Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Draft Report

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Prepared for:

Wooten Engineering

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EXECUTIVE SUMMARY

The following contains a Traffic Impact Study and Neighborhood Impact Assessment (NIA) for a Charter High School in Albuquerque, NM. Lee Engineering has completed this report for Wooten Engineering. All analyses and items contained herein conform to scoping requirements set forth in a scoping meeting held on July 26th, 2022.

Background

The proposed development would repurpose an existing building for a Charter High School on Jefferson St NE, between Osuna Rd and Jefferson Plaza. Study intersections include Osuna Rd and Jefferson St, Jefferson Rd and Presidential Dr North, Jefferson St and Site Entrance, Jefferson St and Site Exit/Presidential Dr South, and Jefferson St and Jefferson Plaza.

The site is anticipated to generate 111 ingress and 68 egress trips during the AM peak hour. It is expected to generate 38 ingress and 60 egress trips during the PM peak hour. The number of vehicle trips generated by the proposed development was based on the trip generation rates and equations provided in the Trip Generation Manual, 10th Edition, by the Institute of Transportation Engineers (ITE) 534– Private High School.

Proposed site access will be available from Jefferson St via one entrance-only driveway and one exit-only driveway, termed "Site Entrance" and "Site Exit," for the purposes of this report. Site Entrance is an existing right-in/right-out access driveway into the development site. Site Exit will be a new right and left-out only access point to be positioned south of Site Entrance, aligned with the Presidential Dr Sothon Jefferson St.

Study intersections include:

1. Osuna Rd & Jefferson St
2. Jefferson St & Site Entrance
3. Jefferson St & Presidential Dr N
4. Jefferson St & Site Exit/Presidential Dr S
5. Jefferson St & Jefferson Plaza

Construction is anticipated to begin in 2022, with full completion of the development in 2023. The development is to be constructed in a single phase.

Analysis scenarios for this study include:

- Existing (2022) – Field counted Existing traffic volumes
- Build-Out Year (2023) Background – Existing traffic volumes with an applied annual growth rate.
- Build-Out Year (2023) Total – Build-Out Year Background volumes plus Charter High School site-generated trips.
- Horizon Year (2033) Background – Existing traffic volumes with an applied annual growth rate.
- Horizon Year (2033) Total – Horizon Year Background volumes plus the Charter High School generated trips.

Existing turning movement counts were collected on August 16th, 2022, for the study intersections specified during the scoping meeting. Lee Engineering identified the additional intersection of Presidential Dr North and Jefferson St for inclusion within the study, and counts at this intersection were collected on August 31st 2022. These volumes were analyzed in the Existing portion of the Capacity Analysis section.

SUMMARY OF RECOMMENDATIONS

The following presents a summary of recommendations included in this report.

CONCLUSIONS

- All study intersections operate at an acceptable overall LOS throughout all study scenarios except the intersection of Osuna Rd and Jefferson St during the AM peak hour under the Horizon Year Total scenario.
- 95^{th} % Queue Lengths only exceed existing queue storage at the intersection of Osuna Rd and Jefferson St. This intersection experiences movements with 95^{th} percentile queue lengths exceeding existing queue storage lengths under all unoptimized scenarios.
- Proposed Drop-Off/Pick-Up Queue Storage may not accommodate 95^{th} percentile vehicle queues as designed. However, the planned presence of traffic direction personnel and the abundance of overflow parking are likely sufficient to mitigate this issue.

DEVELOPMENT SPECIFIC RECOMMENDATIONS

- It is recommended that all development driveways adhere to the sight distance provisions detailed in the AASHTO "Green Book".
- Signage, Drop-Off/Pick-Up plan, and staff traffic coordinators shall notify drivers to turn off engines while not in motion to mitigate noise and air pollution.
- When the student loading zone approaches capacity, drivers shall be instructed to bypass the loading queue and park for Drop-Off and Pick-Up.

ANCILLARY RECOMMENDATIONS

- HCS results suggest the need for future evaluation of capacity and queuing mitigation measures or street improvements unrelated to the proposed development at the intersection of Osuna Rd and Jefferson St.
    - Potential mitigations include an additional southbould left turn lane and accompanying signal re-timing.
- Illegal left turns were observed from the right-out-only westbound approach on Presidential Dr North. There is existing no-left-turn signage, which could be reinforced with the southward extension of the median nose.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

LIST OF APPENDICES

INTRODUCTION

This report details the procedures and findings of a Traffic Impact Study (TIS) and Neighborhood Impact Assessment (NIA) performed by Lee Engineering for Wooten Engineering. This report and the analyses herein were performed for a Charter High School to be constructed on Jefferson St NE in Albuquerque, NM. This study examines the impacts of the proposed development on surrounding traffic conditions and discusses the potential impacts of trips generated by the development on the study intersections.

The scope of this report and the analyses performed were completed in agreement with the scoping requirements set forth by the NMDOT. Scoping meeting notes from the scoping meeting held on July 26th, 2022, are included in Appendix A. Analysis procedures, conclusions, and recommendations for this study were developed according to the *Highway Capacity Manual 6th Edition* and the *Manual on Uniform Traffic Control Devices 2009 Edition*.

Single-phase construction is anticipated to begin in 2022, with full completion of the development in 2023. The proposed development site plan displayed in Figure 1 shows that the proposed development is a charter high school. Traffic generated by the site is anticipated to be 111 ingress and 68 egress trips during the AM peak hour and 38 ingress and 60 egress trips during the PM peak hour. Lee Engineering conducted an HCS Capacity Analysis for the following AM and PM peak hour scenarios:

Traffic Analysis

- Existing (2022) – Field counted Existing traffic volumes
- Build-Out Year (2023) Background – Existing traffic volumes with an applied annual growth rate.
- Build-Out Year (2023) Total – Build-Out Year Background volumes plus Charter High School site-generated trips.
- Horizon Year (2033) Background – Existing traffic volumes with an applied annual growth rate.
- Horizon Year (2033) Total – Horizon Year Background volumes plus the Charter High School generated trips.

The HCS Capacity Analysis Reports are presented in full in the Appendix.

PROJECT LOCATION & SITE PLAN

The Charter High School will be located on Jefferson St NE, south of Osuna Rd NE, in the northeast quadrant of Albuquerque. **Figure 1** shows the proposed site plan, and **Figure 2** shows the site location, study intersections, and the surrounding area. Nearby intersections include Osuna Rd & Jefferson St, Jefferson St & Site Entrance, Jefferson St & Site Exit/Presidential Dr NE, and Jefferson St & Jefferson Plaza.

The proposed development would develop a 2.16-acre tract of land with an existing 30,000 sq ft building into a charter high school. The development would include 178 parking spaces and would provide a student loading zone with queue storage for approximately 33 vehicles. Proposed access points include an existing driveway that would be used for entrance-only access and a newly constructed, exit-only driveway south of the entrance, aligned with Presidential Dr on Jefferson St.

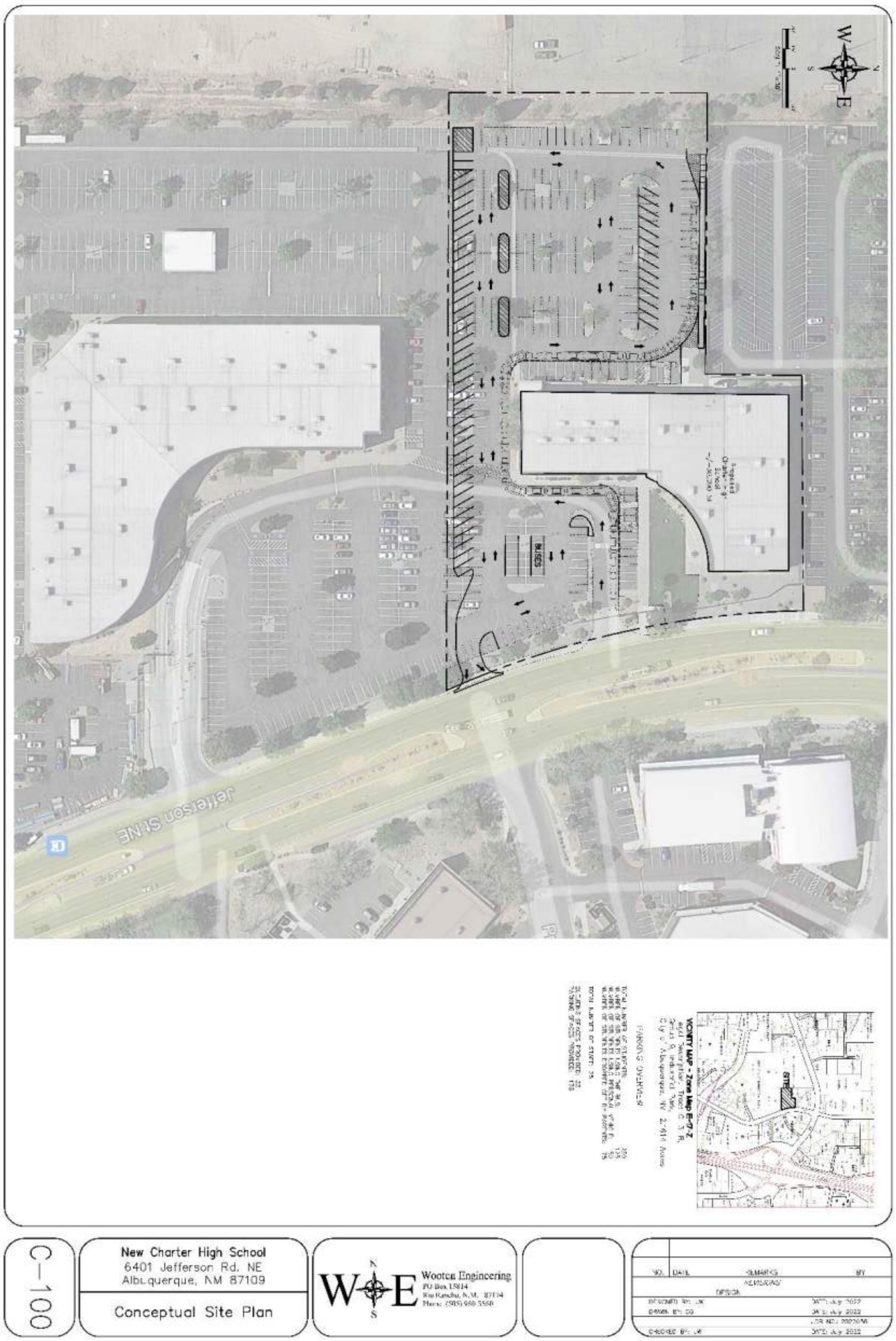

Figure 1: Site Plan

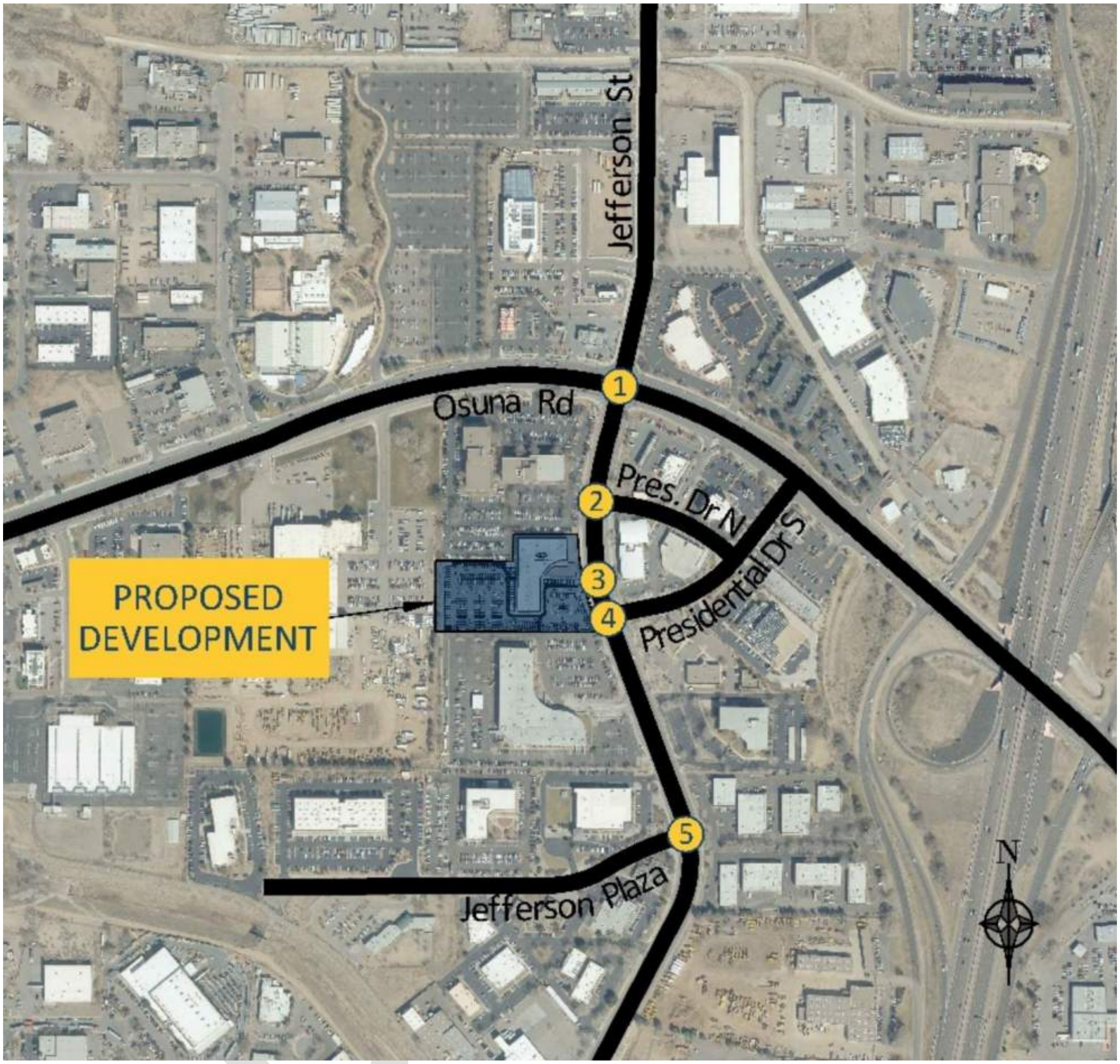

Figure 2: Vicinity Map

STUDY AREA, AREA LAND USE, AND STREETS NARRATIVE SUMMARY

Study Area

The study area is Jefferson St from Osuna Rd to Jefferson Plaza. The following five intersections fall within the study area scope as defined during the scoping meeting held on July 26th. 2022. Intersection 2: Jefferson St and Presidential Dr North was not explicitly identified during the scoping meeting. However, Lee Engineering determined that because site generated traffic traveling northbound on Jefferson St would need to make a U-turn at this intersection. Therefor, to comprehensively assess capacity and queuing conditions along the study corridor, this intersection was included as a study intersection.

