street and W. Drexel Avenue in the City of Franklin

INTRODUCTION

The City of Franklin requested that the Southeastern Wisconsin Regional Planning Commission conduct a traffic engineering study for the intersection of S. 51st Street and W. Drexel Avenue to address vehicle delay and queue length issues experienced during student arrival and departure times at Franklin High School during the school year. The study area is shown on Map 1. Specifically, the study consisted of an analysis of the operation of the existing all-way stop control at the intersection based on current and forecast future traffic conditions, and the identification and evaluation of potential improvements to the operation of the intersection to accommodate both current and future traffic conditions. Potential improvements included an all-way stop controlled intersection with additional lanes at each approach, a traffic signal with right- and left-turn lanes at each approach, a traffic signal with left-turn lanes at each approach, and a single-lane roundabout. The potential improvements were evaluated based on their ability to address vehicle delay and queueing at the intersection, as well as based on their cost and impacts to adjacent right-of-way.

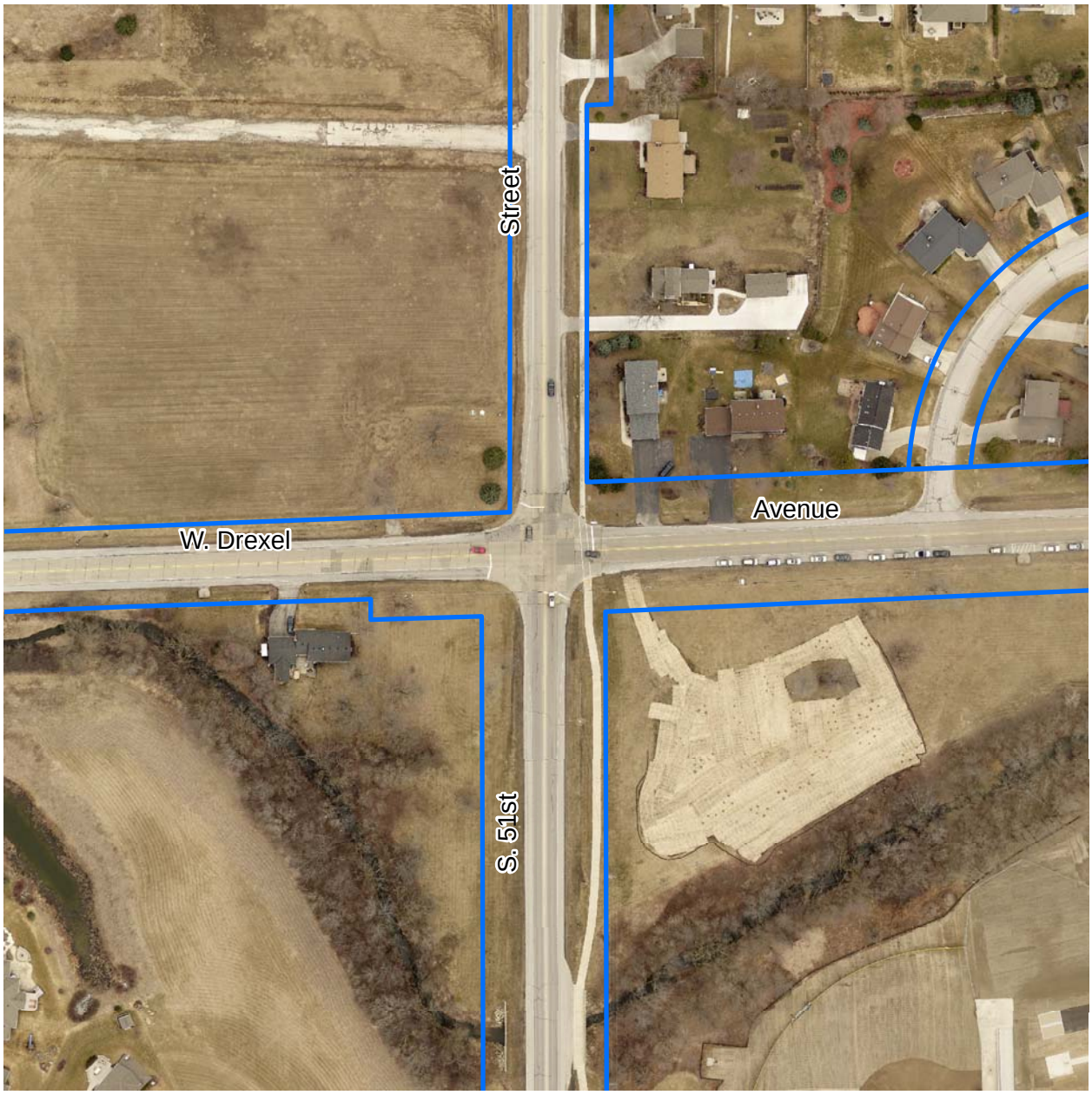
This report documents the process and findings of the traffic engineering study, including inventories of the existing conditions and physical characteristics, the evaluation of current operating conditions, the evaluation of alternatives, and the identification of an intersection improvement recommended by Commission staff to be considered by the City of Franklin for implementation. At the request of City of Franklin officials, the last section of the report describes a potential process for involving the public in the study process.

INVENTORY

This section documents the existing conditions at and near the intersection of S. 51st Street and W. Drexel Avenue, including existing land uses and features adjacent to the intersection, existing physical characteristics of the intersection, such as lane, shoulder, and right-of-way widths; current volumes entering the intersection (including bicycle and pedestrian volumes and truck/bus volumes), current vehicle turning movements within the intersection, and vehicle crashes (including crashes involving pedestrians, bicyclists, and school buses). In addition, this section documents forecast year 2050 entering

Map 1

STUDY AREA OF THE INTERSECTION OF 51ST STREET/DREXEL AVENUE



RIGHT-OF-WAY

N

0 30 60 90 120 150
Feet

and turning movement volumes developed by Commission staff based on forecast population and employment levels under the adopted year 2050 regional land use and transportation plan (VISION 2050).

Land Uses Proximate to the Intersection

Map 2 shows the existing land uses proximate to the intersection of S. 51st Street and West Drexel Avenue. The northeast quadrant of the intersection is predominately low- to medium-density[1] residential development, though this area also includes Pleasant View Elementary School. The northwest quadrant of the intersection is dominated by the Payne and Dolan quarry. The southwest quadrant is predominately medium-density residential development. The southeast quadrant includes Franklin High School and medium-density residential development, located east of the high school.

Franklin High School

Franklin High School, which has direct access to S. 51st Street, has over 1,500 students enrolled and employs about 175 faculty and staff members. Classes at Franklin high School begin at 7:20 a.m. and end at 2:34 p.m. As provided by the Franklin School District, transportation to and from school each day includes approximately 25 school buses to drop-off students in the morning before school and 29 buses to pick-up students in the afternoon after school. About 400 additional students not using the bus are dropped off in the morning and about 100 students not using the bus[2] are picked up in the afternoon when school ends at 2:34 p.m. Students are also allowed to park on campus with a parking pass. About 340 parking passes have been purchased. In addition, students park along W. Drexel Avenue east and west of S. 51st Street.

Pleasant View Elementary School

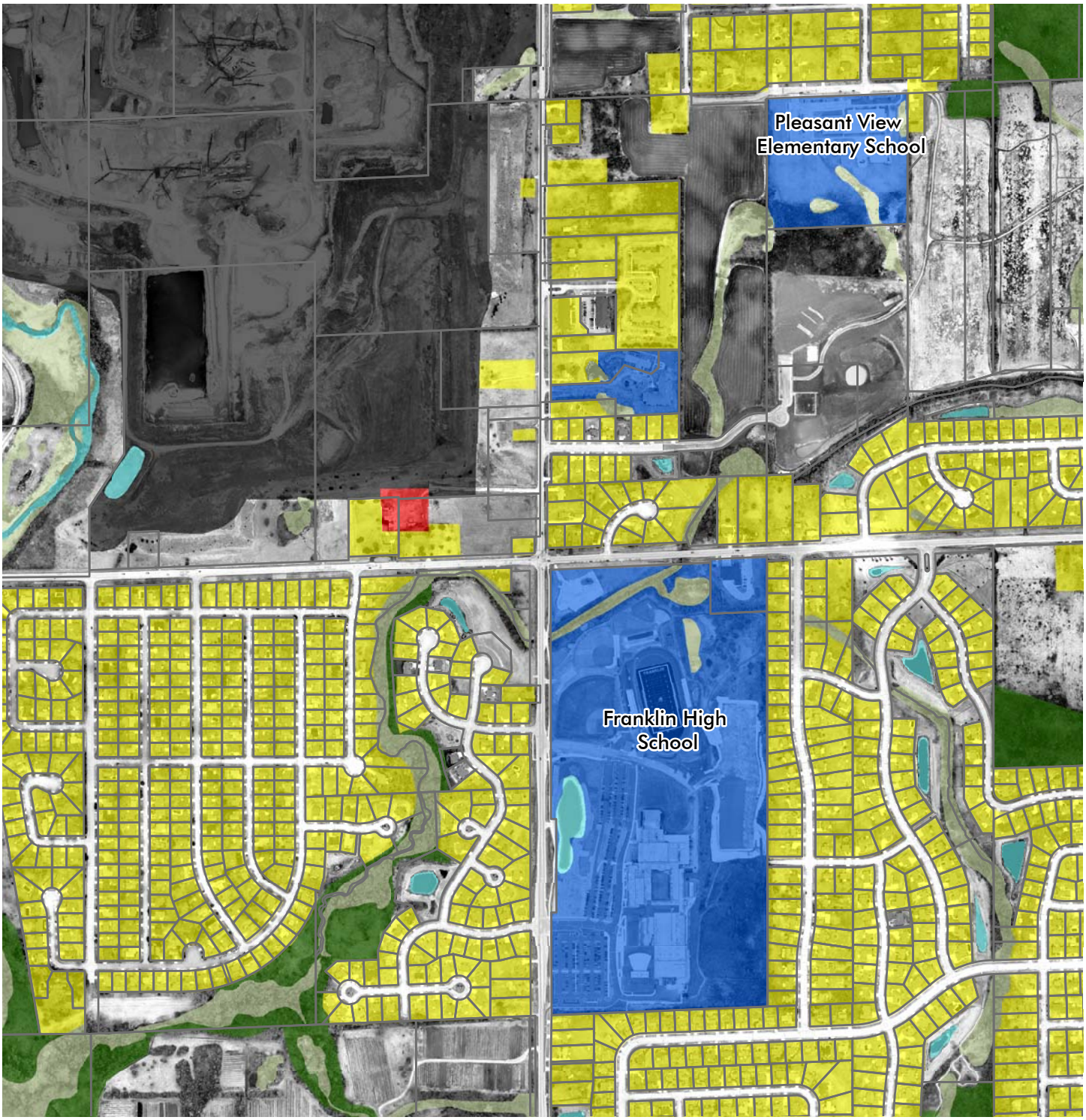
Pleasant View Elementary School is located within the residential area northeast of the intersection. It has about 500 students enrolled and employs about 65 faculty and staff members. Classes at Pleasant View Elementary School begin at 8:30 a.m. and end at 3:15 p.m.

[1] Low-density residential developments are characterized by a density of 0.7 to 2.2 dwelling units per acre and medium-density residential developments are characterized by a density of 2.3 to 6.9 dwelling units per acre.

[2] The significant decrease in dropping offs of students not using the bus between the morning and the picking up of students in the afternoon is likely due to students either using a different means of leaving the school (such as by bus or walking) or remaining at the school for extra-curricular activities.

Map 2

EXISTING LAND USE IN THE AREA OF THE INTERSECTION OF 51ST STREET/DREXEL AVENUE



RESIDENTIAL
COMMERCIAL
GOVERNMENTAL AND INSTITUTIONAL
EXTRACTIVE AND LANDFILL
WETLANDS
WOODLANDS
AGRICULTURAL AND OTHER OPEN LANDS
SURFACE WATER

N

0 250 500 750 1,000 Feet

Residential Land Use Conflicts with Intersection

As shown on Map 3, there are four driveways and one intersecting roadway located within the functional area[3] of the intersection. The proximity of driveways and intersecting roadways to an intersection can affect its operation. Vehicles entering and exiting such driveways and intersecting roadways can conflict with the stopping maneuver of vehicles approaching the intersection. In addition, queueing at the intersection may impact the access of vehicles entering and existing the driveways and intersecting roadways, particularly those driveways and roadways closest to the intersection.

Existing Roadway and Intersection Characteristics

The existing cross-sections for W. Drexel Avenue and S. 51st Street are shown in Figure 1. W. Drexel Avenue is a two-lane arterial roadway with two 12-foot wide traffic lanes and two 8-foot wide paved shoulders east and west of S. 51st Street. Parking is generally permitted on W. Drexel Avenue, with the exception of the south side of the roadway west of S. 51st Street and the north side of the roadway east of S. 51st Street where parking is prohibited during school hours. W. Drexel Avenue has an overall right-of-way width of 125 feet east of S. 51st Street and 78 feet to 98 feet west of S. 51st Street.

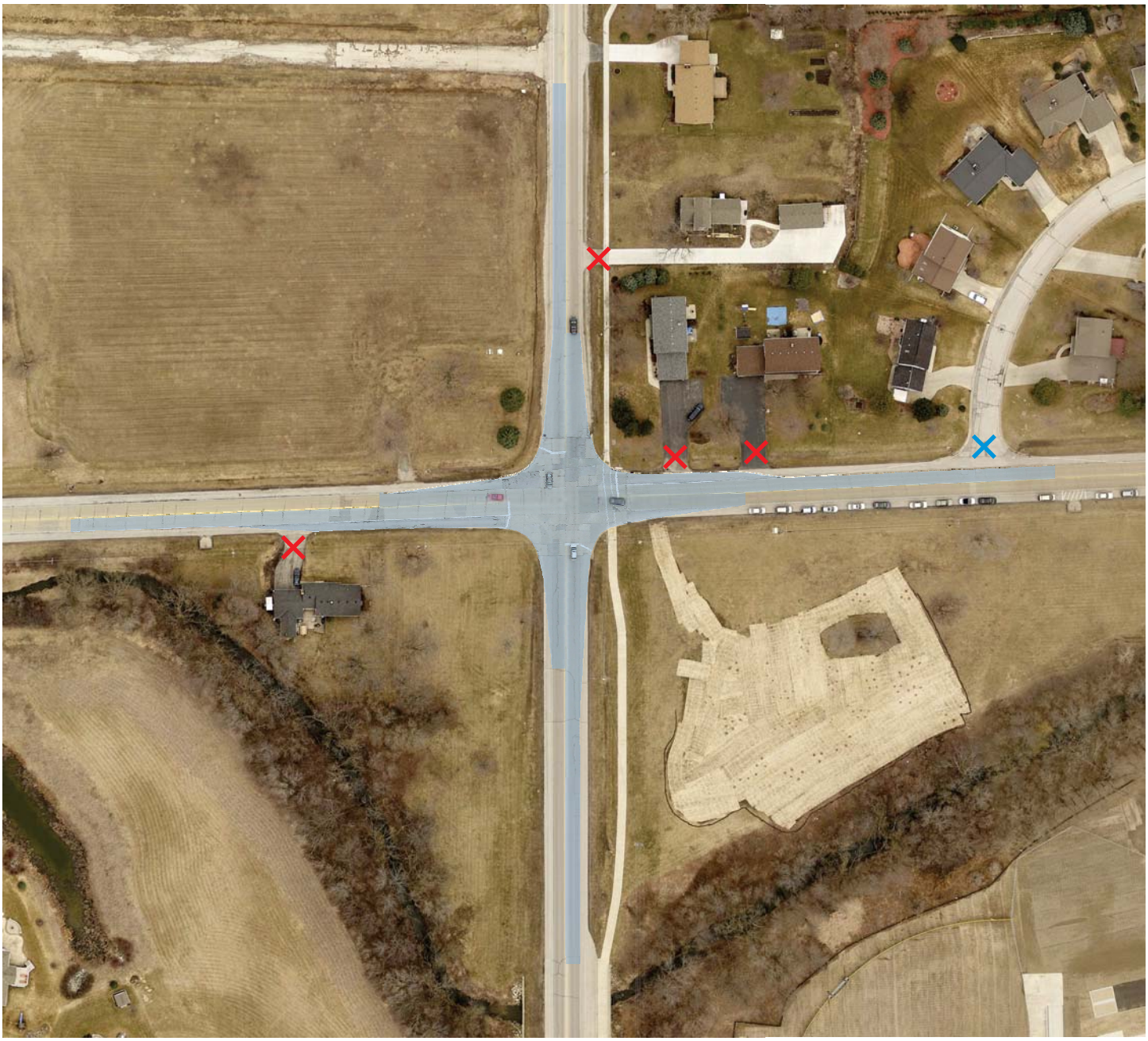
S. 51st Street is a two-lane arterial roadway with two 12-foot wide traffic lanes, along with two 8-foot wide paved shoulders south of W. Drexel Avenue and two 6- to 8-foot wide shoulders (4-foot wide paved shoulders with 2- to 4-foot wide gravel shoulders) north of W. Drexel Avenue. Parking is generally permitted on S. 51st Street, except during school hours. S. 51st Street has an overall right-of-way width of 120 feet south of W. Drexel Avenue and 74 feet north of W. Drexel Avenue.