1. Osuna Rd & Jefferson St
2. Jefferson St & Presidential Dr North
3. Jefferson St & Site Entrance
4. Jefferson St & Site Exit/Presidential Dr South
5. Jefferson St & Jefferson Plaza

AREA LAND USE

The development will be located on the west side of Jefferson St, approximately 750 feet south of Osuna Rd. Land uses adjacent to and surrounding consist of the following:

- Commercial: Existing commercial developments immediately surrounding the development site, including restaurants, banks, call centers, and employment agencies.
- Residential: There are no residential zones immediately adjacent to the development site. Single-family residential developments are located approximately 0.65 miles east of the site and one mile northwest of the development site. Townhouses and multifamily residential developments are also located within a mile radius of the development site to the east and west. Manufactured home communities are located about 0.75 miles northeast of the development.
- Undeveloped: There are no undeveloped lots near the development site.

STREETS

The following details the characteristics and features of streets included in the study area:

Osuna Rd is a 6-lane City of Albuquerque (COA) maintained roadway classified as a principal arterial, running east/west in Albuquerque, NM. The posted speed limit is 45 MPH. Travel lanes are 11 feet wide, and the roadway is divided by a 35-foot-wide raised median. The median narrows to accommodate eastbound and westbound left turn lanes at Jefferson St. There is continuous sidewalk in both directions. A 6-foot bike lane with a 2.5-foot buffer is present on both sides of the roadway.

Jefferson St is a 4-lane COA maintained roadway classified as a minor arterial, running north/south in Albuquerque, NM. The posted speed limit is 35 MPH. Travel lanes are 12 feet wide, and the roadway is divided by a 23-foot raised median. The median narrows to accommodate left turn lanes throughout the study area. There is a 5-foot bike lane in north and southbound directions. Continuous curb, gutter, and sidewalk is present on both sides of the roadway.

Presidential Dr N is a 30-foot-wide roadway that provides access to commercial developments between Jefferson St and Osuna Rd. The roadway has no striping and continuous curb and sidewalk on either side of the roadway. There is no posted speed limit sign, and no bicycle facilities are present.

Presidential Dr S is a 35-foot-wide roadway that provides access to commercial developments between Jefferson St and Osuna Rd. The roadway has no striping and continuous curb, gutter, and sidewalk on either side of the roadway. There is no posted speed limit sign, and no bicycle facilities are present.

Jefferson Plaza is a road providing access to commercial developments on the west side of Jefferson St, with no outlet. The roadway is 35 feet wide with no striping. There is continuous curb, gutter, and sidewalk in the westbound direction. There is no posted speed limit sign, and no bicycle facilities are present.

INTERSECTIONS

The following details the traffic control and characteristics of existing intersections in the study area:

Osuna Rd & Jefferson St is a 4-legged, signalized intersection of a principal arterial and a minor arterial. The eastbound leg consists of two left turn lanes and three through lanes, with right turns permitted. The westbound leg consists of two left turn lanes, three through lanes, and a right turn lane. The northbound leg consists of a left turn lane, two through lanes, and a right turn lane. The southbound leg consists of a left turn lane and two through lanes, with right turns permitted. Painted crosswalks and pedestrian pushbuttons are present at each leg of the intersection. Intersection signal communications consist of 25 pair single mode fiber optic cable. The eastbound and westbound left-turn movements are protected. The northbound and southbound left-turn movements are protected-permissive.

Presidential Dr North and Jefferson St is a three-leg stop controlled intersection of a minor arterial (Jefferson St) with a commercial access road (Presidential Dr N) designated as a local street on the westbound approach. A commercial driveway exists across from Presidential Dr North on the west side of Jefferson St. The driveway is full access with one entry lane and two exit lanes. The northern leg consists of a through/right lane, a through lane, and a left-turn auxiliary lane. The southern leg has two through lanes and dedicated left and right auxiliary lanes. The eastern leg is configured as a right-in/right-out only access. Five-foot-wide striped bicycle lanes are present north/south and no bicycle facilities are present on the minor approaches. Curb, gutter, and sidewalks are present where applicable for all approaches. No pedestrian crossing facilities are present.

Site Entrance and Jefferson St is not truly an intersection as no roadway will converge with Jefferson St at this location. The northbound leg consists of two through lanes and the southbound leg consists of a though/right and a though lane. There is also a southbound left-turn lane for the downstream Presidential Dr South and Jefferson intersection. Five-foot-wide striped bicycle lanes are present north/south. Curb, gutter, and sidewalks are present north/south along Jefferson St. Curb ramps are present for both Site Entrance pedestrian approaches. There are no pedestrian street crossing facilities.

Presidential Dr South and Jefferson St is presently a three-leg intersection of a minor arterial and a commercial access road designated as a local street with stop control on the minor approach. The northbound leg consists of two through lanes and a right-turn auxiliary lane. The southbound leg consists of two through lanes and a dedicated left-turn lane. The westbound leg is a two-lane undivided street. A median opening on Jefferson St provides sufficient space for two-stage left turns from the westbound approach. Five-foot-wide striped bicycle lanes are present north/south, and no bicycle facilities are present on the minor approaches. Curb, gutter, and sidewalks are present on all approaches. No pedestrian crossing facilities are present.

Jefferson St and Jefferson Plaza is a three-legged, stop-controlled intersection of a minor arterial and a commercial access road classified as a local street. The northbound leg consists of a left turn lane and two through lanes. The southbound leg consists of a left turn lane providing access to the business driveway across from Jefferson Plaza, two through lanes, and a right turn lane. The eastbound leg consists of one lane with left and right turns permitted. A median opening on Jefferson St provides sufficient space for two-stage left turns from the westbound approach. Five-foot-wide striped bicycle lanes are present north/south and no bicycle facilities are present on the minor approaches. Curb, gutter, and sidewalks are present on all approaches. No pedestrian crossing facilities are present.

DATA COLLECTION

The following section details the data collection method used in subsequent analyses of this report. The data discussed below was collected via a combination of field observations and machine/video recordings.

Study Area Data Collection

ON-STREET PARKING

On-street parking facilities were assessed via satellite imagery and confirmed by a field visit. No dedicated on-street space is provided in the study area.

PEDESTRIANS AND BICYCLES

Pedestrian and bicycle volumes were collected at all study intersections with turning movement counts (see Turning Movement Counts section below). Pedestrian and bicycle hourly volumes were used in the HCS capacity analyses and are provided in Appendix B. An existing 5-foot-wide bike lane runs adjacent to the proposed development in the northbound, and southbound directions on Jefferson St. on Osuna Rd. An existing 6-foot-wide bike lane with a 2.5-foot buffer is present in both directions.

TRANSIT

Based on the ABQRIDE System Map (February 2022), regular route 251 and commuter route 551 serve the study area on Jefferson St. There is one bus stop on each side of Jefferson St, approximately 600 feet south of the proposed development entrance.

SIGNAL TIMINGS

The City of Albuquerque Traffic Department provided signal timing for the signalized intersection of Osuna Rd and Jefferson St. Signal timing sheets used in the capacity analyses are provided in Appendix C.

Turning Movement Counts

Turning movement counts for the initially scoped study intersections were collected for the periods of 6:00 to 9:00 AM, 11:00 to 2:00 PM, and 2:00 to 6:00 PM, on August 16th, 2022. Turning movement counts for the intersection of Jefferson St and Presidential Dr North were collected on August 31st, 2022. Turning movement volumes collected at the study intersections show a typical commuter directionally biased distribution with observable AM and PM peak hour periods. Network peak hours were determined by summating the Turning Movement Counts from all study intersections to determine the network AM and PM peak hours. Peak hour counts are shown in **Figure 3,** and complete turning movement counts can be found in Appendix B.

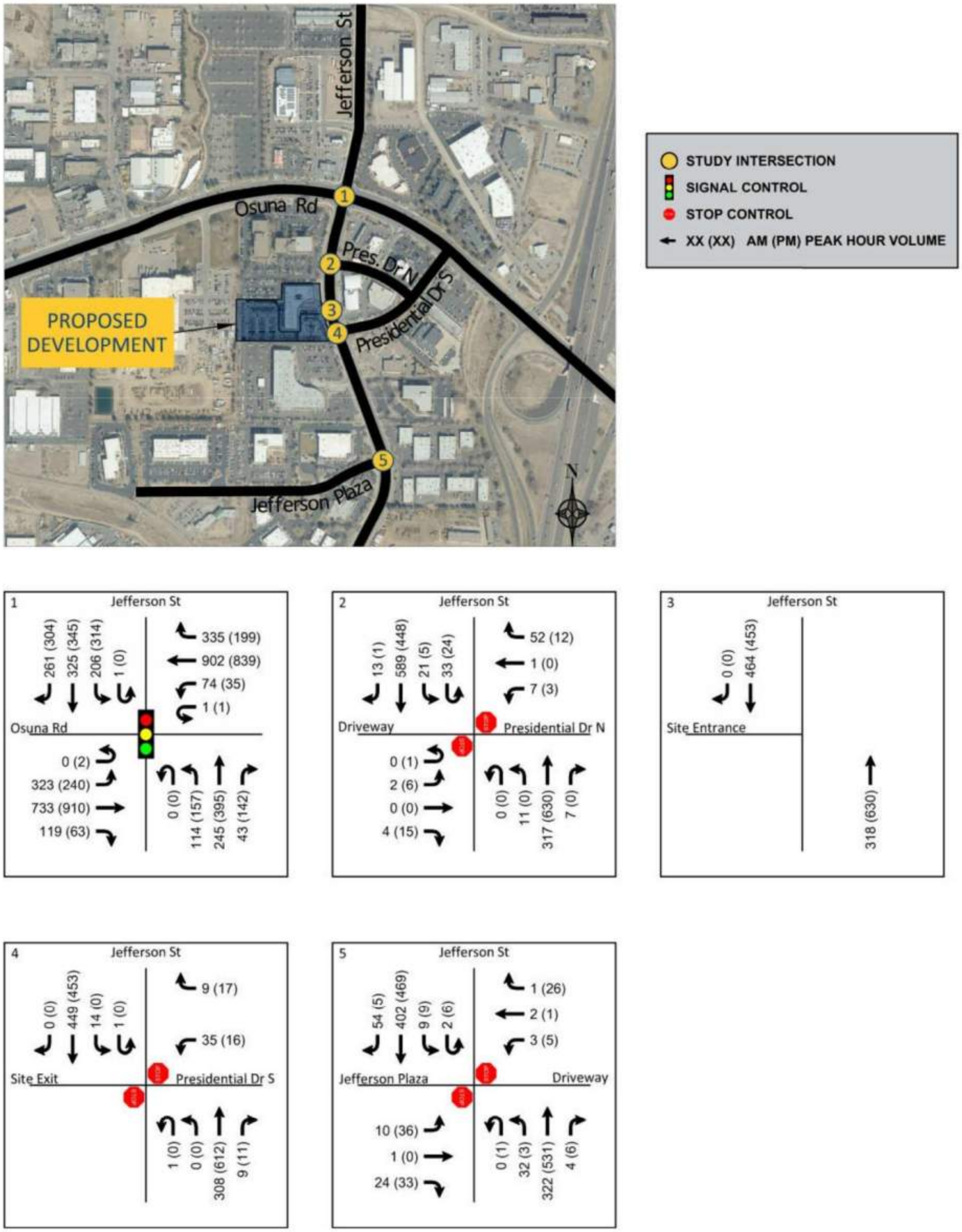

Figure 3: Existing AM (PM) Peak Hour Turning Movement Counts

CAPACITY ANALYSIS: LEVEL OF SERVICE AND QUEUING

Analysis Scenarios and Volume Calculations

EXISTING YEAR

For the Existing Year traffic volumes, video collected turning movement counts (TMCs) were used. AM and PM peak hours were analyzed for service level, capacity, and queueing.