The intersection of S. 51st Street and W. Drexel Avenue is all-way stop controlled (AWSC)—having stop signs located on all four legs of the intersection. A diagram of the existing lane configuration is provided on Figure 2. The north leg of the intersection (S. 51st Street) has a 12-foot wide shared through/left-turn lane and a 9-foot wide right-turn lane with no storage and a 100-foot long taper. The south leg of the intersection (S. 51st Street) has a 12-foot wide shared through/left-turn lane and a 10-foot wide right-turn lane with no storage and a 160-foot long taper. While there is no storage for right turning vehicles in the right-turn lanes, the existing shoulder is wide enough that it can be used for storage of right-turning vehicles, thus operating as “de facto” right-turn lanes. The east leg of the intersection (W. Drexel Avenue) has a 12-foot wide through/left-turn lane and an 11-foot wide right-turn lane with 110 feet of storage and

[3] The functional area for an all-way stopped controlled intersection is determined upstream by the distance needed for storage and the deceleration of vehicles (sum of distance for lane storage, deceleration of vehicle, and reaction of driver) and downstream by the distance to avoid conflict between through vehicles and vehicles entering/exiting roadway/stopping sight distance for 25 mph speed

Map 3

DRIVEWAYS AND CROSS-ROADWAYS IN THE FUNCTIONAL AREA OF THE ROADWAY



Driveways in functional area of intersection

Roadways in functional area of intersection

N

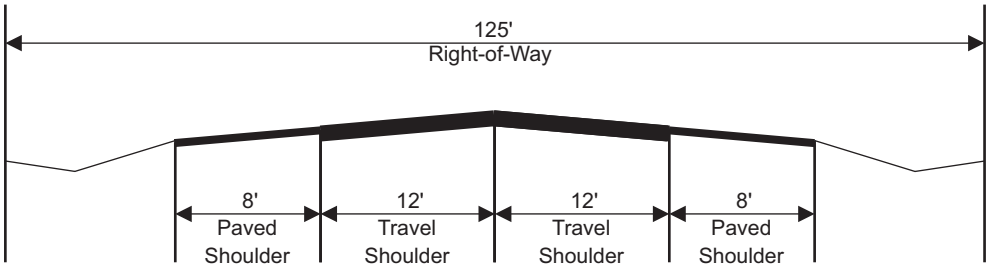
0 25 50 75 100 Feet

Figure 1

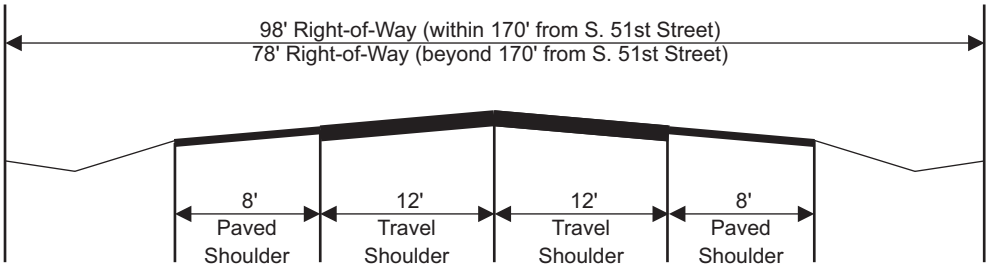
EXISTING TYPICAL CROSS-SECTIONS FOR W. DREXEL AVENUE AND S. 51ST STREET

W. Drexel Avenue

East of 51st Street

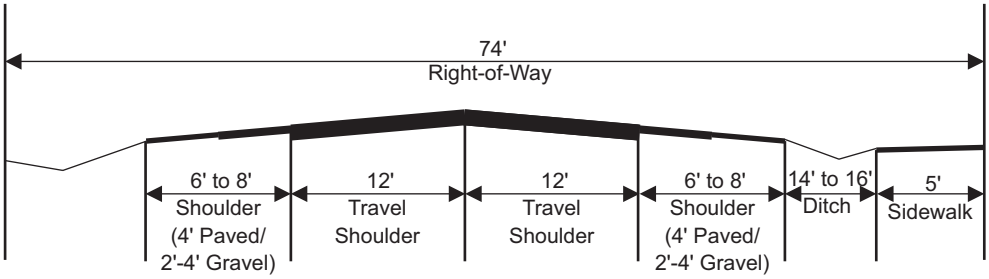


West of 51st Street



S. 51st Street

North of Drexel Avenue



South of Drexel Avenue

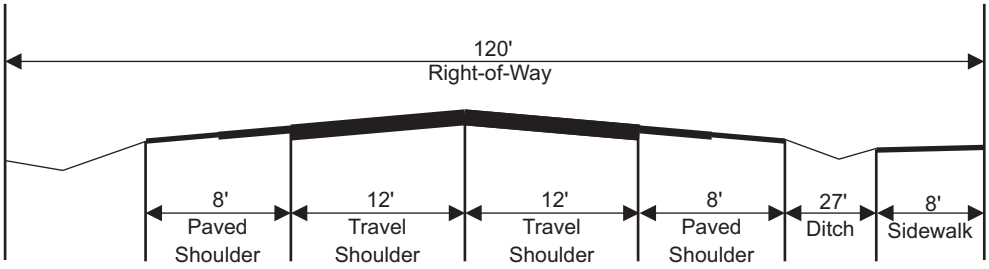
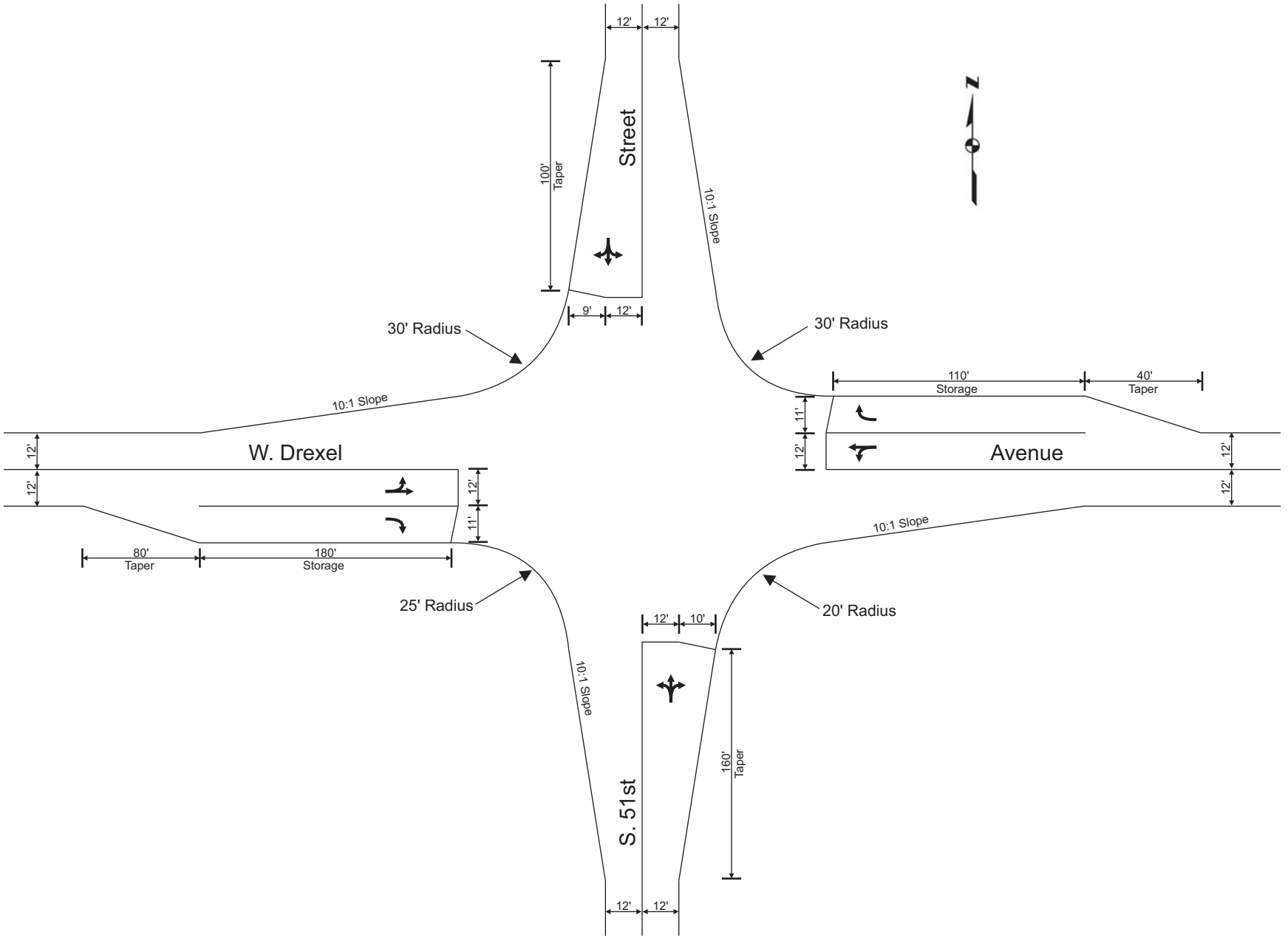


Figure 2

EXISTING LANE CONFIGURATION FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE



a 40-foot long taper. The west leg of the intersection (W. Drexel Avenue) has a 12-foot wide through/left-turn lane and an 11-foot wide right-turn lane with 180 feet of storage and an 80-foot long taper.

Current Traffic Approaching Volumes and Turning Movements

The traffic volume and turning movements at the intersection of S. 51st Street and W. Drexel Avenue were collected, by Commission staff, utilizing video collection equipment from 11:00 a.m. on Monday, October 31, 2016 through 9:00 a.m. on Thursday, November 3, 2016. During this period, the volume and turning movements of vehicles (including trucks, buses, and bicycles travelling on the roadway) were documented. In addition, the number of pedestrians and bicyclists crossing the roadway at the intersection was also collected as part of the turning movement study. For the purpose of the study, the traffic volumes on Tuesday, November 1, 2016, and Wednesday, November 2, 2016, were used to evaluate the performance of the existing intersection, and to develop and evaluate potential alternative intersection improvements to address existing intersection delay and vehicle queueing. These data represent two complete days' worth of data and traffic volumes, and are representative of the average weekday traffic volume. Bicyclists utilizing the roadway were counted as vehicles and bicyclists utilizing crosswalks were counted as pedestrians. Figure 3 shows the total traffic volume approaching the intersection of S. 51st Street and W. Drexel Avenue on an average weekday. The total average weekday traffic volume entering the intersection is about 14,600 vehicles. The average weekday traffic volume entering the intersection is relatively balanced among the four approaches ranging from about 3,400 to about 3,900 vehicles. Figure 3 also shows the turning movement at the intersection during an average weekday.

Based on the data collected, the average weekday traffic volume on W. Drexel Avenue ranges from about 6,900 to about 7,100 and on S. 51st Street from about 7,500 to about 7,700. These volumes are below the existing design capacity of the two roadways of 14,000 vehicles per average weekday. Thus, the existing two traffic lanes along each roadway is sufficient for existing traffic volume.

Nearly all of the vehicles approaching the intersection of S. 51st Street and W. Drexel Avenue on an average weekday, about 98 percent, are automobiles or light-duty trucks (such as pick-up trucks, sport-utility vehicles, or vans). Medium-and heavy-duty trucks and buses represent a relatively small portion of the total vehicles approaching the intersection. Figure 4 shows the number of medium- and heavy-duty trucks and buses on the four approaches, which represents about two to three percent of the total vehicles on these approaches.

Figure 3

AVERAGE WEEKDAY TOTAL TRAFFIC APPROACHING AND TURNING MOVEMENTS IN THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: NOVEMBER 1 AND 2, 2016

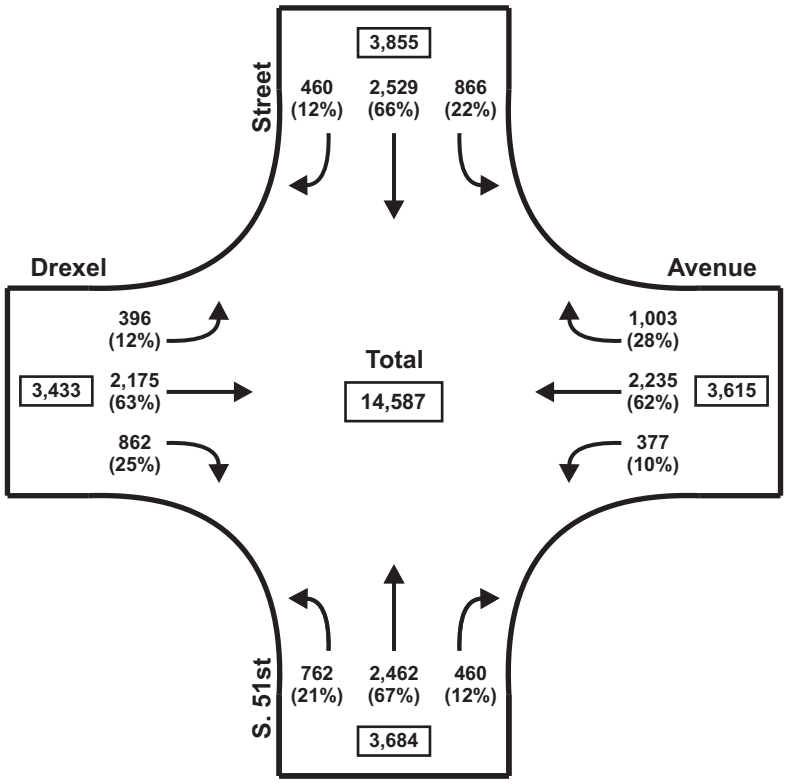
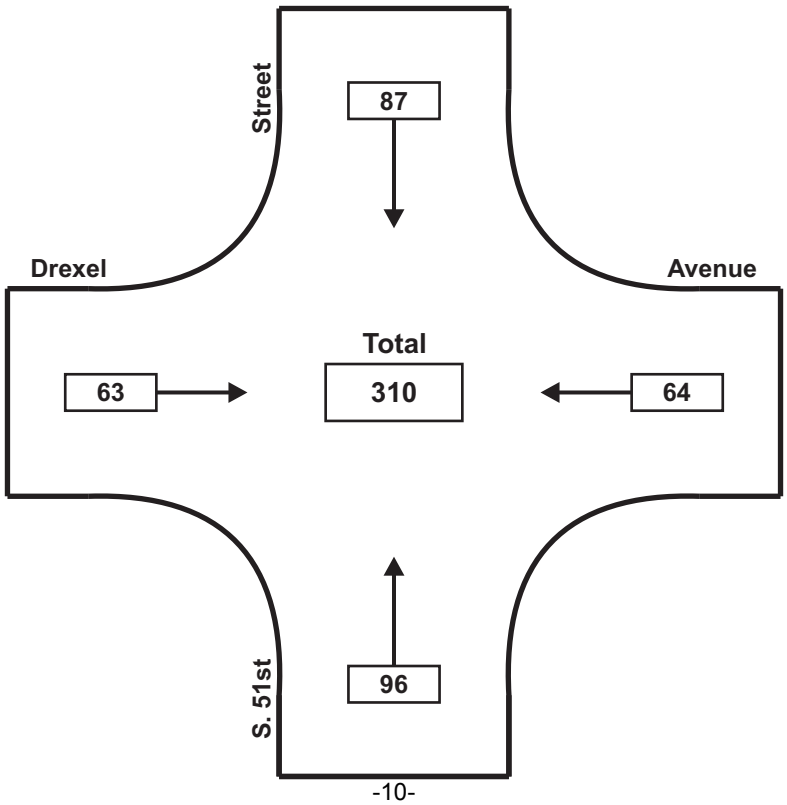


Figure 4

AVERAGE WEEKDAY MEDIUM- AND HEAVY-DUTY TRUCK AND BUS VOLUME APPROACHING THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: NOVEMBER 1 AND 2, 2016



About 34 bicyclists (representing less than a half percent of the total approaching traffic) approached the intersection on an average weekday.[4]

As shown in Figure 5, there are three peak hour periods of traffic volume approaching the intersection of S. 51st Street and W. Drexel Avenue on an average weekday:

- Morning Peak (6:45 a.m. to 7:45 a.m.) coinciding with the Franklin High School start time at 7:20 a.m.;
- After School Peak (2:30 p.m. to 3:30 p.m.) coinciding with the Franklin High School end time at 2:34 p.m.; and
- Evening Peak (4:30 p.m. to 5:30 p.m.).

The morning and evening peaks are consistent with the two peaks in traffic volumes that are typical for arterial roadways as a majority of workers travel to and from work during those times. However, the intersection of S. 51st Street and W. Drexel Avenue experiences a third peak due to the proximity of Franklin High School and the school ending its day in the early afternoon. The morning peak hour experiences a sharp peak in traffic volume between 7:00 a.m. and 7:15 a.m., which represents about 32.8 percent (or 452 vehicles) of the 1,380 total vehicles approaching the intersection during the morning peak period. This sharp peak in traffic contributes to the severe delays and long queues at the intersection that are generally experienced for a short period of time during the morning peak hour. The peak hour factor[5] (PHF) for the morning peak period is 0.76. In contrast the mid-day and evening peak hours experience high but steady traffic volumes between each 15-minute period, likely resulting in more moderate delays and length of queues over a longer period of time. The PHF for these peak hours are 0.93 and 0.97, respectively.

Figure 6 shows the total traffic approaching the intersection under each of the three identified peak hours. Unlike the total volume approaching the intersection of S. 51st Street and W. Drexel Avenue throughout the entire weekday, the amount of volume approaching the intersection is not balanced among the four

[4] The 34 bicyclists approaching the intersection on an average weekday is based on the number of bicyclists measured on Tuesday, November 1, 2016. As only three bicyclists were observed approaching the intersection on Wednesday, November 2, 2016 (likely due to rainfall that day), only the bicyclists observed on November 1st were included in the total average weekday traffic volume.

[5] PHF is a measure of flow variation during the peak hour ranging from 0.25 to 1.00. A low PHF indicates a sharp peak of traffic volumes within the highest or peak 15-minute period within the peak hour as compared to the other three 15-minute periods, while a higher PHF indicates more uniform or steady traffic volumes over the peak hour. It is unusual for a PHF to be below a value of 0.70.