BUILD-OUT YEAR (2023) BACKGROUND

Existing TMCs were used with an applied annual growth rate of 2% compounded annually for the Build-Out Year Background volumes. The growth rate was developed from the MRCOG Metropolitan Transportation Plan (MTP) CUBE/2 Regional Model.

BUILD-OUT YEAR (2023) TOTAL

Site trips generated using the Institute of Transportation Engineers (ITE) Trip Generation Manual, 11th Edition, were added to the Build-Out Year Background volumes for analysis.

HORIZON YEAR (2033) BACKGROUND

Existing TMCs were used with an applied annual growth rate of 2% compounded annually for the Horizon Year Background volumes. This growth rate was developed from the MRCOG Metropolitan Transportation Plan (MTP) CUBE/2 Regional Model.

HORIZON YEAR (2033) TOTAL

Site trips generated using the Institute of Transportation Engineers (ITE) Trip Generation Manual, 11th Edition, were added to the Horizon Year Background volumes for analysis.

Level of Service and 95TH Percentile Queues

Highway Capacity Software (HCS) was used to analyze the study intersections for Level of Service (LOS) and 95th percentile queueing conditions. HCS implements methods and procedures detailed by the Highway Capacity Manual (HCM). Per the HCM, LOS is presented as a letter grade (A through F) based on the calculated average delay for an intersection or movement. Delay is calculated as a function of several variables, including signal phasing operations, cycle length, traffic volumes, and opposing traffic volumes, and is a measurement of the average wait time a driver can expect when moving through an intersection. Factors such as total cycle time (for all movements), queueing restrictions, and vehicle volumes can affect measurements of delay, especially for lower volume movements and side streets. Generally, these factors are only realized when delays reach or exceed LOS E thresholds.

As stipulated in the City of Albuquerque Development Process Manual and the ABC Comprehensive Plan for this analysis, acceptable levels of service (LOS) are defined as a LOS D or better. Intersection delay and level of service for stop-controlled intersections are reported as the delay and level of service for the worst-case movement at each intersection. Detailed HCS output sheets can be found in Appendix D. **Table 1** and **Table 2** below, reproduced from the Highway Capacity Manual, show delay thresholds and the associated Level of Service assigned to delay ranges.

Table 1: LOS Criteria and Descriptions for Signalized Intersections

Level of Service	Average Control Delay (sec/vehicle)	General Description (Signalized Intersections)
A	≤10	Free flow
B	>10 – 20	Stable flow (slight delays)
C	>20 – 35	Stable flow (acceptable delays)
D	>35 – 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 – 80	Unstable flow (intolerable delay)
F	>80	Forced flow (jammed)

Table 2:LOS Criteria and Descriptions for Unsignalized Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F	>50

Queue length is reported in feet for the 95th percentile queue, with a base assumption of 25 feet of queue length per vehicle. It should be noted that 95th percentile queues are statistically expected to occur during only 5% of the peak hour's signal cycles. The 95th percentile queue is a useful measure because it gives a picture of the maximum queue length likely to be present. The average queueing at an intersection would statistically be much shorter than the 95th percentile queue.

NOTE: Capacity and queuing conditions were analyzed for all study intersections and scenarios except at the Site Entrance and Jefferson St intersection. The site entrance intersection was not included in the HCS analysis because no roadway converges with Jefferson St at this location. Additionally, Site Access would be a right-in-only entrance driveway, which would not create any conflict points that could generate delay by HCM methodology. In this situation, HCS cannot determine a LOS or predict a 95th percentile queue length.

EXISTING YEAR (2022) ANALYSES

Table 3 summarizes the intersection capacity and LOS analysis performed for existing conditions at the study intersections. Values within Table 3, shown in red, represent a result that falls below the acceptable threshold. Per HCM6 procedures, intersection peak hour factors for the system peak hour are derived from the collected traffic counts and are used in the Existing conditions analysis and all other scenarios. The current signal timings for Osuna Rd and Jefferson St were provided by the City of Albuquerque and were used in each analysis scenario unless otherwise stated.

Table 3: HCS Result Summary for Existing (2022) Conditions

Study Intersection	Movement	Auxiliary Lane Length (ft)	AM 95th Percentile Queue (ft)	AM Delay (sec)	AM V/C	AM LOS	PM 95th Percentile Queue (ft)	PM Delay (sec)	PM V/C	PM LOS	Intersection LOS AM Delay (sec)	Intersection LOS AM LOS	Intersection LOS PM Delay (sec)	Intersection LOS PM LOS
Osuna Rd & Jefferson St	EBL[1]	200	228.6	53.8	0.88	D	172.9	54.5	0.85	D	**30.7**	**C**	**32.7**	**C**
	EBT	---	157.9	13.5	0.35	B	189.1	14.9	0.40	B				
	EBR	---	151.6	13.8	0.35	B	189.8	15.2	0.40	B				
	WBL[1]	170	52.6	53.8	0.41	D	25.0	55.0	0.25	D				
	WBT	---	331.3	23.1	0.67	C	290.3	21.6	0.60	C				
	WBR	325	161.4	18.9	0.37	B	66.4	16.3	0.16	B				
	NBL	175	132.4	37.1	0.59	D	179.4	35.8	0.65	D				
	NBT	---	156.6	40.3	0.34	D	239.6	42.4	0.53	D				
	NBR	130	41.5	37.2	0.11	D	96.8	38.5	0.24	D				
	SBL	195	227.9	33.8	0.58	C	238.9	63.9	0.90	E				
	SBT	---	388.8	45.9	0.74	D	367.4	43.4	0.70	D				
	SBR	---	353.0	52.2	0.82	D	334.5	47.1	0.77	D				
Presidential Dr North & Jefferson St	EBT/L	---	0.0	19.3	0.01	C	0.1	16.4	0.02	C	**13.5**	**B**	**12.1**	**B**
	EBR	---	0.0	10.7	0.01	B	0.1	9.9	0.02	A				
	WBT/L/R	---	0.3	10.8	0.10	B	0.1	12.1	0.03	B				
	NBL	100	0.0	9.1	0.01	A	0.0	8.4	0.00	A				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	150	---	---	---	---	---	---	---	---				
	SBL	80	0.2	9.5	0.06	A	0.2	12.0	0.06	B				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	---	---	---	---	---	---	---	---	---				
Presidential Dr South /Site Exit & Jefferson St	EBR	---	---	---	---	---	---	---	---	---	**14.0**	**B**	**12.7**	**B**
	WBT/L/R	---	0.3	12.7	0.10	B	0.3	14.0	0.08	B				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	160	---	---	---	---	---	---	---	---				
	SBL	135	0.0	8.1	0.01	A	0.0	9.7	0.01	A				
	SBT	---	---	---	---	---	---	---	---	---				
Jefferson Plaza /Business Park Driveway & Jefferson St	EBT/L/R	---	0.2	11.5	0.06	B	0.5	13.8	0.15	B	**13.3**	**B**	**13.8**	**B**
	WBT/L/R	---	0.0	13.3	0.01	B	0.2	11.5	0.06	B				
	NBL	225	0.1	8.5	0.03	A	0.0	8.9	0.00	A				
	NBT/R	---	---	---	---	---	---	---	---	---				
	SBL	80	0.0	8.3	0.01	A	0.1	9.6	0.02	A				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	120	---	---	---	---	---	---	---	---				

**Intersection LOS and delay for stop-controlled intersection, results are reported as the worst case movement*

[1]Double auxiliary lanes of the listed length

From the above table, the following conclusions are made from the Existing Year analysis:

- For the intersection of Osuna Rd and Jefferson St
    - Capacity Analysis: The intersection operates at an overall LOS C during both the AM and PM peak hours
        - Individual approaches operate at LOS D or better, except for the southbound left-turn movement, which operates at LOS E during the PM peak hour.
    - Queueing Analysis

        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths except in the following cases:
            - Southbound left-turn lane during AM peak hour
            - North and southbound left-turn lanes during the PM peak hour
- For the intersection of Presidential Dr North and Jefferson St
    - Capacity Analysis: The intersection operates at a LOS of B during both the AM and PM peak hours at all approaches.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
- For the intersection of Presidential Dr South/Site Exit and Jefferson St
    - Capacity Analysis: The intersection operates at a LOS of B during both the AM and PM peak hours at all approaches.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
- For the intersection of Jefferson Plaza and Jefferson St
    - Capacity Analysis: The intersection operates at a LOS of B during both the AM and PM peak hours at all approaches.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.

FUTURE YEAR BACKGROUND AND TOTAL METHODOLOGY

The following sections detail the methods and calculations used to obtain traffic volumes for Build-Out and Horizon Year analysis scenarios. This process used the following tools as described below: Future Traffic Projections, Site Trip Generation, and Site Trip Distribution & Assignment. The Figure at the end of this section shows the resulting site-generated traffic volume routing volumes and percentages determined for Build-Out and Horizon Year Total analysis scenarios.

TRAFFIC PROJECTIONS

Development construction is anticipated to begin in the current year (2022), with full completion expected in 2023. Build-Out Year (2023) volumes were forecast from existing traffic volumes using counted values from 2016 and 2040 (updated) travel demand models provided by MRCOG. These models were then compared using AM and PM peak hour direction volumes (AMPH LOAD and PMPH LOAD) to calculate anticipated growth rates for individual roadways near the study area. Roadways calculated to have a yearly growth rate of less than 1% were analyzed with a 1% per year growth rate to facilitate a conservative analysis. Values provided by MRCOG are reproduced verbatim in

Table 4, in addition to the calculated growth rate used in the analysis. Growth rates were then applied to the 2022 existing volumes to forecast future volumes.

Table 4: Growth Rates

Roadway			MRCOG 2016 Model "Peak Hour Load"	MRCOG 2040 Model "Peak Hour Load"	Yearly Growth Rate	Average Area Yearly Growth	Growth Rate for Analysis
Jefferson St North of Osuna Rd	Northbound	AM PH	791	997	0.97%	1.38%	2.00%
		PM PH	789	878	0.45%		
	Southbound	AM PH	355	553	1.86%		
		PM PH	746	901	0.79%		
Jefferson St South of Osuna Rd	Northbound	AM PH	96	287	4.67%		
		PM PH	394	776	2.86%		
	Southbound	AM PH	222	509	3.52%		
		PM PH	176	339	2.77%		
Osuna Rd West of Jefferson St	Eastbound	AM PH	690	1096	1.95%		
		PM PH	1015	1295	1.02%		
	Westbound	AM PH	1084	1180	0.35%		
		PM PH	937	1159	0.89%		
Osuna Rd East of Jefferson St	Eastbound	AM PH	509	870	2.26%		
		PM PH	1314	1820	1.37%		
	Westbound	AM PH	1465	1619	0.42%		
		PM PH	1061	1223	0.59%		
Jefferson St South of Presidential Dr North	Northbound	AM PH	60	259	6.28%		
		PM PH	341	694	3.01%		
	Southbound	AM PH	210	488	3.58%		
		PM PH	188	363	2.78%		

Projected turning movement volumes based on a two percent compound annual growth rate were used for the Build-Out (2023) and Horizon (2033) Year Background scenarios. Projected turning movement volumes plus the site-generated trips were used for the Build-Out and Horizon Year Total scenarios.

SITE TRIP GENERATION

Trip generation for the development was performed using the procedures and methodologies provided in the Institute of Transportation Engineers (ITE) Trip Generation Manual, 11th Edition. The land use category Private High School (ITE 534) was used to generate trips for the development. Trips were calculated using rates for AM and PM peak hour generators. Trips generated by the proposed development are shown below in the tables. The ITE Site-generated trips were added to the background traffic volumes for the system peak hour, as stipulated during the scoping meeting, to create the Build-Out and Horizon Year traffic volumes. Please note the addition of site peak hour volumes to system peak hour traffic volumes is very conservative because the site peak hour generated volumes will occur approximately an hour before the system peak hours. **Table 5** shows the trip generation and associated calculations.

Table 5: ITE Trip Generation and Egress/Ingress Proportions

Use	Units		TRIP GENERATION							PEAK HOUR TRIPS			
			Weekday	AM Peak			PM Peak			AM Peak		PM Peak	
			Trips	Total	Enter	Exit	Total	Enter	Exit	In	Out	In	Out
ITE 534 - Private High School	125	Students (Minus Bus Students)	N/A	179	62%	38%	98	39%	61%	111	68	38	60

Site-Generated Trip Distribution and Assignment

The proposed site-generated traffic distribution was assigned based on direct trip travel behavior alone based on the ITE Trip Generation Manual's available data for the Private High School (534) designation. Direct trip distribution was determined based on the analysis of existing intersection demand characteristics displayed by the turning movement count data within the study area and by engineering judgment of commuter travel patterns through and around the study area.

The routing was based on logical trip attractions and destinations for residential-based trips. **Figure 4** shows the assigned routing percentages and distribution of trips forecasted to be generated by the development. When the applied distribution percentages did not result in whole vehicles or did not summate equal to the total generated trips, rounding preference was assigned to the movement with the highest existing turning movement count volumes.

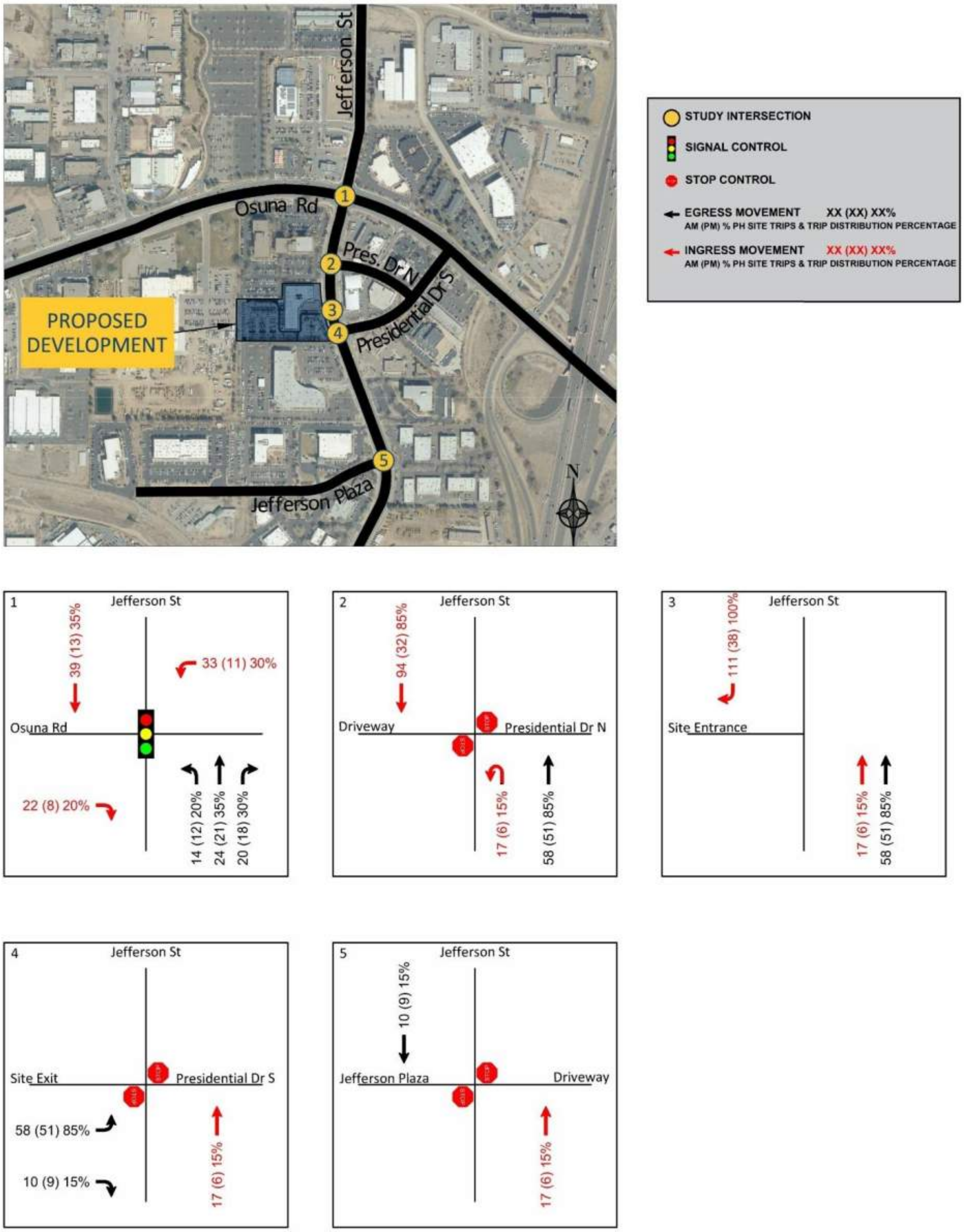

Figure 4: Site Trips & Trip Distribution Percentage

BUILD-OUT YEAR BACKGROUND AND TOTAL ANALYSES

As performed for Existing Background conditions, a Level of Service (LOS) and queueing analysis was performed for all Build-Out Year analysis scenarios using the same procedures, field data, and assumptions.

Build-Out Year (2023) Background Conditions

As discussed in the previous Analysis Scenarios and Volume Calculations subsection the Build-Out Year Background traffic volumes are determined from the application of a 2% growth rate to the Existing traffic movement count data to analyze probable roadway conditions in the Build-Out Year in the absence of the proposed development. The turning movement volumes used for this analysis scenario are shown in **Figure 5.**

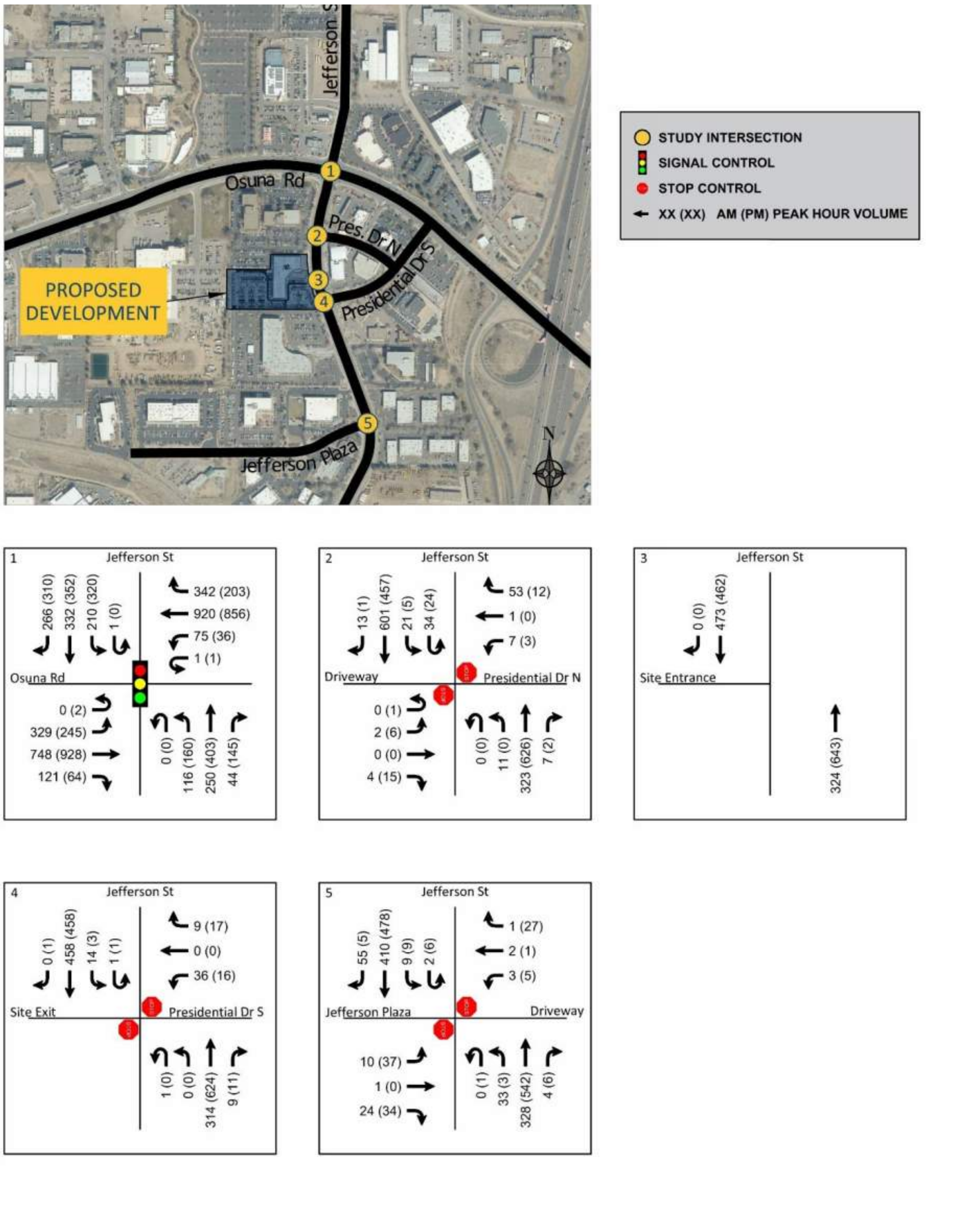

Figure 5: Build-Out Year (2023) Background Traffic Volumes

Table 6 below summarizes the intersection delay, LOS, and 95th percentile queue lengths under Build-Out Year Background conditions. Values within Table 6, shown in red, represent a result that falls below the acceptable threshold. Detailed capacity output sheets showing all individual movements can be found in Appendix D.

Table 6: HCS Result Summary for Build-Out Background Conditions

Build-Out Year Background														
Study Intersection	Queue, Delay, V/C, and LOS										Intersection LOS			
			AM				PM				AM		PM	
	Movement	Auxiliary Lane Length (ft)	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Osuna Rd & Jefferson St	EBL[1]	200	234.4	55.0	0.89	D	176.4	54.4	0.85	D	31.3	C	33.3	C
	EBT	---	164.9	13.9	0.36	B	196.7	15.5	0.41	B				
	EBR	---	158.5	14.2	0.36	B	197.1	15.8	0.41	B				
	WBL[1]	170	53.3	53.9	0.41	D	25.7	54.9	0.26	D				
	WBT	---	349.2	24.3	0.69	C	305.7	22.7	0.62	C				
	WBR	325	171.4	19.7	0.39	B	70.9	16.9	0.17	B				
	NBL	175	133.9	36.8	0.60	D	182.0	35.6	0.66	D				
	NBT	---	158.8	39.9	0.34	D	242.3	41.9	0.53	D				
	NBR	130	42.4	36.8	0.11	D	99.9	38.1	0.25	D				
	SBL	195	230.9	33.6	0.59	C	259.9	67.1	0.91	E				
	SBT	---	396.2	45.9	0.75	D	374.7	43.4	0.70	D				
	SBR	---	359.5	52.5	0.82	D	340.6	47.1	0.78	D				
Presidential Dr North & Jefferson St	EBL	---	0.0	19.6	0.01	C	0.1	16.6	0.02	C	13.7	B	12.2	B
	EBT/L	---	0.0	10.7	0.01	B	0.1	10.0	0.02	A				
	WBT/L/R	---	0.4	10.8	0.11	B	0.1	12.2	0.03	B				
	NBL	100	0.0	9.2	0.01	A	0.0	8.4	0.00	A				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	150	---	---	---	---	---	---	---	---				
	SBL	80	0.2	9.6	0.07	A	0.2	12.1	0.06	B				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	---	---	---	---	---	---	---	---	---				
Presidential Dr South /Site Exit & Jefferson St	EBR	---	---	---	---	---	---	---	---	---	12.9	B	14.2	B
	WBT/L/R	---	0.3	12.9	0.10	B	0.3	14.2	0.09	B				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	160	---	---	---	---	---	---	---	---				
	SBL	135	0.0	8.1	0.01	A	0.0	9.8	0.01	A				
	SBT	---	---	---	---	---	---	---	---	---				
Jefferson Plaza /Business Park Driveway & Jefferson St	EBT/L/R	---	0.2	11.6	0.06	B	0.6	14.0	0.16	B	13.5	B	14.0	B
	WBT/L/R	---	0.0	13.5	0.01	B	0.2	11.5	0.06	B				
	NBL	225	0.1	8.5	0.03	A	0.0	9.0	0.00	A				
	NBT/R	---	---	---	---	---	---	---	---	---				
	SBL	80	0.0	8.4	0.01	A	0.1	9.7	0.02	A				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	120	---	---	---	---	---	---	---	---				

**Intersection LOS and delay for stop-controlled intersection, results are reported as the worst case movement*

[1]Double auxiliary lanes of the listed length

From the above table, the following conclusions are made from the Build-Out Year Background analysis:

- For the intersection of Osuna Rd and Jefferson St
  - Capacity Analysis: The intersection operates at an overall LOS C during both the AM and PM peak hours.
    - Individual approaches operate at LOS D or better except the southbound left-turn movement, which operates at LOS E during the PM peak hour a shift from Existing conditions.