Figure 5

TOTAL VEHICLE AVERAGE WEEKDAY TRAFFIC VOLUME APPROACHING THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE BY 15-MINUTE PERIODS: NOVEMBER 1 AND 2, 2016

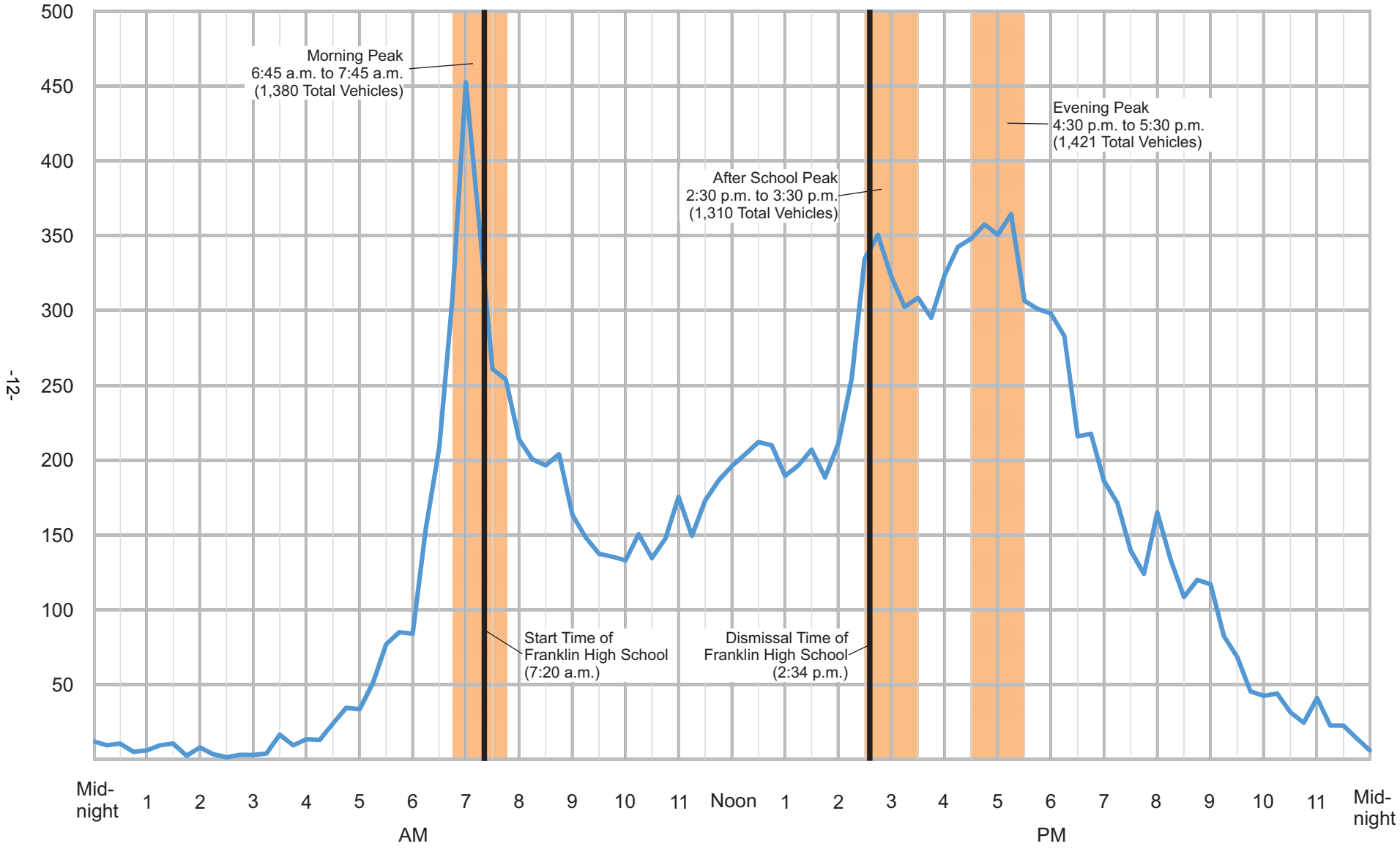
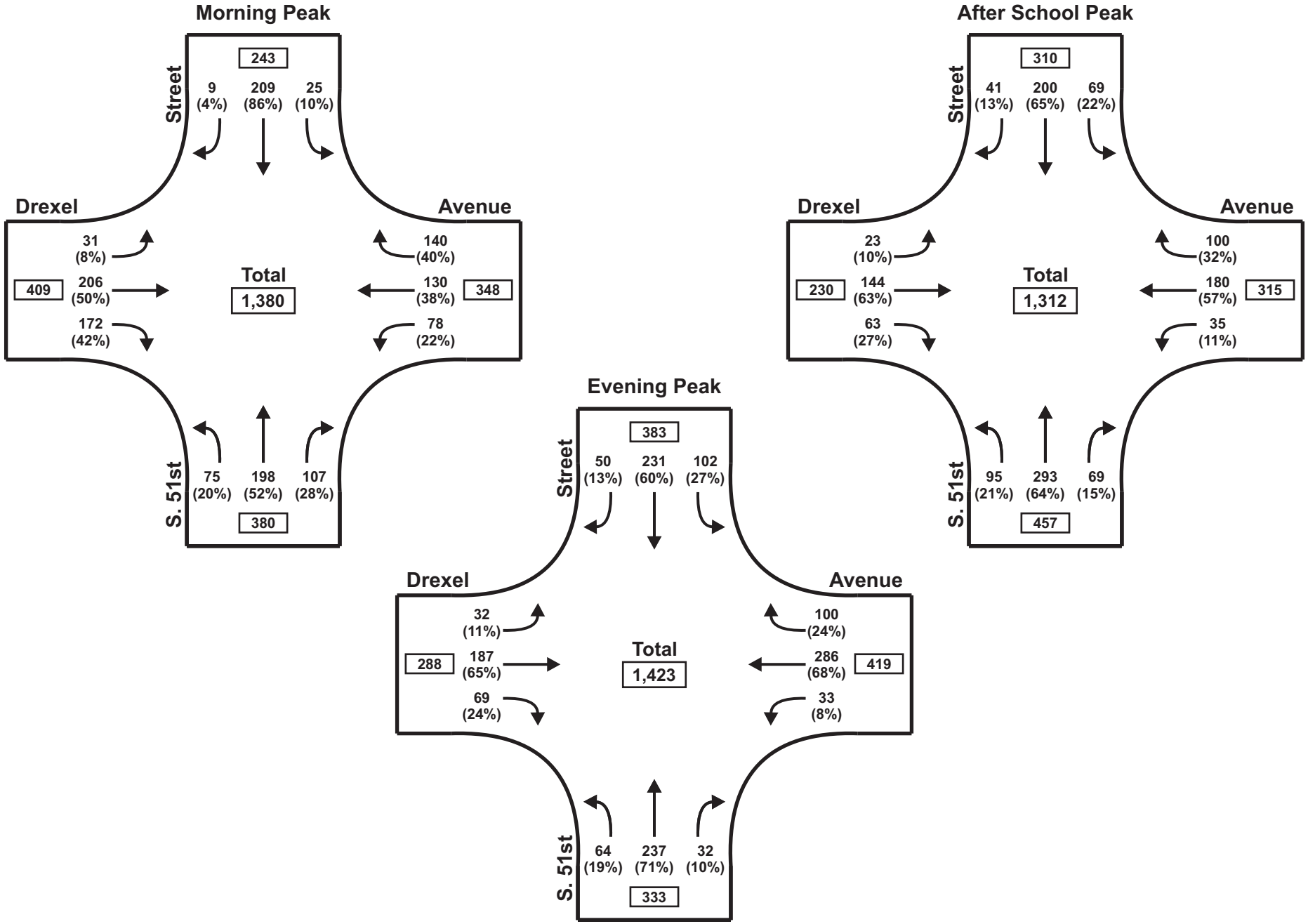


Figure 6

TOTAL APPROACHING AVERAGE WEEKDAY TRAFFIC VOLUME AND TURNING MOVEMENT AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE DURING THE MORNING, AFTER SCHOOL, AND EVENING PEAK PERIODS: NOVEMBER 1 AND 2, 2016



approaches. In addition, the amount of volume carried by each approach varies between the three peak periods. Similarly, the proportion of turning movements varies between the three peak periods, particularly between the morning peak and the two afternoon peak periods. Figure 6 shows the turning movements within the intersection for each of the three peak periods.

Pedestrians

Figure 7 shows the number of pedestrians (including bicyclists crossing the roadway within the crosswalks) that utilized the intersection during the average weekday. As the pedestrian counts from November 2, 2016, were likely impacted by rain, only the 46 pedestrians observed utilizing the intersection on Tuesday, November 1, 2016 are shown on Figure 7. The high temperature for November 1st was about 77 degrees Fahrenheit. While the pedestrian traffic on this day may not be considered representative of an average weekday (which would include pedestrian traffic during inclement weather), Commission staff thought it appropriate to evaluate the intersection based on pedestrian traffic volumes measured during good weather conditions. About half of the pedestrians crossing the roadway at the intersection utilized the only existing crosswalk located on the east leg. While parking is permitted on the north side of W. Drexel Avenue west of the intersection, parking was observed only along the south side of W. Drexel Avenue east of the intersection on days that Commission staff were present at the intersection. The pedestrian traffic would not include any persons walking from this location to Franklin High School.

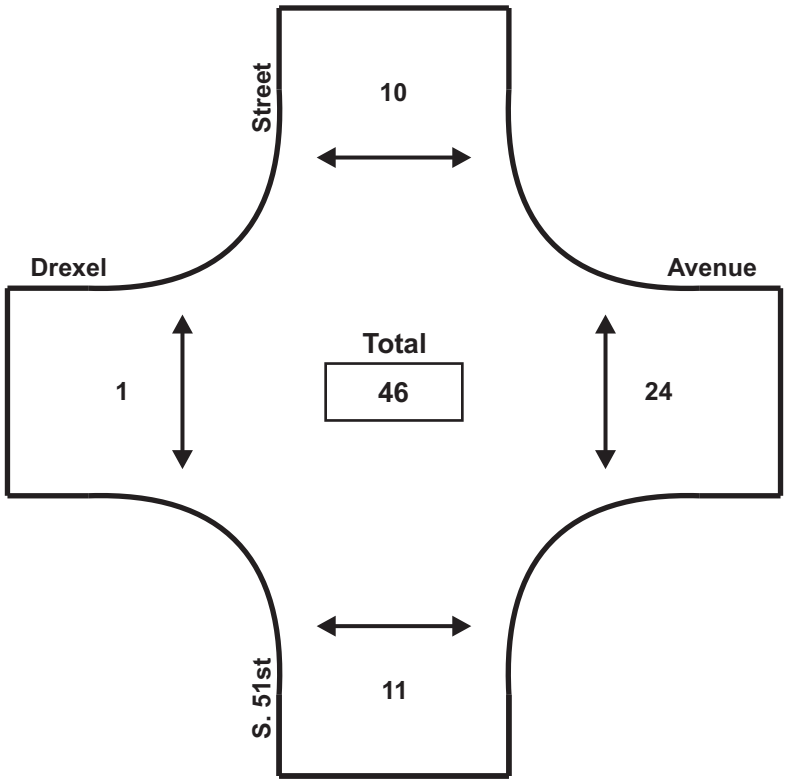
Future Traffic Volumes and Turning Movements

Commission staff utilized the Commission's fifth-generation travel simulation model[6] to prepare forecast year 2050 average weekday traffic volumes and turning movements for the intersection of S. 51st Street and W. Drexel Avenue. The forecast was developed based on the planned population and employment growth and transportation improvements recommended in VISION 2050—the adopted year 2050 regional land use and transportation plan for Southeastern Wisconsin. The forecast year 2050 average weekday traffic volumes approaching the intersection of S. 51st Street and W. Drexel Avenue, along with the

[6] The Commission has, for over 50 years, maintained and refined traffic forecasting and simulation models, similar to ones used by other metropolitan transportation planning organizations across the country. The forecasting and simulation of existing and future travel demand through travel simulation models is a complex procedure requiring development and application of a variety of mathematical models. The simulation of travel and traffic is based upon the premise that the magnitude and pattern of travel is a stable function of the characteristics of the land use pattern and of the transportation system, with the term land use referring to not only land use types and intensity, but also to population, household, and employment levels and characteristics. The fifth-generation travel simulation and forecasting models used in the development of the recently completed year 2050 regional transportation plan (VISION 2050) were validated by comparing the model-estimated travel and traffic—based on inventoried 2000 and 2010 demographic, economic, and land use data and 2001/2002 and 2011/2012 transportation survey data—to estimate existing year 2001 and 2011 traffic volumes.

Figure 7

PEDESTRIAN AVERAGE WEEKDAY TRAFFIC UTILIZING THE INTERSECTION OF N. 51ST STREET AND W. DREXEL AVENUE: NOVEMBER 1, 2016[a]



[a]Pedestrian use of the intersection on November 2, 2016, was not included as the number of pedestrians on that day—22—was likely affected by rain.

forecast turning movements of the intersection, over a 24-hour period and during the three identified peak hour periods are shown in Figure 8.

Based on the forecast year 2050 traffic conditions, the average weekday traffic volume in the year 2050 is estimated to range from about 9,000 to about 9,500 vehicles on W. Drexel Avenue and is estimated to be about 10,000 vehicles on S. 51st Street. These volumes are below the design capacity of the two roadways of 14,000 vehicles per average weekday. Thus, the existing two traffic lanes along each roadway is sufficient for year 2050 traffic volume and is consistent with the recommendations for each roadway in VISION 2050.

Current and Future Year 2050 Intersection Operating Conditions

When traffic volumes exceed the design capacity of an intersection, it experiences congestion. Typically, congestion occurs during the peak traffic times on an average weekday. Congestion at a controlled intersection can result in longer delays and queueing. The level-of-service (LOS) for an intersection is determined by the average delay experienced at the intersection. Table 1 shows the LOS thresholds for the unsignalized (all-way stop and roundabout) and traffic signal controlled intersections. Generally, a LOS of A through C is considered acceptable for an intersection. The operation of the current all-way stop control for the intersection of S. 51st Street and W. Drexel Avenue was analyzed with the HCS 2010 software program for each of the peak-hour periods under both existing and future year 2050 traffic conditions.

Figures 9 and 10 show the vehicle delay and associated level-of-service for each lane and approach for the three peak hours under existing and future traffic conditions. Based on the evaluation, the intersection operates under a LOS of F during the morning peak hour and a LOS of D during the after school and evening peak hours under existing traffic conditions. With respect to future year 2050 traffic volumes, the intersection is estimated to operate at a LOS of F during all three peak hours.

The average length of queued vehicles can be estimated based on the average delay estimated for each lane and approach. Table 2 shows the queue length that is estimated for each lane and approach for each of the three peak periods under both existing and future year 2050 traffic conditions. The northbound approach has the highest estimated queue length of all the lanes during the morning and after-school peak periods with a queue length of 19 and 12 vehicles, respectively. The queue length that was estimated for this approach is consistent with the queueing that was observed to occur at this approach during the morning and after-school peak periods. During the evening peak period the southbound approach is estimated to experience the highest length of queueing at 8 vehicles.

Figure 8

FORECAST YEAR 2050 AVERAGE WEEKDAY AND PEAK HOUR TRAFFIC VOLUMES AND TURNING MOVEMENTS AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

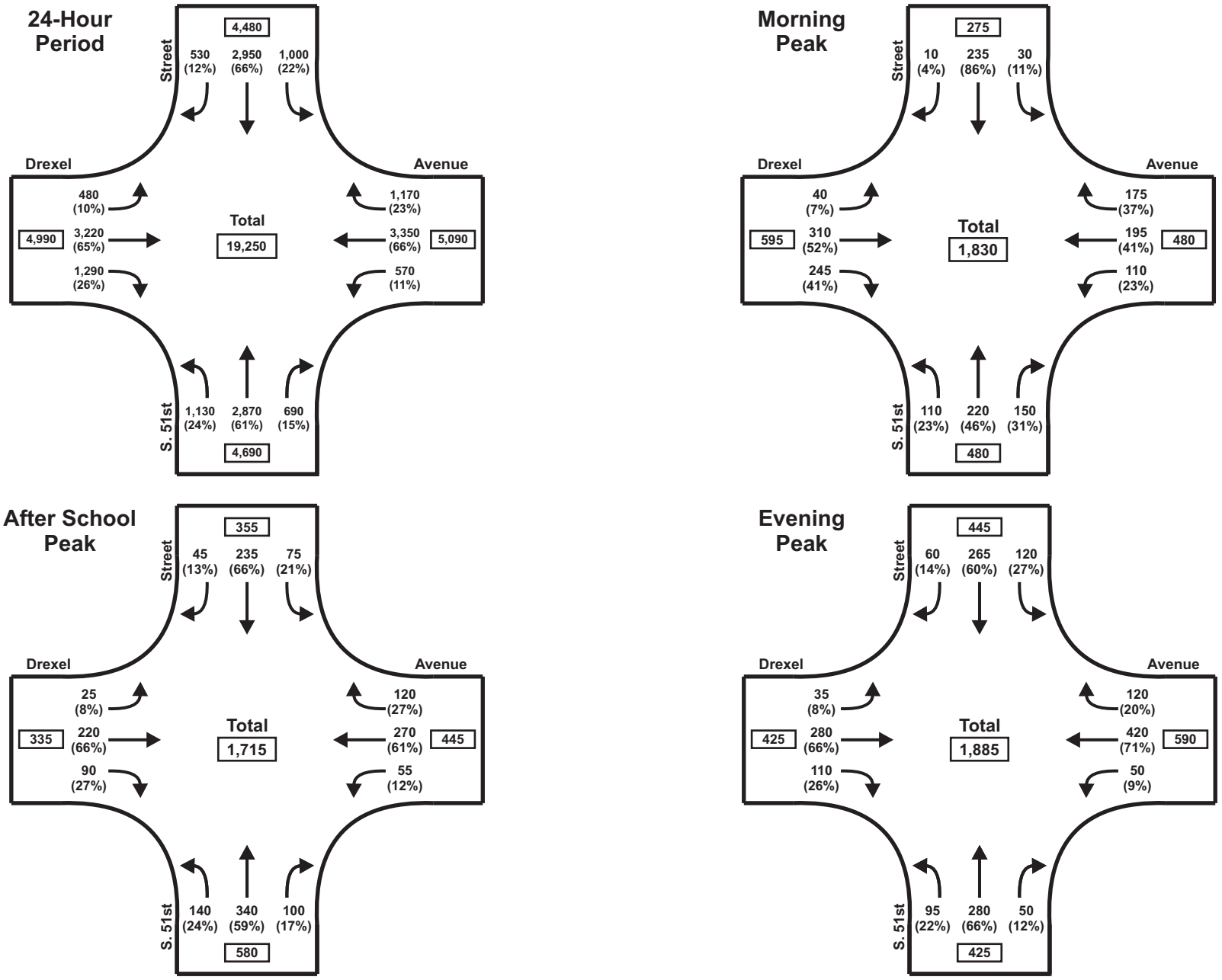


Table 1

LEVEL-OF-SERVICE THRESHOLDS FOR CONTROLLED INTERSECTIONS

Unsignalized Intersections

Level of Traffic Congestion	Level-of-Service	Control Delay at AWSC and Roundabout (veh/sec)	Operating Conditions
None	A	≤ 10	Nearly all drivers find freedom of operation. Very seldom is there more than one vehicle in queue.
	B	> 10 – 15	Some drivers begin to consider the delay an inconvenience. Occasionally there is more than one vehicle in queue.
	C	> 15 – 25	Many times there is more than one vehicle in queue. Most drivers feel restricted, but not objectionably so.
Moderate	D	>25 – 35	Often there is more than one vehicle in queue. Drivers feel quite restricted.
Severe	E	> 35 – 50	Represents a condition in which the demand is near or equal to the probable maximum number of vehicles that can be accommodated by the movement. There is almost always more than one vehicle in queue. Drivers find the delays approaching intolerable levels.
Extreme	F	> 50	Represents an intersection failure condition that is caused by geometric and/or operational constraints external to the intersection.

Signalized Intersections

Level of Traffic Congestion	Level-of-Service	Control Delay at Traffic Signal (veh/sec)	Operating Conditions
None	A	≤ 10	Progression is exceptionally favorable or the cycle length is very short. Most vehicles arrive during the green indication and travel through the intersection without stopping.
	B	> 10 – 20	Progression is highly favorable or the cycle length is short. More vehicles stop than with LOS A.
	C	> 20 – 35	Progression is favorable or cycle length is moderate. Individual cycle failures may begin at this level. The number of vehicles stopping is significant, although many vehicles still pass through the intersection without stopping.
Moderate	D	> 35 – 55	Progression is ineffective or the cycle length is long. Many vehicles stop and individual cycle failures are noticeable.
Severe	E	> 55 – 80	Progression is unfavorable and the cycle length is long. Individual cycle failures are frequent.
Extreme	F	> 80	Progression is very poor and the cycle length is long. Most cycles fail to clear the queue.

Note: Individual cycle failures occur when one or more of the queued vehicles are not able to depart as a result of insufficient capacity during the cycle.

Source: 2010 Highway Capacity Manual and SEWRPC

Figure 9

EXISTING APPROACH AND INTERSECTION DELAY AND LEVEL-OF-SERVICE AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: CURRENT AWSC

Figure 10

FORECAST YEAR 2050 APPROACH AND INTERSECTION DELAY AND LEVEL-OF-SERVICE AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: CURRENT AWSC

Table 2

EXISTING AND FORECAST YEAR 2050 QUEUE LENGTHS OF THE ALL-WAY STOP CONTROL AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

	Morning Peak		After School Peak		Evening Peak	
Approach	**Existing**	**Year 2050**	**Existing**	**Year 2050**	**Existing**	**Year 2050**
Northbound						
Approach……	19	38	12	34	6	17
Southbound						
Approach……	7	11	5	11	8	19
Eastbound						
Thru/Left-turn Lane……	7	21	2	5	3	9
Right-Turn Lane……	3	8	1	1	1	1
Westbound						
Thru/Left-turn Lane……	6	6	3	10	6	23
Right-Turn Lane……	2	4	1	1	1	1

Should no operational or geometric improvements be made to the intersection by the year 2050, the northbound approach may be expected to continue to have the longest queue length during the morning and after-school peak periods at 38 and 34 vehicles, respectively. During the evening peak period, the westbound through/left-turn lane would have the largest queue length at 23 vehicles.

Vehicular Crashes

Between the years 2011 and 2015, 19 vehicular crashes occurred at the intersection of S. 51st Street and W. Drexel Avenue, as shown in Table 3 and Figure 11.[7] This resulted in a crash rate—the ratio of crash frequency to traffic volume—of 0.71 crashes per one million entering vehicles over the five-year period. The five-year crash rate is below the average state-wide crash rate for intersections in an urban area of about one crash per one million entering vehicles and well below the intersection crash rate of 1.50 crashes per one million entering vehicles that WisDOT historically has considered acceptable for intersections. None of the vehicular crashes during the five-year period involved a pedestrian, bicyclist, or school bus. It should be noted that 16 of the 19 vehicular crashes occurred over the three-year period of 2013 through 2015, which resulted in a crash rate of 1.00 crashes per one million entering vehicles. The three-year crash rate is at the average state-wide crash rate for intersections in an urban area of about one crash per one million entering vehicles, but is well below the intersection crash rate of 1.50 crashes per one million entering vehicles that WisDOT historically has considered acceptable for intersections. While, no vehicular crashes resulted in a fatality or serious injury, there were a total of five injury-related crashes—two resulting in at least one non-incapacitating injury and three with reported possible injuries. Rear-end crashes represented 8 of the 19 crashes that occurred at the intersection over the five-year period. This type of crash is typical at intersections with stopped or queued traffic, such as at all-way stop and traffic signal controlled intersections. Such crashes are generally caused by a driver not noticing the vehicle ahead has stopped or slowed, likely due to inattentive driving. Of the 19 crashes, 9 crashes, or about 47 percent, were angle crashes. Angle crashes are generally unusual at all-way stop controlled intersections as vehicles move more orderly and at lower speeds through such intersections. However, the prevalence of these types of crashes at the intersection of S. 51st Street and W. Drexel Avenue could be a result of the excessive delay and queueing that is occurring at the intersection. Under such conditions, drivers can become impatient, and failing to properly yield right-of-way to other vehicles results in angle crashes.

[7] A reportable crash is any crash resulting in: 1) an injury to or death of any person; 2) damage to government-owned non-vehicle property to an apparent extent of $200 or more; 3) damage to a government-owned vehicle to an apparent extent of $1,000 or more; 4) or total damage to property owned by any one person to an apparent extent of $1,000 or more. Vehicular crashes that occurred within the physical intersection as well as crashes that occurred upstream from the intersection due to queues and congestion are included in this analysis. The number of vehicle crashes shown does not include crashes involving a deer.

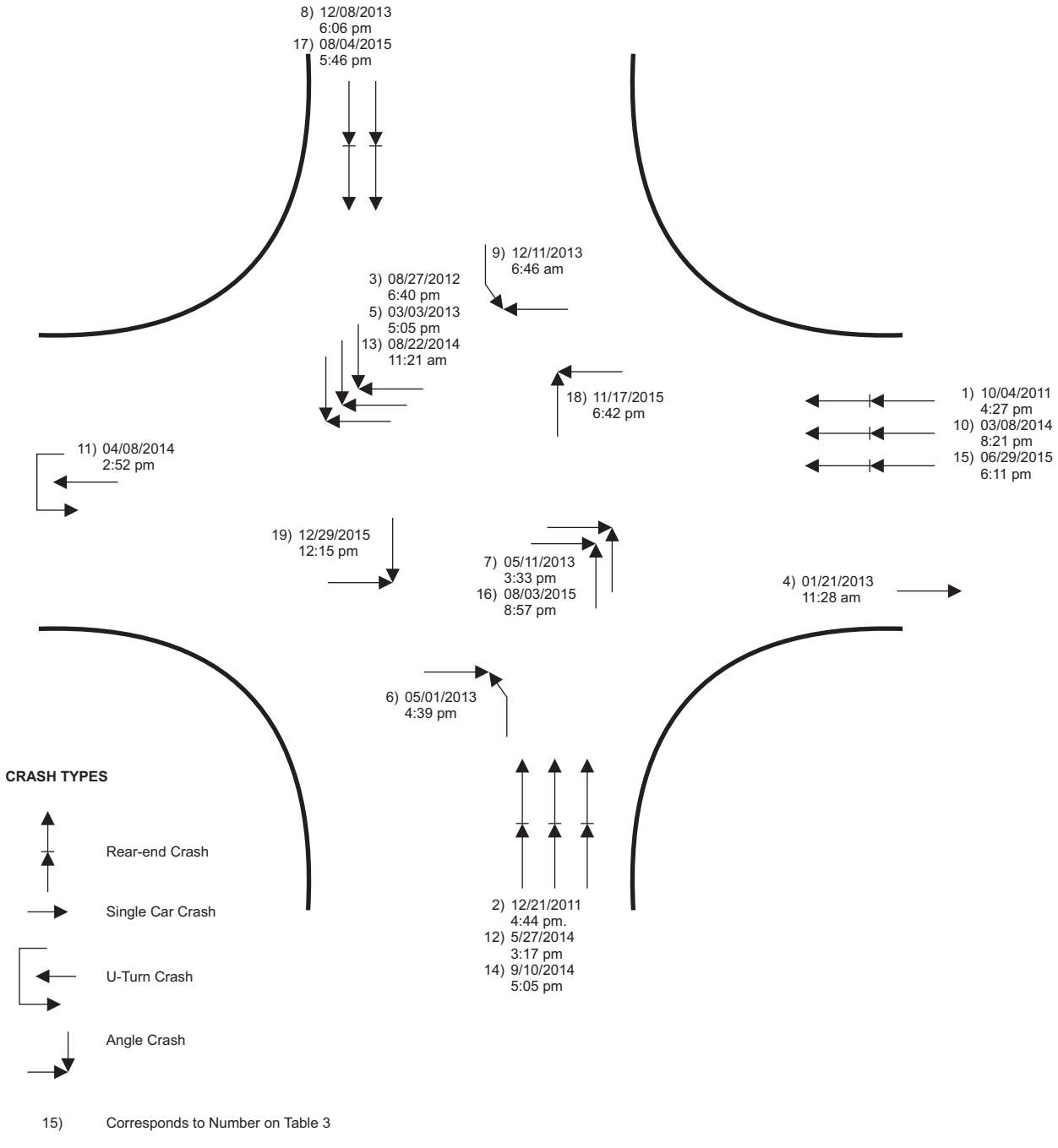
Table 3

TOTAL VEHICULAR CRASHES AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE IN THE CITY OF FRANKLIN BY MANNER OF COLLISION: 2011-2015

Number on Figure 11	Date	Time	Type	Severity	Cause
1	10/4/2011	4:27 pm	Rear	Possible Injury	Inattentive Driving
2	12/21/2011	4:44 pm	Rear	Property Damage Only	Inattentive Driving
3	8/27/2012	6:40 pm	Angle	Non-Incapacitating Injury	Speeding, Inattentive Driving, Fail to Yield Right of Way, Disregarded Traffic Control
4	1/21/2013	11:28 am	Single	Property Damage Only	Failure to have control
5	3/3/2013	5:05 pm	Angle	Property Damage Only	Inattentive Driving
6	5/1/2013	4:39 pm	Angle	Property Damage Only	Fail to Yield Right of Way
7	5/11/2013	3:33 pm	Angle	Property Damage Only	Fail to Yield Right of Way
8	12/8/2013	6:06 pm	Rear	Property Damage Only	Failure to have control
9	12/11/2013	6:46 am	Angle	Property Damage Only	Fail to Yield Right of Way
10	3/8/2014	8:21 pm	Rear	Property Damage Only	Driver Condition
11	4/8/2014	2:52 pm	U-Turn	Property Damage Only	Fail to Yield Right of Way
12	5/27/2014	3:17 pm	Rear	Property Damage Only	Inattentive Driving
13	8/22/2014	11:21 am	Angle	Possible Injury	Speeding, Fail to Yield Right of Way, Disregarded Traffic Control
14	9/10/2014	5:05 pm	Rear	Property Damage Only	Inattentive Driving
15	6/29/2015	6:11 pm	Rear	Non-Incapacitating Injury	Inattentive Driving
16	8/3/2015	8:57 pm	Angle	Possible Injury	Fail to Yield Right of Way
17	8/4/2015	5:46 pm	Rear	Property Damage Only	Inattentive Driving
18	11/17/2015	6:42 pm	Angle	Property Damage Only	Fail to Yield Right of Way
19	12/29/2015	12:15 pm	Angle	Property Damage Only	Fail to Yield Right of Way

Figure 11

TOTAL VEHICULAR CRASHES OCCURRING AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE BETWEEN THE YEARS 2011-2015



15) Corresponds to Number on Table 3

IDENTIFICATION OF ALTERNATIVE INTERSECTION IMPROVEMENTS

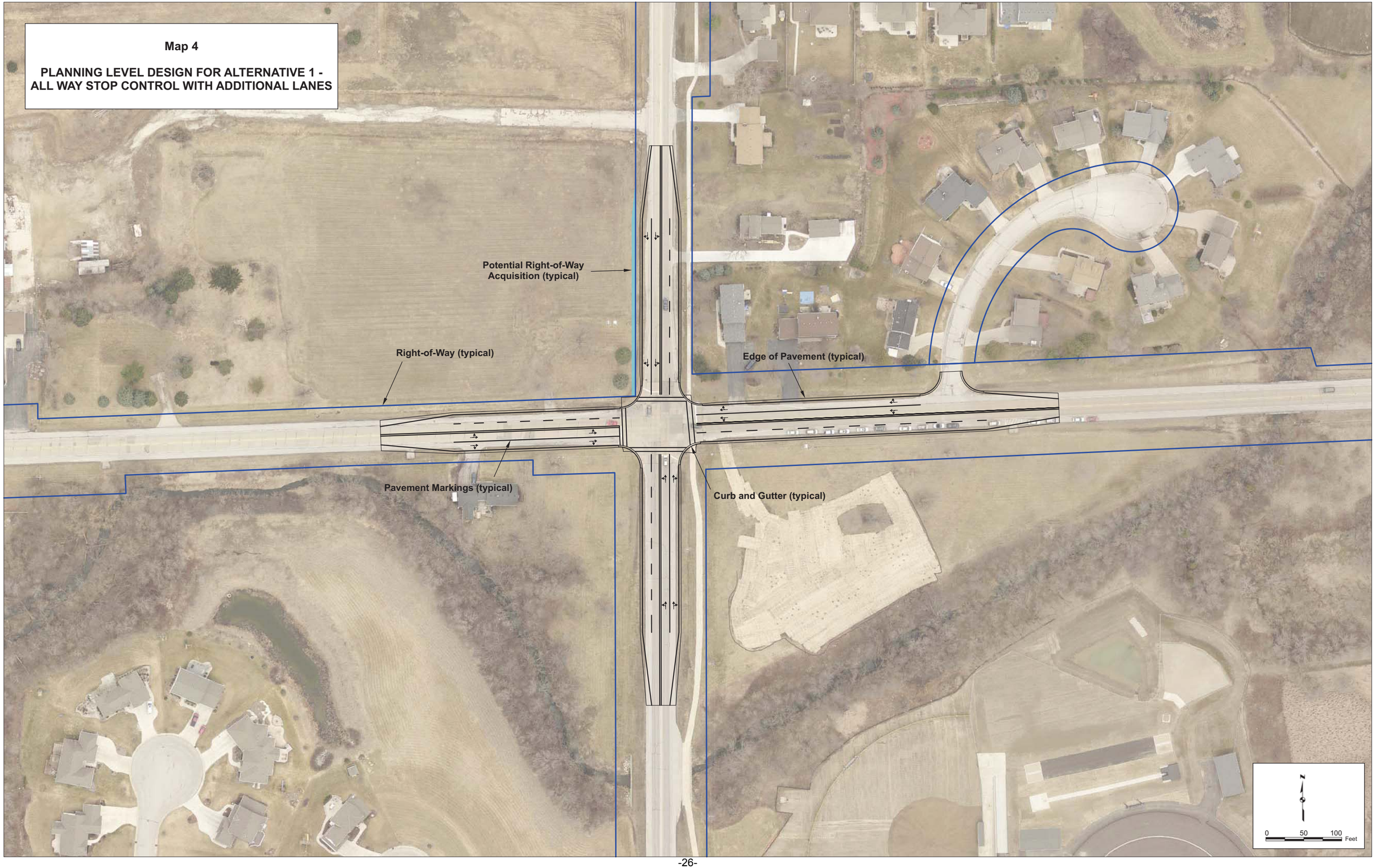
The Commission staff identified four potential alternatives to improve the operation (reducing average delay and queuing) of the intersection of S. 51st Street and W. Drexel Avenue based on existing and forecast future conditions. These alternatives include one alternative that involves improving the current all-way stop control at the intersection with additional turn lanes, two alternatives that involve installing traffic control signals, and one alternative that involves reconstructing the intersection as a roundabout. Planning level designs were developed for each of the alternatives for use in the evaluation of the alternatives. Commission staff would note that preliminary engineering would need to be conducted for any operational and geometric improvement to the intersection that may be pursued by the City of Franklin. Such preliminary engineering would necessarily be conducted at a higher level of detail than this study. Only at the conclusion of preliminary engineering would the actual design, costs, and impacts be more fully understood. With respect to the alternatives involving traffic signals, the Commission staff first needed to determine that a traffic signal was warranted under existing and forecast future conditions based on the standard warrant analysis methodologies. For each alternative, curb ramps and cross-walks were added at locations where sidewalks currently do not exist to assist pedestrians walking in those areas with crossing the intersection and to accommodate any future expansion of sidewalk along W. Drexel Avenue or along the west side of S. 51st Street. The remainder of this section describes the alternatives that were developed and analyzed as part of this study.