            - Note: The eastbound left movement's delay is less than one second from crossing the LOS E threshold during the AM and PM peak hours. Thus, even a minute increase in traffic volume will result in a LOS E for this approach.
        - These intersection LOS results are the same as those seen in under Existing conditions.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths except in the following cases:
            - Southbound left-turn lane during the AM peak hour
            - North and southbound left-turn lanes during the PM peak hour.
        - These queue results are similar to those seen in the Existing conditions analysis.
- For the intersection of Presidential Dr North and Jefferson St
    - Capacity Analysis: The intersection operates at an LOS of B during both the AM and PM peak hours at all approaches.
        - These LOS results are the same as those seen in under Existing conditions.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
- For the intersection of Presidential Dr South/Site Exit and Jefferson St
    - Capacity Analysis: The intersection operates at an LOS of B during both the AM and PM peak hours at all approaches.
        - These LOS results are the same as those seen in under Existing conditions.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the Existing conditions analysis.
- For the intersection of Jefferson Plaza and Jefferson St
    - Capacity Analysis: The intersection operates at an LOS of B during both the AM and PM peak hours at all approaches.
        - These LOS results are the same as those seen in under Existing conditions.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the Existing conditions analysis.

Build-Out Year (2023) Total Conditions

As previously discussed, the Build-Out Year Total traffic volumes are determined from the application of a 2% growth rate to the Existing traffic movement count data with the addition of the site-generated trips to analyze probable roadway conditions with the presence of the proposed development. The turning movement volumes used for this analysis scenario are shown in **Figure 6**.

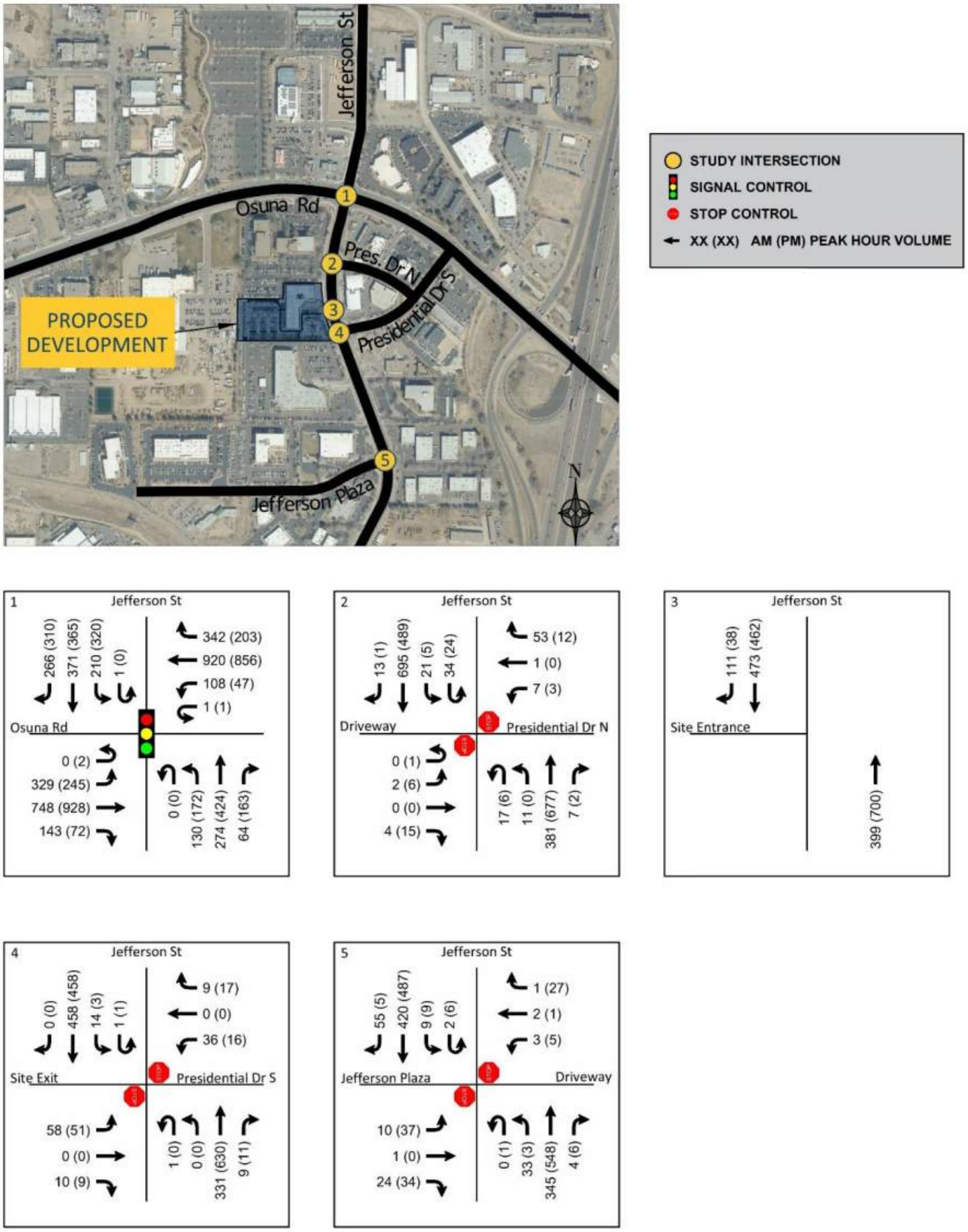

Figure 6: Build-Out Year (2023) Total Traffic Volumes

Figure 6 below summarizes the intersection delay, LOS, and 95th percentile queue lengths under Build-Out Year Total conditions. Values within Figure 6, shown in red, represent a result that falls below the acceptable threshold.

Table 7: HCS Result Summary for Build-Out Year (2023) Total Conditions

Study Intersection	Build-Out Year Total: Queue, Delay, V/C, and LOS										Intersection LOS			
			AM				PM				AM		PM	
	Movement	Auxiliary Lane Length (ft)	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Osuna Rd & Jefferson St	EBL[1]	200	241.0	58.2	0.89	E	176.4	54.4	0.85	D	**32.9**	**C**	**33.8**	**C**
	EBT	---	185.5	15.7	0.38	B	208.3	16.9	0.43	B				
	EBR	---	176.1	16.1	0.39	B	208.2	17.3	0.43	B				
	WBL[1]	170	77.5	54.4	0.56	D	33.3	54.3	0.30	D				
	WBT	---	371.2	26.6	0.72	C	316.2	23.8	0.64	C				
	WBR	325	181.3	21.4	0.40	C	73.2	17.7	0.18	B				
	NBL	175	148.2	36.4	0.64	D	195.2	35.8	0.68	D				
	NBT	---	171.0	38.5	0.35	D	250.8	41.2	0.53	D				
	NBR	130	66.7	35.9	0.16	D	121.5	37.8	0.29	D				
	SBL	195	227.0	32.4	0.58	C	253.1	64.7	0.90	E				
	SBT	---	419.6	46.2	0.76	D	381.4	43.3	0.71	D				
	SBR	---	383.1	53.2	0.83	D	347.5	47.1	0.78	D				
Presidential Dr North & Jefferson St	EBL	---	0.0	23.0	0.01	C	0.1	17.4	0.02	C	**15.2**	**C**	**12.7**	**B**
	EBT/L	---	0.0	11.2	0.01	B	0.1	10.1	0.02	B				
	WBT/L/R	---	0.4	11.5	0.12	B	0.1	12.7	0.04	B				
	NBL	100	0.2	12.5	0.07	B	0.0	8.5	0.00	A				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	150	---	---	---	---	---	---	---	---				
	SBL	80	0.2	10.1	0.07	B	0.2	12.8	0.07	B				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	---	---	---	---	---	---	---	---	---				
Presidential Dr South /Site Exit & Jefferson St	EBR	---	0.7	15.5	0.18	C	0.6	16.2	0.17	C	**15.5**	**C**	**16.2**	**C**
	WBT/L/R	---	0.3	13.1	0.10	B	0.3	14.3	0.09	B				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	160	---	---	---	---	---	---	---	---				
	SBL	135	0.0	8.2	0.01	A	0.0	9.8	0.01	A				
	SBT	---	---	---	---	---	---	---	---	---				
Jefferson Plaza /Business Park Driveway & Jefferson St	EBT/L/R	---	0.2	11.7	0.07	B	0.6	14.1	0.16	B	**13.7**	**B**	**14.1**	**B**
	WBT/L/R	---	0.0	13.7	0.02	B	0.2	11.6	0.06	B				
	NBL	225	0.1	8.5	0.03	A	0.0	9.0	0.00	A				
	NBT/R	---	---	---	---	---	---	---	---	---				
	SBL	80	0.0	8.4	0.01	A	0.1	9.7	0.02	A				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	120	---	---	---	---	---	---	---	---				

**Intersection LOS and delay for stop-controlled intersection, results are reported as the worst case movement*

[1]Double auxiliary lanes of the listed length

From the above table, the following conclusions are made from the Buil-Out Year Total analysis:

- For the intersection of Osuna Rd and Jefferson St
  - Capacity Analysis: The intersection operates at an overall LOS C during both the AM and PM peak hours.
    - Individual approaches operate at LOS D or better except for the southbound left-turn movement during the PM peak hour and the eastbound left turn during the AM peak hour.
  - Queueing Analysis

        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths except in the following cases:
            - East and southbound left-turn lanes during the AM peak hour
            - North and southbound left-turn lanes during the PM peak hour.
        - These queue results are similar to those seen in the Build-Out Background conditions analysis.
- For the intersection of Presidential Dr North and Jefferson St
    - Capacity Analysis: The intersection operates at an LOS of C or better during both the AM and PM peak hours at all approaches.
        - The intersection LOS results indicate a shift from LOS B seen in under Build-Out Background conditions to LOS C for the AM peak hour.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the Build-Out Background conditions analysis.
- For the intersection of Presidential Dr South/Site Exit and Jefferson St
    - Capacity Analysis: The intersection operates at an LOS of C or better during both the AM and PM peak hours at all approaches.
        - The intersection LOS results indicate a shift from LOS B seen in under Build-Out Background conditions to LOS C for AM and PM peak hours.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the Build-Out Background conditions analysis.
- For the intersection of Jefferson Plaza and Jefferson St
    - Capacity Analysis: The intersection operates at an LOS of B or better during both the AM and PM peak hours at all approaches.
        - The LOS results are the same as those seen in under Build-Out Background conditions.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are like those seen in the Build-Out Background conditions analysis.

Build-Out Year (2023) Optimized Conditions

Under Existing conditions, the Osuna Rd and Jefferson St intersection displays spillover 95th percentile queues in the southbound auxiliary lane during the AM peak hour and in the north and southbound auxiliary lanes during the PM peak hour. The intersection also demonstrates a LOS of E for the southbound left movement during the PM peak hour. These conditions worsen with the 2% growth factor application under Build-Out and Horizon conditions.

Also, under Existing conditions at the intersection of Presidential Dr North and Jefferson St, drivers have been observed to make illegal westbound left turns. These illicit turning maneuvers are also in evidenced by the turning movement counts collected by Lee engineering. To mitigate the spillover and operations below the LOS D threshold at Osuna Rd and Jefferson St and the illicit maneuvers at Presidential Dr North, the following roadway geometry and timing changes were modeled for the Optimized scenario using the Build-Out Total volumes as a basis.

The median nose at Presidential Dr North and Jefferson St was extended southward by 25 feet allowing the start point of the southbound left-turn auxiliary lane to be similarly shifted southbound by 25 feet without being shortened. This change would help curtail the illegal westbound left turns. It would also allow the northbound left-turn lane at Osuna Rd and Jefferson St to be extended from 175 feet to 200 feet to mitigate the northbound left lane spillover associated with this movement. To mitigate the southbound left turn spillover and the subpar LOS, a second southbound left auxiliary lane of equal length to the first was added to the model. To achieve LOS D or better for all approaches, a two-second split timing change was also implemented to benefit the eastbound left movement. The HCS results of this Optimized Build-Out scenario at Osuna Rd and Jefferson St are presented in **Table 8**, along with the Build-Out Total scenario results for comparison.