Improving Existing All-Way Stop Intersection (Alternative 1)

This alternative involves retaining the all-way stop control for the intersection of S. 51st Street and W. Drexel Avenue, and providing an additional lane to accommodate a 12-foot wide shared through and left-turn lane and a 12-foot wide shared through and right-turn lane. The additional lane is expected to increase the capacity of the intersection. As shown in Map 4, the additional lanes would continue through the intersection to encourage drivers to use the lane. The additional lane would be dropped under this alternative 220 to 230 feet from the intersection on the north, south, and west legs, and 380 feet from the intersection on the east leg in order to provide vehicles sufficient time to merge back into one lane. Considering that this alternative includes two possible through lanes for each approach, it is necessary to determine the proportion of through vehicles that utilize the left lane—the shared through and left-turn lane—in order to evaluate the existing and future year 2050 operating conditions of the alternative. As such, it was assumed that the approaching traffic in each travel direction, regardless of turning movement, would be split evenly between the shared through and left-turn lane and the shared through and right-turn lane.

Map 4

PLANNING LEVEL DESIGN FOR ALTERNATIVE 1 - ALL WAY STOP CONTROL WITH ADDITIONAL LANES



Traffic Signal Warrant Analysis

Prior to the development of traffic signal alternatives, an analysis was conducted as to whether installing a traffic control signal is warranted at the intersection of S. 51st Street and W. Drexel Avenue. Table 4 lists the eight warrants used to justify the installation of a traffic control signal. Of these eight warrants, the Commission staff evaluated the intersection of S. 51st Street and W. Drexel Avenue with five of the signal warrants—Warrants 1, 2, 3, 7, and 8. These warrants were evaluated because the intended application for each warrant directly relates to the intersection of S. 51st Street and W. Drexel Avenue. A detailed summary of the analysis is provided in Appendix A of this document.

Based on the warrant analysis conducted by Commission staff, installing a traffic control signal is justified for the intersection of S. 51st Street and W. Drexel Avenue as three of the traffic signal warrants—2, 3, and 8—are satisfied, as shown in Table 4.

Traffic Control Signal Alternatives (Alternatives 2 and 3)

Two traffic control signal alternatives were developed as part of this study. One alternative (Alternative 2) involves providing an exclusive left-turn lane and an exclusive right-turn lane at each approach of the intersection. The other alternative (Alternative 3) involves providing an exclusive left-turn lane and a shared through/right-turn lane at each approach to the intersection.

Traffic Control Signal with Exclusive Left- and Right-Turn Lanes (Alternative 2)

Map 5 shows the planning level design for an intersection with exclusive right- and left-turn lanes (Alternative 2). Providing right- and left-turn lanes at signalized intersections increases safety and intersection efficiency. The potential left-turn lanes as part of these alternatives are aligned to directly oppose each other to improve the efficiency and safety of the intersections by maximizing the visibility for left-turning vehicles to see opposing through vehicles and pick an adequate gap to complete the turn. The through and right-turning traffic would be tapered to the right as it approaches the intersection, providing a buffer behind queued left-turning vehicles. This improves the safety of the intersection as it decreases the likelihood of a through vehicle rear-ending a queued left-turning vehicle. It also improves intersection efficiency as it allows through traffic, as well as right-turning traffic, to continue through the intersection without the delay of decelerating left-turning vehicles.

Traffic Control Signal with Only Exclusive Left-Turn Lanes (Alternative 3)

Map 6 shows the planning level design for a traffic signal alternative with exclusive left-turn lanes and shared through/right-turn lanes (Alternative 3). This alternative was developed to provide a traffic signal alternative that would be expected to have a lower cost and impact to adjacent properties than Alternative 2. While at certain times of the day right-turning traffic can be relatively high compared to through traffic

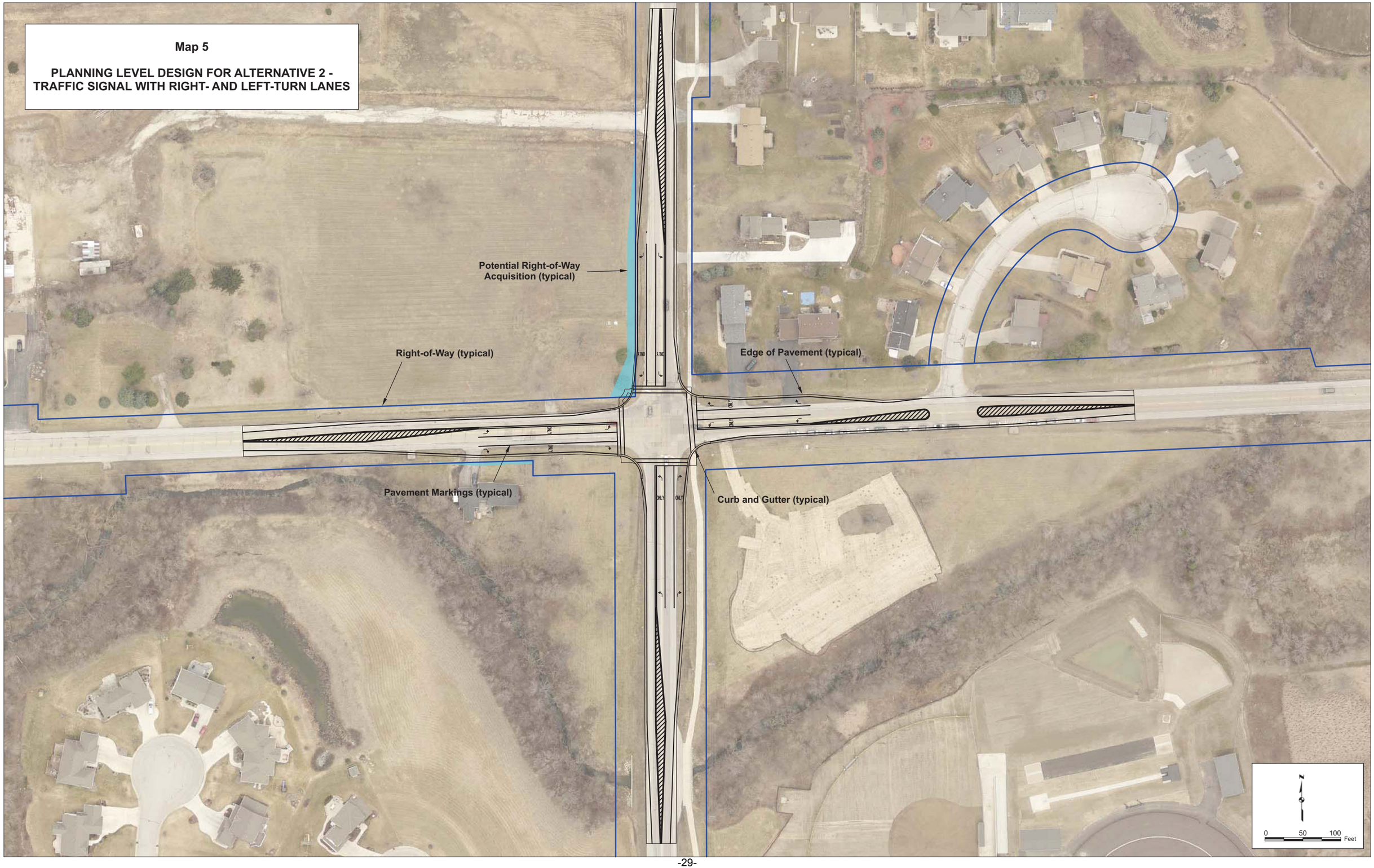
Table 4

TRAFFIC SIGNAL WARRANT ANALYSIS SUMMARY FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

Warrant	Description	Satisfied
Warrant 1	Eight-Hour Vehicular Volume	No
Warrant 2	Four-Hour Vehicular Volume	Yes
Warrant 3	Peak-Hour Vehicular Volume	Yes
Warrant 4	Pedestrian Volume	Not Evaluated
Warrant 5	School Crossing	Not Evaluated
Warrant 6	Coordinated Signal System	Not Evaluated
Warrant 7	Crash Experience	No
Warrant 8	Roadway Network	Yes

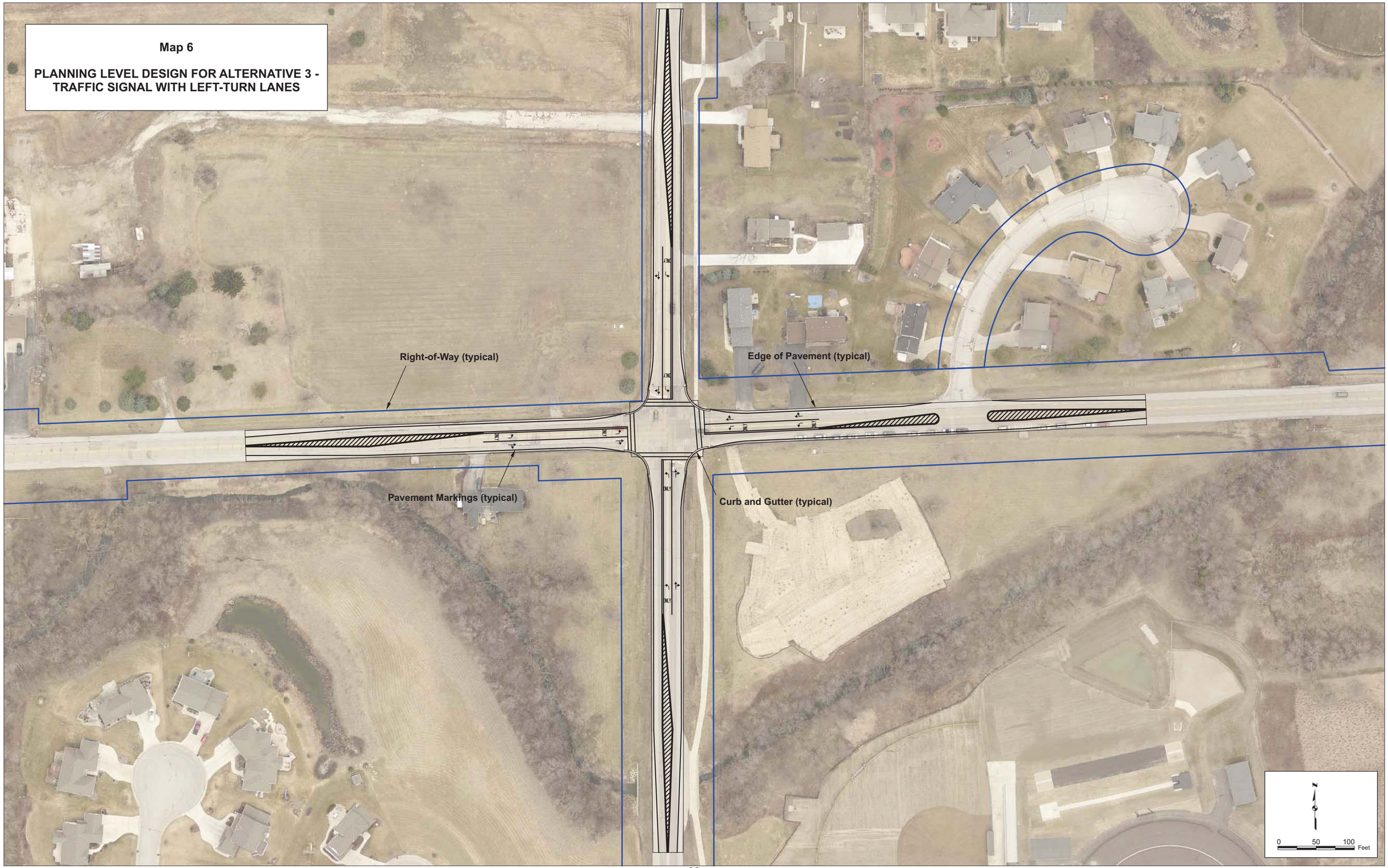
Map 5

PLANNING LEVEL DESIGN FOR ALTERNATIVE 2 - TRAFFIC SIGNAL WITH RIGHT- AND LEFT-TURN LANES



Map 6

PLANNING LEVEL DESIGN FOR ALTERNATIVE 3 - TRAFFIC SIGNAL WITH LEFT-TURN LANES



for certain approaches, the right-turn lane was removed as part of this alternative, rather than removing a left-turn lane, as exclusive left-turn lanes generally provide more safety and traffic flow benefits than providing exclusive right-turn lanes at a signalized intersection. Like Alternative 2, the opposing left-turn lanes on each roadway are aligned to allow visibility of on-coming through traffic.

Traffic Signal Assumptions

For purposes of evaluating the two traffic signal alternatives, a number of planning-level assumptions were made with respect to the operation of the traffic signal, including the signal type (pre-timed, actuated, or adaptive), phasing (whether or not to include a protected left-turning phase), and timing.

Signal Type

The type of signal used (pre-timed[8], actuated[9], or adaptive[10]) is largely dependent on how the intersection operates (isolated or in coordination with other traffic signals) and in some cases the amount of traffic approaching the intersection. Because the closest signalized intersection is one or more miles away, the intersection of S. 51st Street and W. Drexel Avenue can be considered to operate as an isolated intersection. As such, an actuated-type traffic signal was selected for the analysis based on that type of signal typically being used for isolated traffic controlled intersections. Actuated signals use detectors (either embedded in the roadway or mounted over the intersection) to indicate the presence of either a stopped vehicle or vehicle approaching the intersection. The number and location of the detectors (at the stop bar and/or upstream of the intersection) can affect the timing for the traffic signal. With respect to the analysis, it was assumed that there would be a detector both at the stop bar to detect the presence of stopped vehicle during a red-light signal and upstream of the intersection to detect the presence of vehicles approaching the intersection during a green-light signal.

Signal Phasing

The phasing of the traffic signal represents the period of time (including green time and yellow/all red clearance time) that is assigned to the movement of vehicles from specific approaches or lanes (such as a left-turn lane). The number of phases is dependent on the magnitude of the approaching traffic volume and turning movements at an intersection. If the number of phases are more than necessary, vehicles

[8] Pre-timed traffic signals are a type of traffic signal timing approach where the length of green times available each cycle are predetermined and the phase sequence is fixed.

[9] Actuated traffic signals are a type of traffic signal timing approach where the length of green times available each cycle is dependent on the number and frequency of vehicles detected by detectors either embedded in the roadway or mounted over the intersection.

[10] Adaptive traffic signals are a type of traffic signal timing approach where the length of green times and the phase sequence adjusts, or adapts, based on real-time traffic demand.

stopped at the intersection can experience excessive delay. For purposes of evaluating the traffic signal alternatives as part of this study, it was assumed that the traffic signals at the intersection of S. 51st Street and W. Drexel Avenue would have two phases with permissive left turns—one for the northbound/southbound traffic and one for the eastbound/westbound traffic. A protected left-turn phase was considered, but was dismissed because existing and future year 2050 traffic approach and left-turning movement volumes at the intersection would generally not be sufficient for a left-turn phase.[11]

Signal Timing

Table 5 shows the minimum and maximum green time, the yellow and all-red time, and the gap time used for the evaluation of the traffic signal alternatives. The minimum green time of 15 seconds was selected, which is consistent with driver expectations. Because of the potential presence of students at the intersection, pedestrian countdown timers were included in the analysis. The maximum green time countdown commences should a vehicle cross the roadway detector located upstream of the intersection before the minimum green time expires. During the maximum green countdown and beyond the minimum green time, should there be no vehicle that crosses the detector within the set gap time, the signal will change to the clearance interval (yellow and all-red).

Roundabout Alternative (Alternative 4)

Map 7 shows the planning-level design for the roundabout alternative (Alternative 4). It was assumed that a single lane roundabout would be sufficient to handle the current and future forecast year 2050 traffic volumes approaching and turning at the intersection of S. 51st Street and W. Drexel Avenue. The inscribed circle diameter—the diameter of the outer curb of the roadway—of a typical single lane roundabout can range from 120 to 160 feet in size. An inscribed circle diameter of 126 feet was selected for the intersection of S. 51st Street and W. Drexel Avenue as this diameter would be sufficient for larger vehicles, in particular, buses, fire trucks, and semi-trucks. As shown on Map 7, the center of the roundabout was offset about 25 feet west of the current center of the intersection to avoid impacting driveways on W. Drexel Avenue and utility poles on S. 51st Street.

[11] Because a protected left-turn phase may only benefit westbound vehicles on W. Drexel Avenue turning left onto S. 51st Street during only the morning peak period under the future year 2050 average weekday traffic volume conditions, it was determined to first evaluate the two alternative traffic signal alternatives without the protected left-turn phase to determine whether this phase would be needed based how well each alternative performs with respect to intersection delay and vehicle queuing.

Table 5

TRAFFIC SIGNAL TIMING ASSUMPTIONS FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

Phase	Drexel Avenue	51st Street
Minimum Green[1]	15 seconds	15 seconds
Maximum Green[2]	30 seconds	30 seconds
Yellow/Red	4 seconds	4 seconds
Gap Time[3]	2 seconds	2 seconds

[1]The minimum green time is based on driver expectation

[2]The maximum green time countdown commences should a vehicle cross the vehicle loop detector before the minimum green time expires

[3]During the maximum green countdown and beyond the minimum green time, should there be no vehicle that crosses the detector within the set gap time, the signal will change to yellow

Map 7

PLANNING LEVEL DESIGN FOR ALTERNATIVE 4 - ROUNDABOUT

EVALUATION OF ALTERNATIVE INTERSECTION IMPROVEMENTS

The four identified improvements to the intersection of S. 51st Street and W. Drexel Avenue were evaluated based on the criteria shown on Table 6. The evaluation of the four identified intersection improvements with these criteria are also shown on Table 6. As previously noted, preliminary engineering would necessarily be conducted for any operational and attendant geometric improvement to the intersection that may be pursued by the City of Franklin. Such preliminary engineering would necessarily be conducted at a higher level of detail than this study. Only at the conclusion of preliminary engineering would the actual design, costs, and impacts be better understood.

All of the alternative intersection improvements would provide an improvement to delay and vehicle queues over the current intersection configuration. However, the two traffic signal alternatives (Alternatives 2 and 3) and the roundabout alternative (Alternative 4) would provide the greatest reduction in average intersection delay and improvement in level-of-service under both existing and future year 2050 average weekday traffic conditions. In addition, these alternatives would be expected to have an LOS of C or better under both existing and future conditions. Whereas, the all-way stop control alternative (Alternative 1) would be expected to have a LOS of E during the morning peak period under year 2050 traffic conditions. Appendix B includes figures showing the estimated delay and level-of-service for all of the lanes for each of the alternatives under both existing and future year 2050 average weekday traffic conditions.

With respect to vehicle queueing, the traffic signal alternative with both exclusive left-and right-turn lanes (Alternative 2) is estimated to provide the greatest reduction in queuing with the highest vehicle queue length ranging from two to four vehicles during the three peak periods under both existing and future year 2050 average weekday traffic conditions. However, with the exception of the morning peak period under year 2050 traffic conditions, the other three alternatives had highest queue lengths similar to Alternative 2. The queuing is caused by excessive future year 2050 eastbound traffic turning south onto S. 51st Street towards Franklin High School. With respect to the traffic signal alternative with only a left-turn lane (Alternative 3), should such queuing eventually occur on the westbound W. Drexel Avenue approach, it could be alleviated by adding an exclusive right turn lane on the westbound approach to the intersection (which would slightly increase the cost of this alternative). Adding a protected left-turn phase to the traffic signal under this alternative would be expected to alleviate the delay for westbound vehicles turning left onto S. 51st Street, but would potentially increase the delay on all of the approaches, resulting in an increase in the overall delay experienced at the intersection to 28.6 seconds (LOS of C) during the morning peak hour under year 2050 traffic conditions. With respect to the roundabout, should such queuing eventually occur by the year 2050 on the eastbound W. Drexel Avenue approach, it could be

Table 6

EVALUATION OF ALTERNATIVES AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

Alternative	Existing Operating Conditions						Year 2050 Operating Conditions						Highest Queue Length					
	Morning Peak		After School Peak		Evening Peak		Morning Peak		After School Peak		Evening Peak		Morning Peak		After School Peak		Evening Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Existing	Year 2050	Existing	Year 2050	Existing	Year 2050
AWSC – No Improvement	59.4	F	31.3	D	29.9	D	160.1	F	122.2	F	121.0	F	19	38	11	34	8	23
Alternative 1: AWSC – Additional Lanes	19.4	C	14.0	B	14.4	B	49.3	E	21.2	C	22.7	C	4	12	3	6	2	5
Alternative 2: Traffic Signals With Right- and Left- Turn Lanes	8.5	A	8.4	A	8.4	A	9.3	A	8.8	A	8.9	A	2	3	3	3	2	4
Alternative 3: Traffic Signals With Only Left-Turn Lane	10.3	B	9.2	A	9.0	A	18.7	B	10.0	B	10.1	B	5	13	3	4	3	5
Alternative 4: Roundabout	10.8	B	8.1	A	8.1	A	24.5	C	12.1	B	12.3	B	4	14	3	5	2	5

Alternative	Potential Impacts to Adjacent Land			Estimated Planning-Level Cost		
	Potential Right-of-Way Acquisition (acres)	Number of Driveways Affected	Potential Utility Pole Relocation	Planning-Level Construction Cost[a]	Planning-Level Right-of-Way Cost	Planning-Level Total Cost[b]
Alternative 1: AWSC – Additional Lanes	0.02	Four residences affected by two additional lanes	0	$0.92 Million	$0.01 Million	$0.93 Million
Alternative 2: Traffic Signals With Right- and Left- Turn Lanes	0.07	Two residences affected by the added left-turn lane	2	$1.78 Million	$0.02 Million	$1.80 Million
Alternative 3: Traffic Signals With Only Left-Turn Lane	0.00	Two residences affected by the added left-turn lane	0	$1.61 Million	$0.00 Million	$1.61 Million
Alternative 4: Roundabout	0.05	Entering/exiting the driveway of one resident could potentially be affected by the splitter island	0	$0.60 Million	$0.02 Million	$0.62 Million

[a] The estimated planning-level construction costs include reconstructing the segments of S. 51st Street and W. Drexel Avenue affected by each of the alternatives, as shown on the planning-level designs. The construction costs for Alternatives 1, 2, and 3 could be reduced if the current pavement structure for all or portions of the affected roadway is in good enough condition that they could be resurfaced or reconditioned, rather than reconstructed. The estimated construction costs include preliminary and final engineering.

[b] Does not include cost for utility relocation.

Note: With respect to operation and maintenance costs, Alternative 1 (upgrade existing AWSC) would have slightly higher annual operation and maintenance costs than the current intersection due to the additional lanes and pavement markings, but would be expected to have the lowest operation and maintenance costs of the four alternatives.

Alternatives 2 and 3 (provide traffic signals) would be expected to have the highest annual operation and maintenance costs of the alternatives, mostly due to the cost to provide electricity to the traffic signals and to regularly service equipment.

Alternative 4 (provide a roundabout) would be expected to have annual operation and maintenance costs less than those for Alternatives 2 and 3, but more than that for Alternative 1. Operation and maintenance costs for a roundabout typically include the costs to regularly re-stripe pavement markings, to maintain the additional pavement (including the colored pavement of the truck apron), and to maintain any landscaping in the center of the roundabout.

alleviated by adding a yielding bypass lane for the eastbound W. Drexel Avenue traffic turning right onto S. 51st Street which would increase the capacity of the approach by separating the right-turning vehicles from the rest of the approaching traffic. Appendix C includes figures showing the estimated length of queues for all of the lanes for each alternative under both existing and future year 2050 average weekday traffic conditions.

With respect to impacts to adjacent lands, it is estimated that the four alternative intersection improvements would be expected to require little to no additional right-of-way. All four of the alternative intersection improvements would affect the ease of vehicles entering or exiting certain driveways. Under Alternative 1, vehicles entering or exiting four existing driveways would potentially be affected by the two additional lanes. However, the continued use of all-way stop control under this alternative should have sufficient gaps for vehicles to enter or exit driveways and roadways along W. Drexel Avenue and S. 51st Street downstream of the intersection. Under the two traffic signal alternatives (Alternatives 2 and 3), there would be two additional driveways—both on S. 51st Street north of the intersection—that would be located along the functional area of the intersection. Additionally, vehicles entering or exiting the two driveways closest to the intersection on W. Drexel Avenue would potentially be affected by the added left-turn lane under Alternatives 2 and 3. However, the traffic signals under these two alternatives should allow sufficient gaps for vehicles to enter and exist driveways and roadways along W. Drexel Avenue and S. 51st Street downstream of the intersection. With respect to the roundabout alternative (Alternative 4), vehicles entering or exiting the driveway closest to the intersection on W. Drexel Avenue could potentially be affected by being in proximity to a splitter island. Should it be difficult for a vehicle exiting this driveway to travel eastbound on W. Drexel Avenue, the vehicle can exit the driveway and travel west on W. Drexel Avenue and complete a U-turn maneuver through the roundabout to travel east. A vehicle turning left into this driveway from the eastbound lane on W. Drexel Avenue may cause vehicles to stop within the roundabout, which may not be expected by the other vehicles utilizing the roundabout. Further, during peak traffic times of the day, the roundabout under this alternative may not allow sufficient gaps for vehicles to enter or exit driveways and roadways along W. Drexel Avenue and S. 51st Street downstream of the intersection.

With respect to the effect on utility poles, the traffic signal alternative with right- and left-turn lanes (Alternative 2) is estimated to require the relocation of two utility poles—one in the northeast corner of the intersection and the other in the southeast corner of the intersection. The other three alternatives are expected to have no impacts to utility poles, as they either essentially utilize the existing pavement envelope or, in the case of Alternative 4, the center of the roundabout was moved to avoid impacts to the utility poles, along with avoiding impacts to an existing driveway.

The estimated planning-level construction costs include reconstructing the segments of S. 51st Street and W. Drexel Avenue affected by each of the alternatives, as shown on the planning-level designs. Thus, while the roundabout alternative (Alternative 4) has the lowest estimated planning-level construction costs, the estimated planning-level construction costs for the other three alternatives could be reduced if the current pavement structure for all or portions of the affected roadway is in good enough condition that they could be resurfaced or reconditioned, rather than reconstructed.

With respect to operation and maintenance costs, the all-way stop control alternative (Alternative 1) would have slightly higher annual operation and maintenance costs than the current intersection due to the additional lanes and pavement markings, but would be expected to have the lowest operation and maintenance costs of the four alternatives. The two traffic signal alternatives (Alternatives 2 and 3) would be expected to have the highest annual operation and maintenance costs of the alternatives, mostly due to the cost to provide electricity to the traffic signals and to regularly service equipment. The roundabout alternative (Alternative 4) would be expected to have annual operation and maintenance costs less than those for Alternatives 2 and 3, but more than that for Alternative 1. Operation and maintenance costs for a roundabout typically include the costs to regularly re-stripe pavement markings, to maintain the additional pavement (including the colored pavement of the truck apron), and to maintain any landscaping in the center of the roundabout.

While the planning level designs developed for the four alternative improvements to the intersection of S. 51st Street and W. Drexel Avenue did not include sufficient shoulder widths to accommodate parking, the provision of parking along W. Drexel Avenue and S. 51st Street near this intersection would be expected to be addressed during the necessary preliminary engineering for any intersection improvement the City of Franklin decides to pursue. Currently, parking is only permitted during school hours along the north side of W. Drexel Avenue west of S. 51st Street and the south side of W. Drexel Avenue east of S. 51st Street. It is expected that implementation of the traffic control types—all-way stop, traffic signal, or roundabout—included in the alternatives would not necessarily preclude parking at these locations. However, the shoulder shown on the planning-level designs for Alternatives 1, 2, and 3 would need to be widened to continue permitting parking at these two locations on W. Drexel Avenue. Additionally, more restrictive parking restrictions—such as prohibiting parking during all times of the day or during times of heavier traffic on weekdays—should be considered along the shared and turn lanes on the intersection approaches to minimize the “workload’ for drivers approaching the intersection and reduce additional opportunities for collisions.

With respect to safety, it would be expected that crashes caused by the excessive delay and vehicle queuing experienced at the intersection of S. 51st Street and W. Drexel Avenue during periods of heavy

traffic would potentially be reduced (particularly the angle crashes) with implementation of any of the alternatives. However, while such crashes could be reduced, depending on the type of traffic control pursued by the City of Franklin for the intersection, certain crashes that occur at the intersection may not be significantly reduced (such as rear-end crashes) and other types of crashes may occur that are not currently experienced at the intersection. For example, the addition of lanes as part of Alternative 1 and the implementation of a roundabout under Alternative 4 could result in the occurrence of side-swipe crashes. As well, the implementation of traffic signals under Alternatives 2 and 3 could result in the occurrence of left-turning crashes.[12] However, estimating the potential effect (positive and negative) on crashes by these alternatives would require a detailed safety assessment that was not conducted as part of this study.

PUBLIC PARTICIPATION

A public comment period and information meeting could be held to allow the public to review and provide comment on the inventory data collected (adjacent land uses and features, physical characteristics of the intersection, traffic volumes, intersection operating conditions, and vehicle crashes), alternative operational and geometric intersection improvements, and the results of the evaluation of the alternatives. The meeting could be held at Franklin High School in an open house format with boards presenting information on the inventory, alternatives, and the evaluation results. In addition, large display aerial maps of the identified alternative geometric and operational improvements could be laid out on tables allowing the public attending the meeting to identify issues and make suggestions. The public will also be able to provide written comments related to the alternatives and the results of their evaluation. Any comments received during the public information meeting and public comment period could be reviewed by City officials to determine whether changes should be made to the evaluation and alternatives considered, and to assist in determining what potential operational and geometric intersection improvements to take into preliminary engineering study and for potential implementation.

* * *

KJM/CTH/RWH/JWD
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[12] Should the City of Franklin choose to install traffic signals at the intersection and excessive amounts of left-turning crashes occurs (3 or more of such crashes on an approach), a protected left-turn phase could be added. However, this would lengthen the delay experienced by all of the approaches and increase the overall intersection delay.

Appendix A

Traffic Signal Warrant Analysis Summary

Prior to developing a traffic control signal alternative for improving the operation of the intersection of S. 51st Street and W. Drexel Avenue, a traffic control signal warrant analysis was conducted to determine if installing a traffic control signal is justified under current and future traffic conditions. The eight traffic signal warrants considered (as shown in Table A-1) are consistent with the Wisconsin Department of Transportation's *Traffic Signal Design Manual* and the U.S. Department of Transportation's *Manual on Uniform Traffic Control Devices*. Of the eight warrants used to justify the installation of a traffic control signal, the Commission staff evaluated five—Warrants 1, 2, 3, 7, and 8. These warrants were evaluated because the intended application for each warrant directly relates to, or addresses the issues experienced at, the intersection of S. 51st Street and W. Drexel Avenue. Specifically, Warrants 1, 2, and 3 determine whether the traffic volume observed at the intersection exceeds specified thresholds which have been established for specific timeframes. Warrant 7 determines whether a traffic control signal is needed based on the severity and frequency of crashes experienced at the intersection. This warrant focuses on those types of crashes which would likely be reduced with the installation of a traffic control signal. Warrant 8 determines whether a traffic control signal is needed based on its ability to concentrate and organize the traffic flow on a roadway network and whether the five-year projected traffic volumes would satisfy either Warrants 1, 2, or 3.

The remaining three warrants—4, 5, and 6—were not evaluated as the Commission staff determined that the warrants did not apply or address the issues experienced at the intersection of S. 51st Street and W. Drexel Avenue. Warrant 4 is intended for locations where traffic volume on a major street is so heavy that pedestrians experience excessive delay crossing the street. Although pedestrians (and bicyclists) utilize the pathway along S. 51st Street, the total number of pedestrians crossing the intersection is relatively low and they do not experience excessive delay that would warrant a traffic signal. Similarly, Warrant 5 is intended for locations where there is a high number of school children crossing the street. In the same respect to Warrant 4, the total number of school children crossing the intersection is low because the intersection is not adjacent to, or does not directly serve, a school. Warrant 6 is intended for locations where installing a traffic signal is necessary to maintain proper platooning of vehicles. This warrant was not evaluated since the intersection of S. 51st Street and W. Drexel Avenue is an isolated intersection, one mile or more away from the nearest traffic signal controlled intersection.

For purposes of the warrant analysis, S. 51st Street was considered the major roadway and W. Drexel Avenue was considered the minor roadway, based on S. 51st Street carrying a higher level of traffic.

Table A-1

TRAFFIC SIGNAL WARRANT ANALYSIS SUMMARY FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

Warrant	Description	Satisfied
Warrant 1	Eight-Hour Vehicular Volume	No
Warrant 2	Four-Hour Vehicular Volume	Yes
Warrant 3	Peak-Hour Vehicular Volume	Yes
Warrant 4	Pedestrian Volume	Not Evaluated
Warrant 5	School Crossing	Not Evaluated
Warrant 6	Coordinated Signal System	Not Evaluated
Warrant 7	Crash Experience	No
Warrant 8	Roadway Network	Yes

Additionally, consideration must be given for the volume-based warrants as to what proportion of right-turning vehicles should be included in the traffic volumes of the minor roadway. Right-turning vehicles from the minor roadway are less likely to receive benefit from a signalized intersection, as such vehicles typically experience less delay than through and left-turning movements. Thus, right-turning vehicles from minor roadways with an exclusive left-turn lane having adequate storage, such as on W. Drexel Avenue, should be excluded from the traffic volumes applied to the traffic-volume based warrants. Therefore, the right-turning vehicles on W. Drexel Avenue were not included in the minor street traffic volume in the traffic signal warrant evaluation.

Of the five warrants evaluated, three of the warrants were satisfied—2, 3, and 8.[13] The following summarizes the evaluation conducted for each warrant:

Warrant 1 – Eight-Hour Vehicular Volume

Warrant 1 is used to determine whether traffic signals are warranted based on excessive traffic volume approaching the intersecting or if traffic on a major roadway is so heavy as to delay or conflict with crossing traffic for at least eight hours of a day. Warrant 1 is satisfied if one of the following three conditions are met over any eight hours on an average weekday:

A) The major street volume in both directions is greater than or equal to 500 vehicles per hour and the minor street volume in one direction is greater than or equal to 150 vehicles per hour[14]
B) The major street volume in both directions is greater than or equal to 750 vehicles per hour and the minor street volume in one direction is greater than or equal to 75 vehicles per hour
C) The major street volume and the minor street volume is greater than or equal to 80 percent of the volumes given in Condition A and the major street volume and the minor street volume are greater than or equal 80 percent of the volumes given in Condition B[15]

As shown in Table A-2, Condition A was satisfied for six out of the required eight hours and Condition B was not satisfied for any of the required eight hours. With respect to Condition C, only one of the two

[13] Assuming W. Drexel Avenue as the major roadway and S. 51st Street as the minor roadway, two of the signal warrants would be satisfied—Warrants 2 and 8. Because there is no marked right-turn lane, all of the right-turning vehicles on S. 51st Street were included in the signal analysis.