Table 8: HCS Result Summary for Build-Out Year (2023) Optimized Conditions

Optimized Build-Out Year Total														
Study Intersection	Queue, Delay, V/C, and LOS										Intersection LOS			
			AM				PM				AM		PM	
	Movement	Auxiliary Lane Length (ft)	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Osuna Rd & Jefferson St Optimized	EBL[1]	200	233.9	54.7	0.89	D	176.4	54.4	0.85	D	32.0	C	30.1	C
	EBT	---	184.1	15.5	0.38	B	206.5	16.6	0.43	B				
	EBR	---	175.0	15.9	0.39	B	206.4	17.0	0.43	B				
	WBL[1]	170	77.5	54.4	0.56	D	33.3	54.3	0.30	D				
	WBT	---	369.0	26.4	0.71	C	313.1	23.5	0.63	C				
	WBR	325	180.7	26.4	0.40	C	72.5	17.5	0.18	B				
	NBL	200	140.7	21.2	0.62	C	185.4	33.2	0.67	C				
	NBT	---	161.7	33.9	0.31	C	239.9	37.4	0.47	D				
	NBR	130	63.1	35.0	0.14	C	2.4	34.3	0.25	C				
	SBL[1]	195	112.1	32.5	0.32	C	166.2	30.3	0.51	C				
	SBT	---	419.2	30.7	0.76	D	380.7	43.1	0.71	D				
	SBR	---	382.3	46.0	0.83	D	346.4	46.8	0.78	D				
Osuna Rd & Jefferson St Build-Out Total	EBL[1]	200	241.0	58.2	0.89	E	176.4	54.4	0.85	D	32.9	C	33.8	C
	EBT	---	185.5	15.7	0.38	B	208.3	16.9	0.43	B				
	EBR	---	176.1	16.1	0.39	B	208.2	17.3	0.43	B				
	WBL[1]	170	77.5	54.4	0.56	D	33.3	54.3	0.30	D				
	WBT	---	371.2	26.6	0.72	C	316.2	23.8	0.64	C				
	WBR	325	181.3	21.4	0.40	C	73.2	17.7	0.18	B				
	NBL	175	148.2	36.4	0.64	D	195.2	35.8	0.68	D				
	NBT	---	171.0	38.5	0.35	D	250.8	41.2	0.53	D				
	NBR	130	66.7	35.9	0.16	D	121.5	37.8	0.29	D				
	SBL	195	227.0	32.4	0.58	C	253.1	64.7	0.90	E				
	SBT	---	419.6	46.2	0.76	D	381.4	43.3	0.71	D				
	SBR	---	383.1	53.2	0.83	D	347.5	47.1	0.78	D				

[1]Double auxiliary lanes of the listed length

From the above table, the following conclusions are made from the Optimized Build-Out Year analysis:

- For the intersection of Osuna Rd and Jefferson St

- Capacity Analysis: The intersection operates at an overall LOS C during the AM and PM peak hours. There is no significant change in overall intersection delay or LOS between the Build-Out Total and the Optimized Build-Out scenarios.
    - With the aforementioned geometric and timing changes, all approaches operate at a LOS D or better during the AM and PM peak hours.
    - These individual approach LOS results improve those seen in the analysis of the Existing conditions.
- Queueing Analysis
    - With the aforementioned geometric and timing changes, all auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
    - These queue results improve those seen in the analysis of the Existing conditions.

HORIZON YEAR BACKGROUND AND TOTAL ANALYSES

A Level of Service (LOS) and queueing analysis was performed for Horizon Year analysis scenarios using the same procedures, field data, and assumptions as used for the previous analyses.

Horizon Year (2033) Background Conditions

As discussed in the previous Analysis Scenarios and Volume Calculations subsection, the Horizon Year Background traffic volumes were determined by applying a 2% compound growth rate to the Existing traffic movement count data to analyze probable roadway conditions in the Horizon Year in the absence of the proposed development. The turning movement volumes used for this analysis scenario are shown in **Figure 7**.

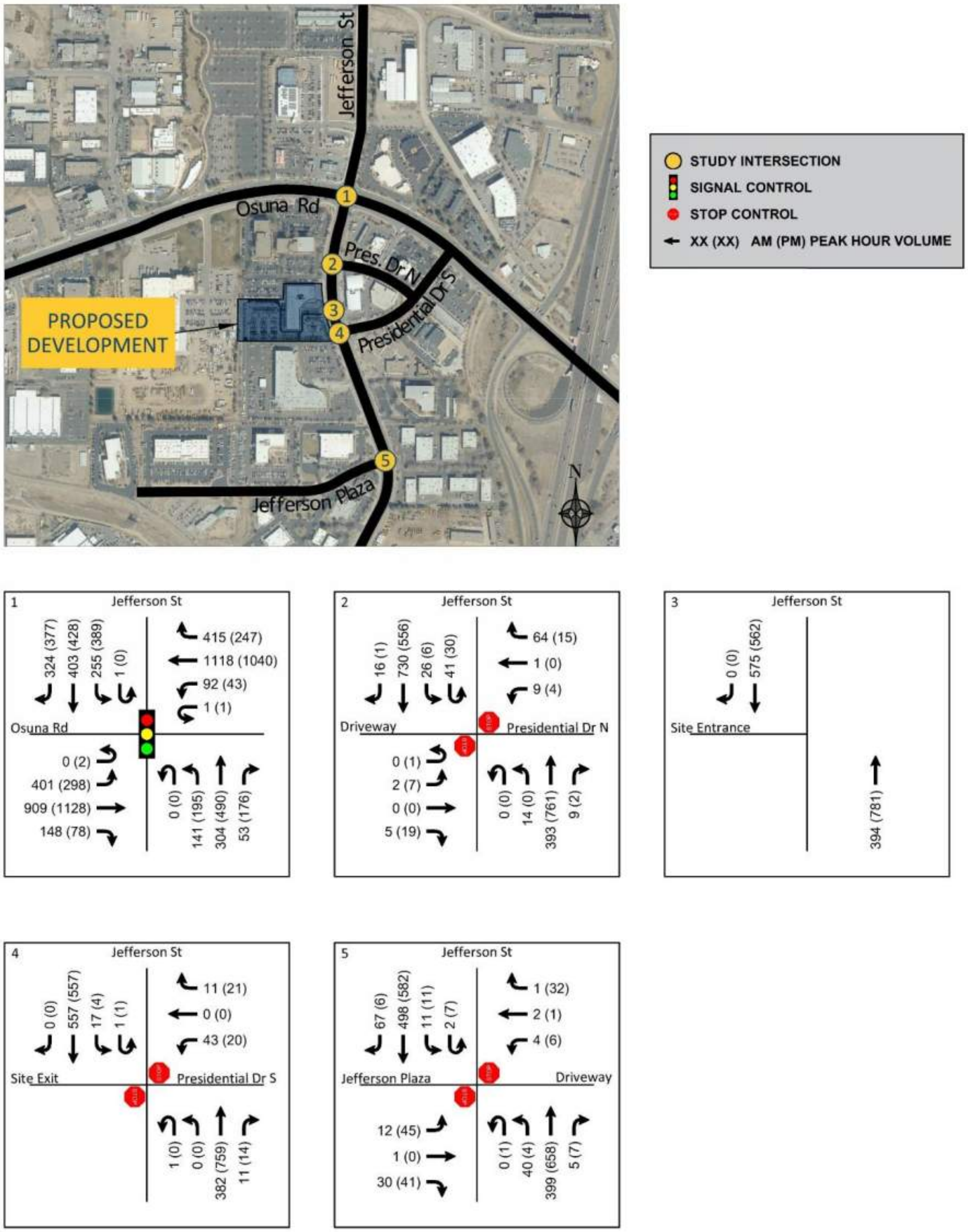

Figure 7: Horizon Year (2033) Background Traffic Volumes

Table 9 below summarizes the intersection delay, LOS, and 95th percentile queue lengths under Horizon Year Background conditions. Values within Table 9, shown in red, represent a result that falls below the acceptable threshold.

Table 9: HCS Result Summary for Horizon Year (2033) Background Conditions

Study Intersection	Horizon Year Background — Queue, Delay, V/C, and LOS										Intersection LOS			
			AM				PM				AM		PM	
	Movement	Auxiliary Lane Length (ft)	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	95th Percentile Queue (ft)	Delay (sec)	V/C	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Osuna Rd & Jefferson St	EBL[1]	200	319.5	74.6	0.92	E	211.9	55.4	0.88	E	48.0	D	49.0	D
	EBT	---	239.1	18.9	0.48	B	282.1	22.1	0.57	C				
	EBR	---	229.5	19.7	0.49	B	283.9	23.2	0.57	C				
	WBL[1]	170	65.6	54.0	0.49	D	30.5	54.5	0.28	D				
	WBT	---	767.1	74.3	0.99	E	537.1	43.3	0.90	D				
	WBR	325	278.2	30.7	0.61	C	129.3	24.1	0.29	C				
	NBL	175	160.6	37.3	0.70	D	216.1	38.0	0.77	D				
	NBT	---	183.9	36.2	0.35	D	272.3	37.7	0.53	D				
	NBR	130	50.5	33.0	0.12	C	129.6	34.0	0.28	C				
	SBL	195	75.6	34.9	0.67	C	726.7	178.1	1.05	F				
	SBT	---	484.2	47.9	0.80	D	460.9	44.0	0.77	D				
	SBR	---	444.2	58.2	0.87	E	418.6	49.9	0.82	D				
Presidential Dr North & Jefferson St	EBL	---	0.0	24.5	0.01	C	0.1	19.9	0.03	C	15.2	C	13.8	B
	EBT/L	---	0.0	11.4	0.01	B	0.1	10.5	0.03	B				
	WBT/L/R	---	0.5	11.8	0.14	B	0.2	13.8	0.05	B				
	NBL	100	0.1	9.8	0.02	A	0.0	8.8	0.00	A				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	150	---	---	---	---	---	---	---	---				
	SBL	80	0.3	10.4	0.09	B	0.3	14.3	0.10	B				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	---	---	---	---	---	---	---	---	---				
Presidential Dr South /Site Exit & Jefferson St	EBR	---	---	---	---	---	---	---	---	---	14.3	B	16.6	C
	WBT/L/R	---	0.5	14.3	0.14	B	0.4	16.6	0.13	C				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	160	---	---	---	---	---	---	---	---				
	SBL	135	0.1	8.3	0.02	A	0.0	10.5	0.01	B				
	SBT	---	---	---	---	---	---	---	---	---				
Jefferson Plaza /Business Park Driveway & Jefferson St	EBT/L/R	---	0.3	12.5	0.09	B	0.9	16.5	0.23	C	15.1	C	16.5	C
	WBT/L/R	---	0.1	15.1	0.02	C	0.3	12.6	0.08	B				
	NBL	225	0.1	8.9	0.04	A	0.0	9.3	0.01	A				
	NBT/R	---	---	---	---	---	---	---	---	---				
	SBL	80	0.0	8.6	0.01	A	0.1	10.5	0.03	B				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	120	---	---	---	---	---	---	---	---				

**Intersection LOS and delay for stop-controlled intersection, results are reported as the worst case movement*

[1]Double auxiliary lanes of the listed length

From the above table, the following conclusions are made from the Existing Year analysis:

- For the intersection of Osuna Rd and Jefferson St
  - Capacity Analysis: The intersection operates at an overall LOS D during both the AM and PM peak hours. The intersection LOS results indicate a shift from LOS C seen in under Build-Out Background conditions to LOS D.
    - Individual approaches operate at LOS D or better except for the following movements:
      - The eastbound left-turn, the southbound right-turn, and the westbound through movements operate at LOS E during the AM peak hour.
      - The eastbound left-turn operates at LOS E and the southbound left-turn operates at LOS F during the PM peak hour.

- Queueing Analysis
    - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths except in the following cases:
        - Eastbound left-turn lane during the AM peak hour
        - East, north, and southbound left-turn lanes during the PM peak hour.
    - These queue results differ from those seen in the Build-Out Background conditions analysis.
- For the intersection of Presidential Dr North and Jefferson St
    - Capacity Analysis: The intersection operates at a LOS of C or better during both the AM and PM peak hours at all approaches.
        - The intersection LOS results indicate a shift from LOS B under Existing conditions to LOS C for the AM peak hour.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the analysis of the Existing condition.
- For the intersection of Presidential Dr South/Site Exit and Jefferson St
    - Capacity Analysis: The intersection operates at a LOS of C or better during both the AM and PM peak hours at all approaches.
        - The intersection LOS results indicate a shift from LOS B under Existing conditions to LOS C for the AM and PM peak hour conditions.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the analysis of the Existing conditions.
- For the intersection of Jefferson Plaza and Jefferson St
    - Capacity Analysis: The intersection operates at a LOS of C or better during both the AM and PM peak hours at all approaches.
        - The intersection LOS results indicate a shift from LOS B seen in under Existing conditions to LOS C for AM and PM peak hours.
    - Queueing Analysis
        - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
        - These queue results are similar to those seen in the Existing conditions analysis.

Horizon Year (2033) Total Conditions

The Horizon Year Total analysis assesses the probable roadway conditions in the Horizon Year with the addition of the proposed development's contribution to the study area traffic volumes. The turning movement volumes used for this analysis scenario are shown in **Figure 8**.