[14] The major street and minor street volumes must be for the same 8 hours.

[15] Condition C may be used after an adequate trial of other alternatives fails to solve traffic problems. The 8 hours satisfied in Condition A are not required to be the same 8 hours in Condition B.

Table A-2

WARRANT 1: EIGHT-HOUR VEHICULAR VOLUME AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE IN THE CITY OF FRANKLIN

Hour	Major Street VPH (Both Directions)	Minor Street VPH (One Direction)[a]	Condition A	Condition B	Condition C	
					80 Percent of Condition A	80 Percent of Condition B
6:00 AM to 7:00 AM	352	161				
7:00 AM to 8:00 AM	589	254	•		•	
8:00 AM to 9:00 AM	377	187				
9:00 AM to 10:00 AM	262	155				
10:00 AM to 11:00 AM	272	121				
11:00 AM to 12:00 PM	344	130				
12:00 PM to 1:00 PM	465	140			•	
1:00 PM to 2:00 PM	432	149			•	
2:00 PM to 3:00 PM	645	180	•		•	•
3:00 PM to 4:00 PM	695	252	•		•	•
4:00 PM to 5:00 PM	691	321	•		•	•
5:00 PM to 6:00 PM	655	278	•		•	•
6:00 PM to 7:00 PM	535	188	•		•	
7:00 PM to 8:00 PM	324	119				
8:00 PM to 9:00 PM	302	83				
9:00 PM to 10:00 PM	194	52				
10:00 PM to 11:00 PM	64	34				
11:00 PM to 12:00 AM	60	19				
Condition Total			6	0	8	4
Condition Satisfied			No	No	No	

[a] Right turns were not included on the Minor Street due to the presence of a right turn lane at the Eastbound and Westbound approaches.

NOTE: Condition A is satisfied when the major street volume in both directions is greater than or equal to 500 vehicles per hour and the minor street volume in one direction is greater than or equal to 150 vehicles per hour. Condition B is satisfied when the major street volume in both directions is greater than or equal to 750 vehicles per hour and the minor street volume in one direction is greater than or equal to 75 vehicles per hour. Condition C is satisfied when the major street volume and the minor street volume is greater than or equal 80 percent of the volumes given in Condition A and the major street volume and the minor street volume is greater than or equal 80 percent of the volumes given in Condition B.

required conditions was met. Therefore, the traffic volumes measured for the intersection of S. 51st Street and W. Drexel Avenue do not satisfy Warrant 1.

Warrant 2 – Four-Hour Vehicular Volume

Warrant 2 is intended for intersections with a large volume of intersecting traffic on at least four hours of a day. Warrant 2 is satisfied if any four hours of an average weekday fall above the applicable curve shown in Figure A-1. A total of 4 hours—7:00 a.m. to 8:00 a.m. and the three hours between 3:00 p.m. and 6:00 p.m.—fall above the threshold curve for an intersection with one-lane approaches. Therefore, Warrant 2 is satisfied for the intersection of S. 51st Street and W. Drexel Avenue.

Warrant 3 – Peak Hour

Warrant 3 is intended to determine whether the minor street of an intersection experiences excessive delays over at least one hour of a day. This warrant is generally applied only at intersections near land uses that can attract or discharge large number of vehicles over a short period of time, as is the case with Franklin High School. Warrant 3 is satisfied if either of the following conditions are met:

A. In the same hour (four consecutive 15 minute periods), the traffic on one minor-street approach experiences greater than or equal to 4 hours of total stopped time delay, the traffic on the same minor-street approach experiences traffic volume greater than or equal to 100 vehicles per hour, and the total intersection volume over the same hour is 800 vehicles per hour
B. Any hour (four consecutive 15 minute periods) of an average weekday falls above the applicable curve, as shown on Figure A-2

Only Condition B was analyzed due to the ease of determining whether this condition is satisfied. As shown in Figure A-2, Condition B was satisfied as the evening peak hour falls slightly above the applicable curve. Therefore, Warrant 3 is satisfied for the intersection of S. 51st Street and W. Drexel Avenue.[16]

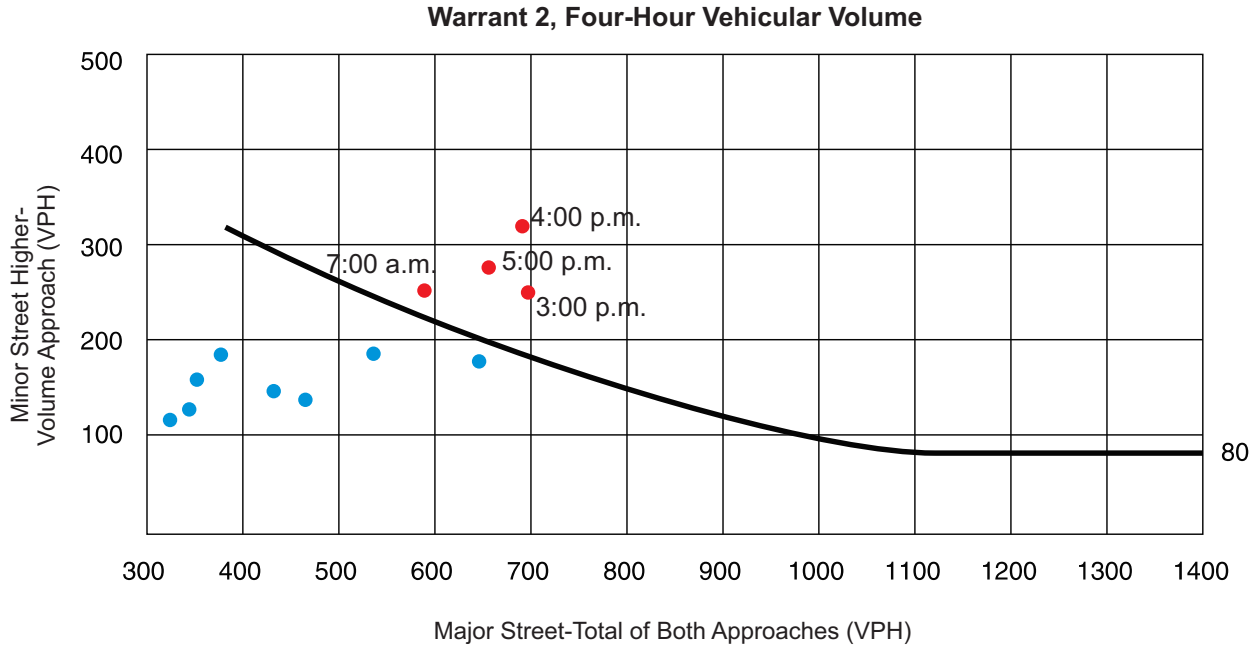
Warrant 7 – Crash Experience

Warrant 7 determines the need for a traffic control signal based on the severity and frequency of crashes experienced at the intersection. This warrant focuses on those types of crashes which would likely be

[16] Meeting Warrant 3 alone is not justification for the installation of a traffic signal. At least one additional warrant must also be met.

Figure A-1

TRAFFIC SIGNAL WARRANT 2 FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE

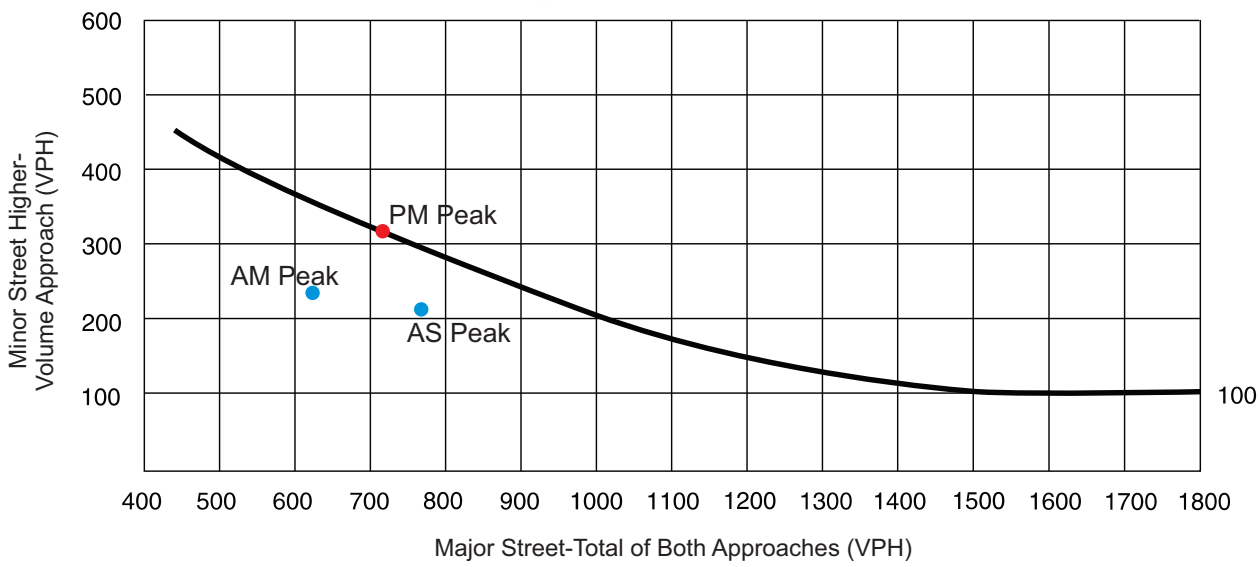


- Satisfies Condition for Warrant
- Does Not Satisfy Condition for Warrant

Source: 2009 MUTCD and SEWRPC

Figure A-2

TRAFFIC SIGNAL WARRANT 3 FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE



- Satisfies Condition for Warrant
- Does Not Satisfy Condition for Warrant

Source: 2009 MUTCD and SEWRPC

reduced with the installation of a traffic control signal. Warrant 7 is satisfied if all of the following conditions are met:

A. An adequate trial of alternatives has failed to reduce the crash frequency
B. Five or more reported crashes susceptible to correction by a traffic control signal have occurred within a 12 month period
C. For any 8 hours of an average day, the major street volume in both directions is greater than or equal to 400 vehicles per hour and the minor street volume in one direction is greater than or equal to 120 vehicles per hour, the major street volume in both directions is greater than or equal to 600 vehicles per hour and the minor street volume in one direction is greater than or equal to 60 vehicles per hour;[17] or for any 4 hours of an average day the volume of pedestrian traffic crossing the major street at an intersection or midblock location is greater than or equal to 80; or for any one hour during the average day the volume of pedestrian traffic is greater than or equal to 152.

With respect to Condition B, installing a traffic control signal may reduce the number of right-angle and left-turning related crashes. Over the five-year period of 2011 through 2015, the twelve month period of January 1, 2013 through December 31, 2013 had a total of four angle- or turning-related crashes, less than the required five of such crashes need to satisfy Condition B. As such, Warrant 7 is not satisfied.

Warrant 8 – Roadway Network

Warrant 8 determines the need for a traffic control signal to facilitate traffic flow on a network of major roadways. Warrant 8 is satisfied if the intersection is of two major routes[18] and if either of the following conditions are met:

A. The intersection has a total existing or projected volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes that meet either Warrant 1, 2, or 3
B. The intersection has a total existing or projected volume of at least 1,000 vehicles per hour for any 5 hours of a non-normal business day (Saturday or Sunday).

[17] The vehicles per hour thresholds for this condition is the same as Condition C under Warrant 1

[18] A major route is defined by the *2009 MUTCD* as a segment that is part of the street or highway system that serves as the principal roadway network for through traffic flow; includes rural or suburban highways outside, entering, or traversing a city; or appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

plan. The existing peak hour of a typical weekday—between 4:30 p.m. and 5:30 p.m.—exceeds the required 1,000 vehicles per hour stated under Condition A. Year 2021 traffic volumes for S. 51st Street and W. Drexel Avenue are shown on Table A-3. While the hourly volumes in 2021 do not satisfy Warrant 1, as shown in Table A-3, these volumes do satisfy Warrants 2 and 3, as shown in Figure A-3, thus satisfying Condition A of Warrant 8. Under the existing and forecasted conditions, the intersection of S. 51st Street and W. Drexel Avenue satisfies the first condition for Warrant 8.

Table A-3

WARRANT 8: EIGHT-HOUR YEAR 2021 VEHICULAR VOLUME AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE IN THE CITY OF FRANKLIN

Hour	Major Street VPH (Both Directions)	Minor Street VPH (One Direction)[a]	Condition A	Condition B	Condition C	
					80 Percent of Condition A	80 Percent of Condition B
6:00 AM to 7:00 AM	363	172				
7:00 AM to 8:00 AM	611	271	•		•	•
8:00 AM to 9:00 AM	390	199				
9:00 AM to 10:00 AM	271	165				
10:00 AM to 11:00 AM	280	129				
11:00 AM to 12:00 PM	354	140				
12:00 PM to 1:00 PM	479	149			•	
1:00 PM to 2:00 PM	445	160			•	
2:00 PM to 3:00 PM	667	193	•		•	•
3:00 PM to 4:00 PM	718	271	•		•	•
4:00 PM to 5:00 PM	713	345	•		•	•
5:00 PM to 6:00 PM	675	298	•		•	•
6:00 PM to 7:00 PM	552	202	•		•	
7:00 PM to 8:00 PM	334	127				
8:00 PM to 9:00 PM	313	88				
9:00 PM to 10:00 PM	200	56				
10:00 PM to 11:00 PM	66	36				
11:00 PM to 12:00 AM	62	20				
Condition Total			6	0	8	5
Condition Satisfied			No	No	No	

[a] Right turns were not included on the Minor Street due to the presence of a right turn lane at the Eastbound and Westbound approaches.

NOTE: Condition A is satisfied when the major street volume in both directions is greater than or equal to 500 vehicles per hour and the minor street volume in one direction is greater than or equal to 150 vehicles per hour. Condition B is satisfied when the major street volume in both directions is greater than or equal to 750 vehicles per hour and the minor street volume in one direction is greater than or equal to 75 vehicles per hour. Condition C is satisfied when the major street volume and the minor street volume is greater than or equal 80 percent of the volumes given in Condition A and the major street volume and the minor street volume is greater than or equal 80 percent of the volumes given in Condition B.

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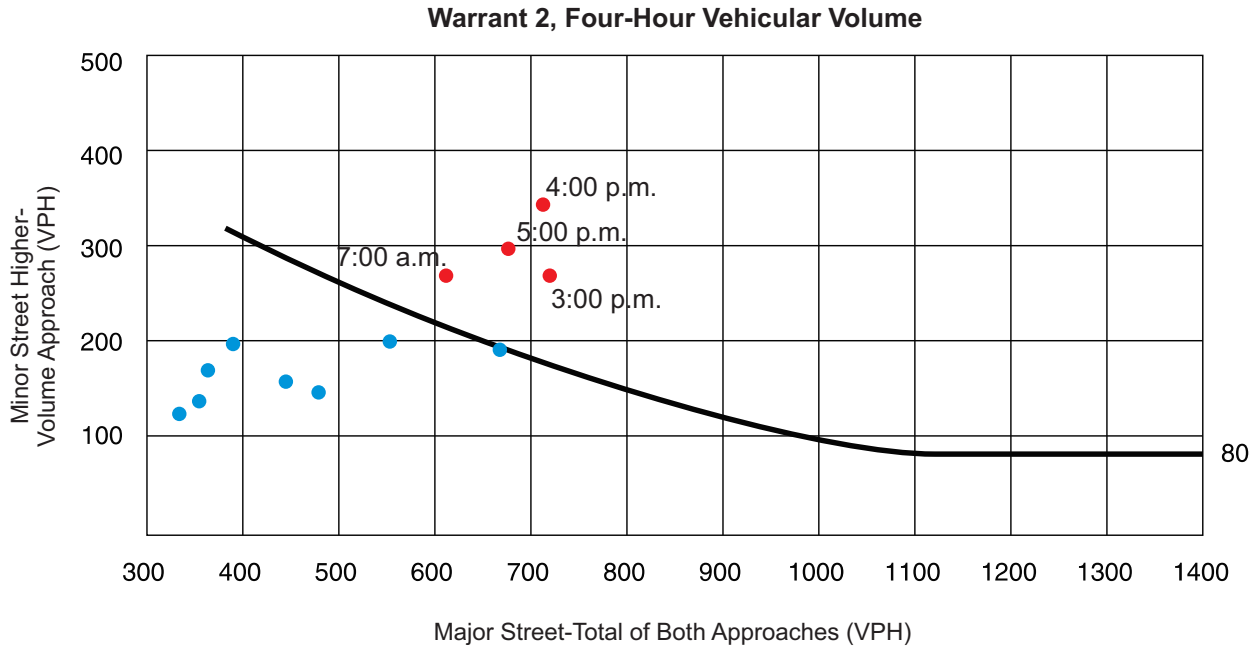
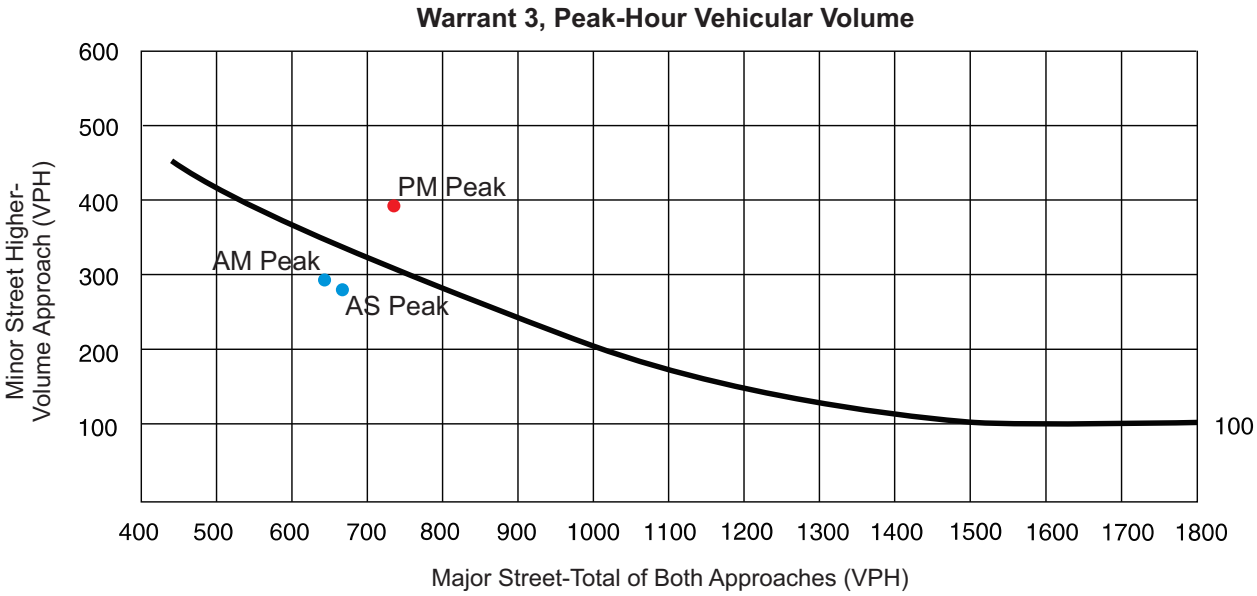
Figure A-3