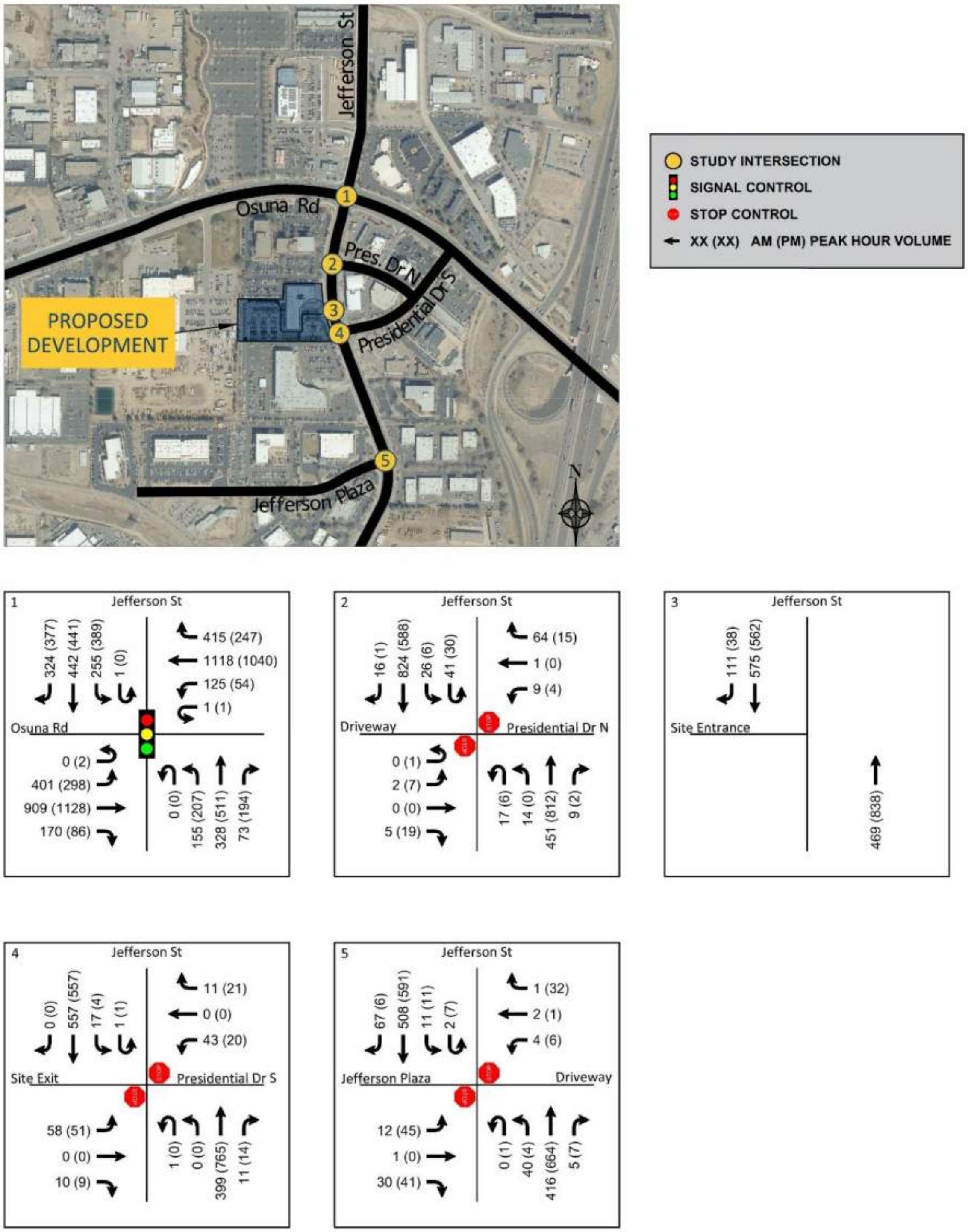

Figure 8: Horizon Year (2033) Background Traffic Volumes

Table 10 below summarizes the intersection delay, LOS, and 95th percentile queue lengths under Horizon Year Total conditions. Values within Table 10, shown in red, represent a result that falls below the acceptable threshold.

Table 10: HCS Result Summary for Horizon Year (2033) Total Conditions

Horizon Year Total														
Study Intersection	Queue, Delay, V/C, and LOS										Intersection LOS			
			AM				PM				AM		PM	
	Movement	Auxiliary Lane Length (ft)	95th Percentile Queue (ft)	Delay[1] (sec)	V/C	LOS[2]	95th Percentile Queue (ft)	Delay[1] (sec)	V/C	LOS[2]	Delay[1] (sec)	LOS[2]	Delay[1] (sec)	LOS[2]
Osuna Rd & Jefferson St	EBL[1]	200	337.4	83.0	0.93	F	214.3	56.7	0.88	E	57.5	E	50.5	D
	EBT	---	255.2	20.5	0.51	C	295.2	23.5	0.59	C				
	EBR	---	243.7	21.5	0.51	C	296.7	24.7	0.59	C				
	WBL[1]	170	90.4	55.0	0.64	D	38.2	54.1	0.32	D				
	WBT	---	931.5	106.9	1.02	F	559.1	46.9	0.92	D				
	WBR	325	287.5	32.4	0.63	C	131.9	24.7	0.30	C				
	NBL	175	183.4	40.5	0.75	D	231.5	40.3	0.80	D				
	NBT	---	195.5	35.3	0.36	D	280.9	37.3	0.54	D				
	NBR	130	73.7	32.4	0.16	C	150.7	34.0	0.32	C				
	SBL	195	71.2	34.0	0.67	C	739.8	182.1	1.05	F				
	SBT	---	515.0	49.6	0.83	D	469.7	44.4	0.77	D				
	SBR	---	480.8	62.2	0.89	E	428.5	50.8	0.83	D				
Presidential Dr North & Jefferson St	EBL	---	0.0	29.2	0.02	D	0.1	21.3	0.04	C	16.9	C	14.5	B
	EBT/L	---	0.0	12.0	0.01	B	0.1	10.6	0.03	B				
	WBT/L/R	---	0.6	12.7	0.16	B	0.2	14.5	0.05	B				
	NBL	100	0.3	14.2	0.09	B	0.0	12.0	0.01	B				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	150	---	---	---	---	---	---	---	---				
	SBL	80	0.3	11.0	0.10	B	0.4	15.2	0.10	C				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	---	---	---	---	---	---	---	---	---				
Presidential Dr South /Site Exit & Jefferson St	EBR	---	0.8	18.0	0.22	C	0.8	19.0	0.21	C	18.0	C	19.0	C
	WBT/L/R	---	0.5	14.6	0.14	B	0.4	16.7	0.13	C				
	NBT	---	---	---	---	---	---	---	---	---				
	NBR	160	---	---	---	---	---	---	---	---				
	SBL	135	0.1	8.4	0.02	A	0.0	10.5	0.01	B				
	SBT	---	---	---	---	---	---	---	---	---				
Jefferson Plaza /Business Park Driveway & Jefferson St	EBT/L/R	---	0.3	12.6	0.09	B	0.9	16.7	0.23	C	15.3	C	16.7	C
	WBT/L/R	---	0.1	15.3	0.02	C	0.3	12.6	0.08	B				
	NBL	225	0.1	8.9	0.04	A	0.0	9.4	0.01	A				
	NBT/R	---	---	---	---	---	---	---	---	---				
	SBL	80	0.0	8.7	0.01	A	0.1	10.5	0.03	B				
	SBT	---	---	---	---	---	---	---	---	---				
	SBR	120	---	---	---	---	---	---	---	---				

**Intersection LOS and delay for stop-controlled intersection, results are reported as the worst case movement*

[1]Double auxiliary lanes of the listed length

From the above table, the following conclusions are made from the Existing Year analysis:

- For the intersection of Osuna Rd and Jefferson St
  - Capacity Analysis: The intersection operates at an overall LOS E during the AM peak hour and LOS D during the PM peak hour. The intersection LOS results indicate a shift from LOS D seen in under Horizon Background conditions to LOS E during the AM peak hour.
    - Individual approaches operate at LOS D or C except for the following movements:
      - The eastbound left-turn and the westbound through movements operate at LOS F during the AM peak hour.
      - The southbound right-turn operates at LOS E during the AM peak hour.
      - The eastbound left-turn operates at LOS E and the southbound left-turn operates at LOS F during the PM peak hour.

- Queueing Analysis
  - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths except in the following cases:
    - East and northbound left-turn lanes during the AM peak hour
    - East, north, and southbound left-turn lanes during the PM peak hour.
  - These queue results differ slightly from those in the Horizon Background conditions analysis.
- For the intersection of Presidential Dr North and Jefferson St
  - Capacity Analysis: The intersection operates at a LOS of C or better during both the AM and PM peak hours at all approaches.
    - The intersection LOS results are similar to those seen under Horizon Background conditions.
  - Queueing Analysis
    - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
    - These queue results are similar to those in the Horizon Background conditions analysis.
- For the intersection of Presidential Dr South/Site Exit and Jefferson St
  - Capacity Analysis: The intersection operates at a LOS of C during both the AM and PM peak hours at all approaches.
    - The intersection LOS results indicate a shift from LOS B seen in under Horizon Background conditions to LOS C during the AM peak hour.
  - Queueing Analysis
    - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
    - These queue results are similar to those seen in the Build-Out Background conditions analysis.
- For the intersection of Jefferson Plaza and Jefferson St
  - Capacity Analysis: The intersection operates at a LOS of C during both the AM and PM peak hours at all approaches.
    - The intersection LOS results are the same as those seen under Horizon Background conditions.
  - Queueing Analysis
    - Where HCS results for queue lengths are present, existing auxiliary lane lengths are sufficient to accommodate 95th percentile queue lengths.
    - These queue results are similar to those in the Horizon Background conditions analysis.

Summary of Capacity Improvement Recommendations

Based on the Optimized Build-Out scenario analysis, it is recommended that the City of Albuquerque consider adding additional queue storage capacity for the north and southbound left-turn auxiliary lanes. Additionally, a second southbound left turn could be construted to provide additional capacity for this movement. Extending the median nose at Presidential Dr North to further restrict illegal left turn maneuvers would allow for the expansion of the northbound left-turn lane. However, the turning movement counts show seven drivers in the AM peak hour and three in the PM peak hour, disregarding the turn restrictions.

Further, in keeping with the regular reevaluation and retiming of traffic signals conducted by the City of Albuquerque, the intersection of Osuna Rd and Jefferson should be assessed for signal timing optimization. Signal timings should be performed by a registered Professional Traffic Operations Engineer (PTOE).

DEVELOPMENT SITE-RELATED ASSESSMENT OF ACCESS CONDITIONS

The following sections assess the relevant site access and internal traffic conditions. The site conditions analyzed include the intersection sight distance based on the American Association of State Highway and Transportation Officials (AASHTO) "Green Book", an auxiliary lane warrant and deceleration lane length analyses based on the COA DPM, and an internal queuing analysis based on the North Carolina Department of Transportation's (NCDOT) Municipal and School Transportation Assistance (MSTA) guidelines for student drop-off and pick-up plans.

SITE ACCESS SIGHT DISTANCE

The following presents recommended intersection sight distance requirements for the Exit only driveway serving the development. Intersection sight distance requirements were calculated based on the 2018 AASHTO "Green Book" chapter 9.5. A passenger vehicle was used as the design vehicle.

- Case B1 – A stopped vehicle turning left turn from a minor street approach onto a major road.
- Case B2 – A stopped vehicle turning right from a minor street approach onto a major road.

Intersection sight distances were calculated based on the following assumptions:

- Required intersection sight distance for Case B2 was calculated based on the design vehicle crossing into the first lane of the roadway.

Values shown below in **Table 11** were rounded up to the nearest 5-foot increment. Formulas, values, and calculations used in the sight distance analysis can be found in the Appendix.

Table 11: Site Distance Requirements

Location	Roadway	Speed	Site Distance
Case B1 - Turning Left from Site Exit	Jefferson St	35	490 ft.
Case B2 - Turning Right from Site Exit	Jefferson St	35	335 ft.

It is recommended that all development driveways adhere to the sight distance provisions detailed in the AASHTO "Green Book". An area bounded by the above sight distances with the decision point placed 14.5 feet back from the edge of the shoulder midway between the outbound driving lane should be maintained clear of any obstructions.

CHARTER SCHOOL ON-SITE QUEUING ANALYSIS

The queuing analysis uses a methodology to estimate the maximum queue length. The analysis was based on the North Carolina Department of Transportation's (NCDOT) Municipal and School Transportation Assistance (MSTA) guidelines for student drop-off and pick-up plans. The NCDOT MSTA methodology was chosen because it was among the methods reviewed and recommended by School Site Planning, Design, And Transportation report produced by the ITE Engineering Council included in Appendix E. Of the methods for drop-off and pick-up queue analyses discussed within the ITE report, the NCDOT MSTA School Traffic Calculator was the only method specifically applicable to an urban charter high school.

The NCDOT School Traffic Calculator (STC) was created with a special focus on vehicular rates and queue lengths generated by schools. It is based on data collected pre-COVID19 from schools throughout North Carolina and across schools of various types and geographic locations. The resulting queue length produced by the calculator is the 95th percentile queue length to provide a conservative estimate.

PROPOSED PICK-UP AND DROP-OFF OPERATIONS PLAN

The proposed student Drop-Off and Pick-Up plan includes an approximately 680-foot-long student loading zone and the presence of staff during all loading periods to direct and manage traffic flow and queuing. The Site Plan also includes parking spaces for 178 passenger vehicles. This number of parking spaces is sufficient to accommodate 25 staff members and the anticipated 50 student drivers with 103 additional spaces for queue overflow parking. Per the proposed Drop-Off/Pick-Up plan, staff traffic coordinators would direct parents out of the student loading zone queue and into parking spaces when queues extend near the loading zone's capacity to prevent spillback onto Jefferson St. Therefore, the plan is not dependent on the presence of a student loading zone designed for the 95th percentile queue storage length to avoid negatively impacting the neighboring roadway.

QUEUING VARIABLES

The NCDOT MSTS STC is an Excel workbook that requires the following data: the total number of students (250), the number of school busses (3), the number of school staff (25), and the number of student drivers (50). The calculator then uses the following averages and assumption based on the NCDOT data collection, 50.08% cars per student during the AM and 47.58% in the PM, an average car length of 22.83 and a Peak Hour Factor of 0.5. From this information the calculator estimates the total AM and PM peak hour trips and the resulting 95th percentile queue length. For background information regarding the data collection used in, and an evaluation of the STC an independent report by the North Carolina State University Institute for Transportation Research and Education (ITRE) has been provided in Appendix F.