CONDITION A OF TRAFFIC SIGNAL WARRANT 8 FOR THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE





- Satisfies Condition for Warrant
- Does Not Satisfy Condition for Warrant

Source: 2009 MUTCD and SEWRPC

Appendix B

Figures Showing Delay and Level-of-Service for Each Alternative Intersection Improvement Per Peak Hour Under Existing and Forecast Year 2050 Traffic Conditions

Figure B-1

DELAY AND LEVEL-OF-SERVICE AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: ALTERNATIVE 1 - AWSC WITH ADDITIONAL LANES

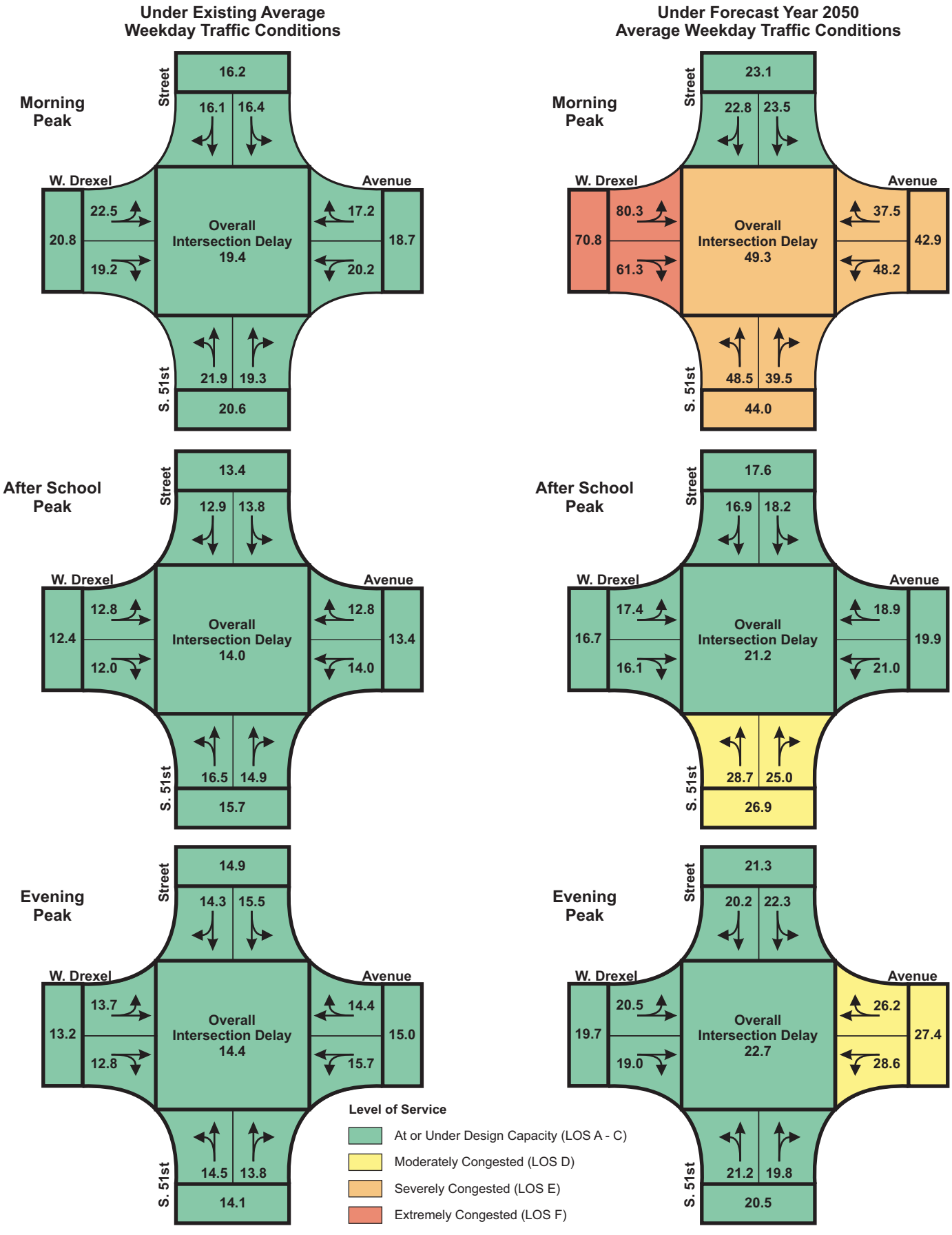


Figure B-2

DELAY AND LEVEL-OF-SERVICE AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: ALTERNATIVE 2 - TRAFFIC SIGNAL WITH RIGHT- AND LEFT-TURN LANES

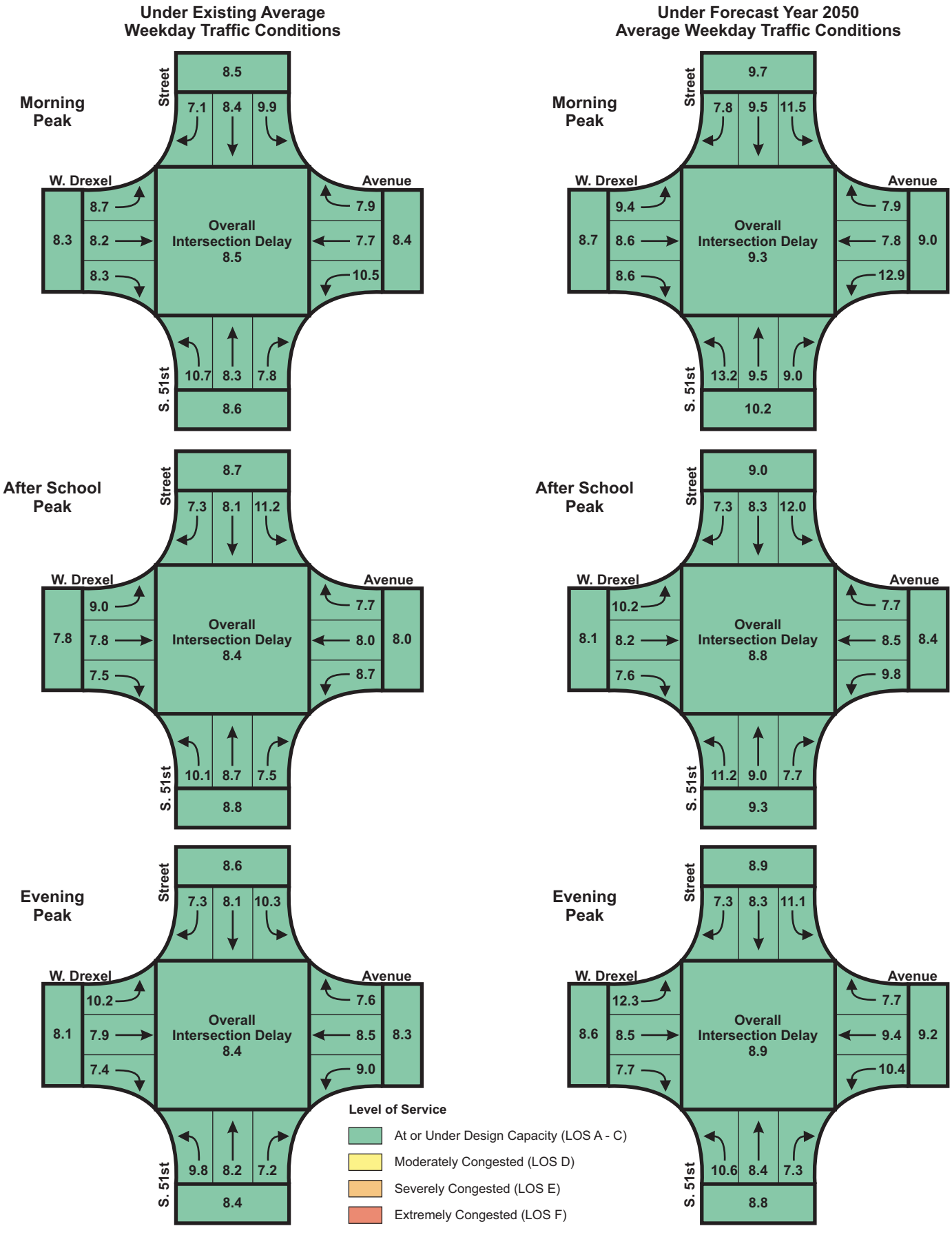
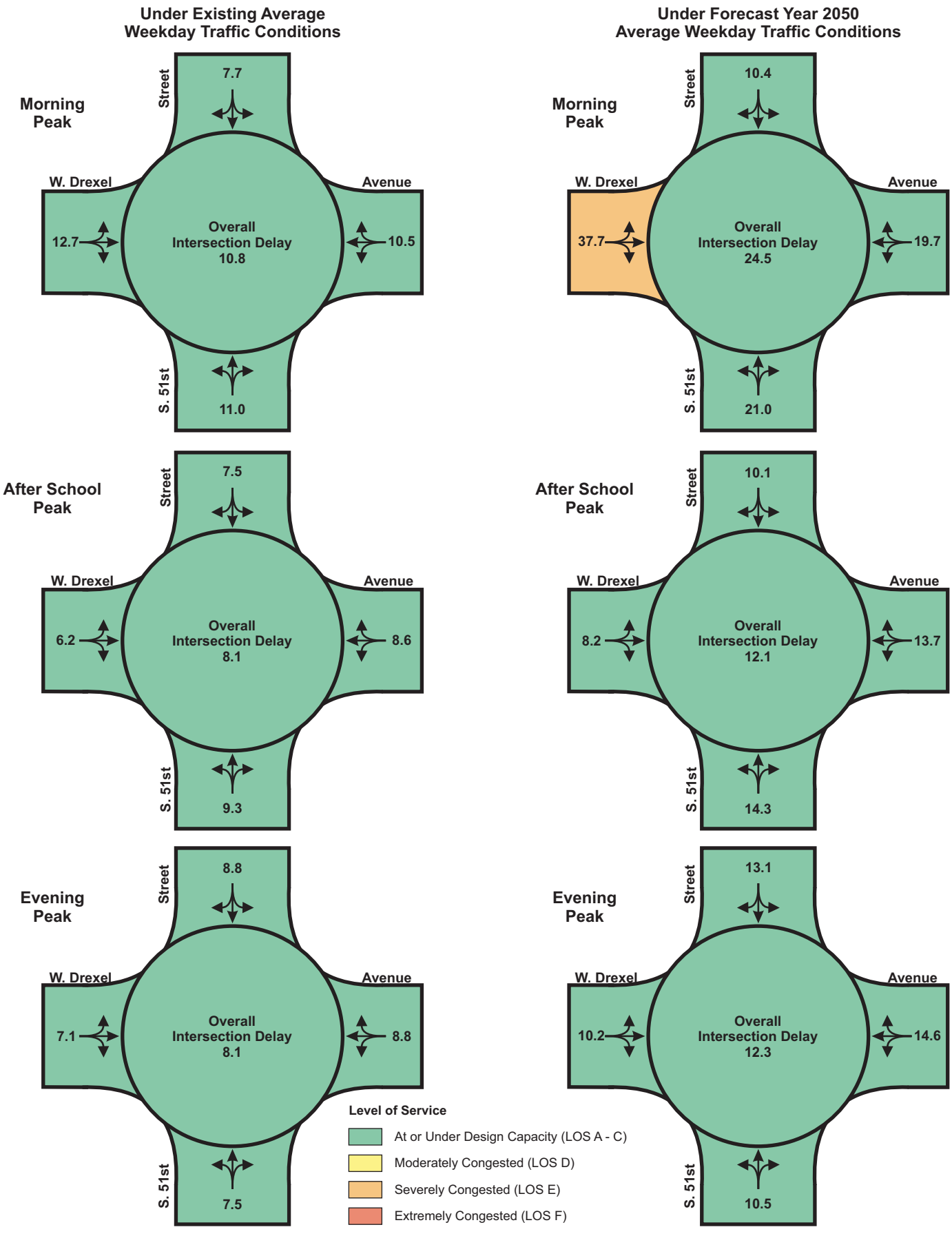


Figure B-3

DELAY AND LEVEL-OF-SERVICE AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: ALTERNATIVE 3 - TRAFFIC SIGNAL WITH LEFT-TURN LANES

Figure B-4

DELAY AND LEVEL-OF-SERVICE AT THE INTERSECTION OF S. 51ST STREET AND W. DREXEL AVENUE: ALTERNATIVE 4 - ROUNDABOUT



Appendix C

Tables Showing Number of Queued Vehicles for Each Alternative Intersection Improvement Per Peak Hour Under Existing and Forecast Year 2050 Traffic Conditions

Table C-1

LENGTH OF QUEUED VEHICLES UNDER EXISTING AND FORECAST YEAR 2050 CONDITIONS FOR ALTERNATIVE 1: AWSC WITH ADDITIONAL LANES

	Morning Peak		After School Peak		Evening Peak	
Approach	Existing	Year 2050	Existing	Year 2050	Existing	Year 2050
Northbound						
Thru/Left-turn Lane……	4	8	3	6	2	3
Thru/Right-Turn Lane….....	3	7	2	5	2	3
Southbound						
Thru/Left-turn Lane……	2	3	2	2	2	3
Thru/Right-Turn Lane….....	2	3	1	2	2	3
Eastbound						
Thru/Left-turn Lane……	4	12	1	2	1	3
Thru/Right-Turn Lane….....	3	11	1	2	1	3
Westbound						
Thru/Left-turn Lane……	3	8	2	3	2	5
Thru/Right-Turn Lane….....	3	7	1	3	2	5

Table C-2

LENGTH OF QUEUED VEHICLES UNDER EXISTING AND FORECAST YEAR 2050 CONDITIONS FOR ALTERNATIVE 2: TRAFFIC SIGNAL WITH RIGHT- AND LEFT-TURN LANES

	Morning Peak		After School Peak		Evening Peak	
Approach	Existing	Year 2050	Existing	Year 2050	Existing	Year 2050
Northbound						
Left-turn Lane……..….	1	2	1	1	1	1
Thru Lane……	2	2	2	3	2	2
Right-Turn Lane……....	1	2	1	1	0	0
Southbound						
Left-turn Lane……..….	0	0	1	1	1	1
Thru Lane……	2	3	2	2	2	2
Right-Turn Lane……....	0	0	0	0	0	0
Eastbound						
Left-turn Lane……..….	0	0	0	0	0	0
Thru Lane……	2	3	1	2	1	2
Right-Turn Lane……....	2	3	0	1	1	1
Westbound						
Left-turn Lane……..….	1	2	0	1	0	1
Thru Lane……	1	2	1	2	2	4
Right-Turn Lane……....	1	2	1	1	1	1

Table C-3

LENGTH OF QUEUED VEHICLES UNDER EXISTING AND FORECAST YEAR 2050 CONDITIONS FOR ALTERNATIVE 3: TRAFFIC SIGNAL WITH LEFT-TURN LANES

	Morning Peak		After School Peak		Evening Peak	
Approach	**Existing**	**Year 2050**	**Existing**	**Year 2050**	**Existing**	**Year 2050**
Northbound						
Left-turn Lane…….	1	3	1	2	1	1
Thru/Right-Turn Lane….....	4	9	3	4	2	3
Southbound						
Left-turn Lane…….	0	1	1	1	1	1
Thru/Right-Turn Lane….....	3	5	2	2	2	3
Eastbound						
Left-turn Lane…….	0	1	0	0	0	0
Thru/Right-Turn Lane….....	4	13	2	3	2	3
Westbound						
Left-turn Lane…….	1	4	0	1	0	1
Thru/Right-Turn Lane….....	3	7	2	4	3	5

Table C-4

LENGTH OF QUEUED VEHICLES UNDER EXISTING AND FORECAST YEAR 2050 CONDITIONS FOR ALTERNATIVE 4: ROUNDABOUT

	Morning Peak		After School Peak		Evening Peak	
Approach	**Existing**	**Year 2050**	**Existing**	**Year 2050**	**Existing**	**Year 2050**
Northbound						
Approach…….	3	8	3	5	2	3
Southbound						
Approach…….	2	2	2	2	2	4
Eastbound						
Approach…….	4	14	1	2	1	3
Westbound						
Approach…….	3	7	2	4	2	5