QUEUING ANALYSIS

The NCDOT MSTS STC calculated 95th percentile queue length for the worst-case inbound drop-off or pick-up is 1006-feet. **Table 12** below summarizes the results of the NCDOT MSTA STC. It should be noted the STC's estimated AM and PM peak hour trips exceed the number of inbound trips calculated by the ITE Trip Generation Manual by 63% and 134% during the AM and PM peak hours, respectively. Thus, the resulting queue length should be considered a very conservative estimation.

Table 12: NCDOT School Traffic Calculator 95% Queue Length Results

MSTA School Queue Input					Calculations						
Grade Level	Student Population	Number of Buses	Staff Member	Student Drivers	All AM TRIPS	In	181	All PM TRIPS	In	89	95% Queue Length (ft)
						Out	115		Out	167	
9-12	250	3	25	50		Total	295		Total	256	**1006**

The average queueing would statistically be much shorter than the 95th percentile queue length. Given the high level of conservatism built into the NCDOT's STC, it can be expected that a 680-foot-long student loading zone will be sufficient to accommodate drop-off and pick-up operations without spillback onto Jefferson St for average and slightly above-average queues. For significantly higher than average queues, the planned presence of traffic direction personnel coupled with the availability of overflow parking are reasonable mitigation measures to prevent negatively impacting the traffic operations on Jefferson St.

Additionally, to minimize noise and air pollution during drop-off and pick-up operations, signage should be installed notifying drivers not to idle and to turn off engines while stopped. Parents should be also educated about the drop-off and pick-up plan, particularly the importance of not running their engines while stopped and using the available parking when the student loading zone approaches capacity.

FIVE-YEAR CRASH DATA SUMMARY

At the request of the NMDOT, a crash summary for the intersections within the study area has been completed. The intersection of Osuna Rd and Jefferson St was not included in this summary per COA instructions given during the scoping meeting. The purpose of this summary is to highlight trends and observations from summarized crash data. Crash data was provided by NMDOT for the years 2016 to 2020 in aggregate form and is summarized in the table below.

Table 13: Crash Summary

Crash Summary		Jefferson St & Presidential Dr N	Jefferson St & Site Entrance	Jefferson St & Presidential Dr S	Jefferson St & Jefferson Plaza
Total Crashes		**0**	**0**	**7**	**4**
By Year	2016	0	0	1	1
	2017	0	0	1	0
	2018	0	0	1	1
	2019	0	0	2	1
	2020	0	0	2	1
By Type	Fixed Object	0	0	2	0
	Other Vehicle - Both Turn Left/Entering At Angle	0	0	1	1
	Other Vehicle - From Opposite Direction/Both Going	0	0	1	1
	Other Vehicle - From Opposite Direction/Sideswipe	0	0	1	1
	Other Vehicle - From Same Direction/Both Going Straight	0	0	1	0
	Other Vehicle - One Left Turn/Entering At Angle	0	0	1	1
	% Other Vehicle - From Same Direction/Rear End Collision	*0%*	*0%*	*0%*	*0%*
	% Other Vehicle - From Same Direction/Both Going	*0%*	*0%*	*14%*	*0%*
	% Other Vehicle - One Left Turn/Entering At Angle	*0%*	*0%*	*14%*	*25%*
By Lighting Conditions	Daylight	0	0	5	3
	Dawn/Dusk	0	0	0	0
	Dark	0	0	1	0
	Left Blank	0	0	1	1
	% Day	*0%*	*0%*	*71%*	*75%*
By Severity	Property Damage Only	0	0	2	0
	Injury	0	0	5	4
	Fatality	0	0	0	0
	% Property Damage Only	*0%*	*0%*	*29%*	*0%*
	% Injury	*0%*	*0%*	*71%*	*100%*
By Cause	Collision with Fixed Object	0	0	1	0
	Collision with Motor Vehicle	0	0	1	1
	Driver Inattention	0	0	2	2
	Failed to Yield Right of Way	0	0	1	1
	Other - No Driver Error	0	0	1	0
	Other Improper Driving	0	0	1	0
	% Driver Inattention	*0%*	*0%*	*29%*	*50%*
	% Failed to Yield Right of Way	*0%*	*0%*	*14%*	*25%*
	% Following Too Closely	*0%*	*0%*	*0%*	*0%*

From the above table, the following observations are made:

- For the intersection of Jefferson St and Presidential Dr N:
  - Within the years 2016 to 2020, no crashes were reported.

- For the intersection of Jefferson St and Site Entrance:
  - Within the years 2016 to 2020, no crashes were reported.

- For the intersection of Jefferson St & Presidential Dr S:
  - Within the years 2016 to 2020, 7 crashes were reported.
  - The most common crash classification was Other Vehicle – From Same Direction/Rear End and Other Vehicle – One Left turn/Entering at Angle.
  - The majority of collisions at this intersection occurred during daylight hours.
  - No fatal crashes were reported from 2016 to 2020. Injuries were reported in 71% of crashes.
  - The most common cause of crashes was Driver Inattention.

- For the intersection of Jefferson St & Jefferson Plaza:
  - Within the years 2016 to 2020, 4 crashes were reported.
  - The most common crash classification was Other Vehicle – One Left turn/Entering at Angle.
  - The majority of collisions at this intersection occurred during daylight hours.
  - No fatal crashes were reported from 2016 to 2020. Injuries were reported in 100% of crashes.
  - The most common cause of crashes was Driver Inattention.

SUMMARY OF RECOMMENDATIONS

The following presents a summary of recommendations included in this report.

CONCLUSIONS

- All study intersections operate at an acceptable overall LOS throughout all study scenarios except the intersection of Osuna Rd and Jefferson St during the AM peak hour under the Horizon Year Total scenario.
- 95th % Queue Lengths only exceed existing queue storage at the intersection of Osuna Rd and Jefferson St. This intersection experiences movements with 95th percentile queue lengths exceeding existing queue storage lengths under all unoptimized scenarios.
- Proposed Drop-Off/Pick-Up Queue Storage may not accommodate 95th percentile vehicle queues as designed. However, the planned presence of traffic direction personnel and the abundance of overflow parking are likely sufficient to mitigate this issue.

DEVELOPMENT SPECIFIC RECOMMENDATIONS

- It is recommended that all development driveways adhere to the sight distance provisions detailed in the AASHTO "Green Book".
- Signage, Drop-Off/Pick-Up plan, and staff traffic coordinators shall notify drivers to turn off engines while not in motion to mitigate noise and air pollution.
- When the student loading zone approaches capacity, drivers shall be instructed to bypass the loading queue and park for Drop-Off and Pick-Up.

ANCILLARY RECOMMENDATIONS

- HCS results suggest the need for future evaluation of capacity and queuing mitigation measures or street improvements unrelated to the proposed development at the intersection of Osuna Rd and Jefferson St.
    - Potential mitigations include an additional southbould left turn lane and accompanying signal re-timing.
- Illegal left turns were observed from the right-out-only westbound approach on Presidential Dr North. There is existing no-left-turn signage, which could be reinforced with the southward extension of the median nose.

Table of Contents

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix A

Scoping Meeting Minutes

Prepared for:

Wooten Engineering

Prepared By:

LEE ENGINEERING

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ALBUQUERQUE, NM 87113
505/338-0988
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LEE ENGINEERING

Agenda for Charter High School Scoping Meeting
July 26, 2022
-Meeting Notes in Red-

Attendees:
Matt Grush – City of Albuquerque
Jonathon Kruse – Lee Engineering
Michael Policastro – Lee Engineering
Jeff Wooten – Wooten Engineering
Steve Nakamura – Rachel Matthew Development

1. Introductions
2. Review of Site Plan
    a. Site Plan & land Uses
    b. Queueing: vehicles will be required to park if the pickup/drop-off queue is full.
    c. Access & Circulation
        i. Existing Access to Jefferson
        ii. New Exit to Jefferson
3. Discussion of Scope for TIS
    a. Study Intersections
        i. Osuna Rd & Jefferson St
        ii. Jefferson St & Site Access Entrance
        iii. Jefferson St & Presidential Dr NE / Site Access Exit
        iv. Jefferson St & Jefferson Plaza
    b. Data Collection
        i. Data collection to be conducted during school year.
    c. Trip Generation, Pass By, & Internal Capture
        i. Trip Generation Manual (11th Edition) Land Use – See attachments for details.
            1. 250 Students with 125 riding busses
            2. AM Peak Hour: 111 Entering / 68 Exiting
            3. PM Peak Hour: 38 Entering / 60 Exiting

            Pass-by trips

            None
        ii. No Internal Capture

            None
        iii. Trips distributed based on existing traffic patterns
    d. Known Developments or Pending Improvements in Area:

        XRANM – South of Site

e. Build-out and Horizon Year and Growth Rate
    i. Growth Rates (2023 and 2033)
        1. Build-Out and Horizon Year growth rates to be based on MRCOG Model Projections and calculate growth rate (if any), otherwise will assume 1% growth per year.

f. Analysis scenarios
    i. Existing Conditions (2022)
    ii. Opening Year (2023) Background (No Build)
    iii. Opening Year (2023) Buildout (Full Build)
    iv. Opening Year (2023) Buildout Optimized
    v. Horizon Year (2033) Background (No Build)
    vi. Horizon Year (2033) Buildout (Full Build)

g. Required Analysis & Methodology
    i. LOS Capacity analysis based on HCM 6th Edition (HCS)
    ii. 95th Percentile Queue demands (HCS)
        1. Capacity & Queueing for network peak rather than individual intersection peaks
    iii. Sight Distance Analysis at Proposed Driveways
    iv. Crash Summary
        1. Yes, 5 years for the area around the school including presidential way.
    v. NIA
        1. Include best practices/recommendations to reduce noise and air pollution:
            a. Signage to not idle etc.
        2. On-site queuing analysis for Pickup/Dropoff operations

4. Agency Input (Comments & Issues)
5. Meeting Notes (distributed by Lee Engineering)

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix B

Turning Movement Count Sheets

Prepared for:

Wooten Engineering

Prepared By:

LEE ENGINEERING

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School
NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Data

Start Time	Osuna Rd Eastbound							Osuna Rd Westbound							Jefferson St Northbound							Jefferson St Southbound							
	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Int. Total
6:00 AM	17	72	8	2	0	0	99	4	89	12	11	0	1	116	6	25	2	1	0	0	34	18	19	8	3	0	0	48	297
6:15 AM	23	95	7	0	0	0	125	2	80	23	20	0	0	125	8	31	3	1	0	0	43	24	41	21	1	0	0	87	380
6:30 AM	25	102	13	0	0	0	140	6	102	27	16	0	0	151	15	38	2	1	0	0	56	37	46	18	7	0	0	108	455
6:45 AM	39	116	10	5	0	2	170	15	125	41	19	0	0	200	14	40	0	5	0	0	59	40	73	29	5	1	0	148	577
Hourly Total	104	385	38	7	0	2	534	27	396	103	66	0	1	592	43	134	7	8	0	0	192	119	179	76	16	1	0	391	1709
7:00 AM	42	138	15	4	0	0	199	13	141	52	11	0	0	217	20	38	3	5	0	0	66	43	58	28	7	0	0	136	618
7:15 AM	52	148	6	4	0	0	210	13	177	42	31	0	0	263	30	59	7	3	0	0	99	51	64	31	6	0	0	152	724
7:30 AM	69	170	21	5	0	1	265	21	220	63	17	1	0	322	17	58	3	4	0	1	82	24	50	36	13	0	1	123	792
7:45 AM	83	218	28	6	0	0	335	18	253	72	26	0	2	369	27	70	8	2	0	0	107	50	85	77	5	0	0	217	1028
Hourly Total	246	674	70	19	0	1	1009	65	791	229	85	1	2	1171	94	225	21	14	0	1	354	168	257	172	31	0	1	628	3162
8:00 AM	86	193	24	8	0	0	311	27	216	49	40	1	0	333	34	64	8	2	0	1	108	37	82	49	13	1	1	182	934
8:15 AM	59	162	19	6	0	0	246	15	210	56	29	0	0	310	29	51	12	3	0	0	95	59	82	43	15	0	0	199	850
8:30 AM	95	160	21	7	0	0	283	14	223	42	21	0	0	300	24	60	5	3	0	0	92	60	76	51	8	0	1	195	870
8:45 AM	60	182	23	3	0	0	268	16	166	35	32	0	0	249	30	52	2	3	0	0	87	59	96	68	4	0	1	227	831
Hourly Total	300	697	87	24	0	0	1108	72	815	182	122	1	0	1192	117	227	27	11	0	1	382	215	336	211	40	1	3	803	3485
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11:00 AM	60	189	17	5	0	0	271	10	152	32	11	0	0	205	33	63	17	10	1	0	124	53	61	46	9	0	0	169	769
11:15 AM	64	181	26	2	1	0	274	11	130	44	22	0	0	207	22	74	8	13	1	0	118	68	75	45	27	0	0	215	814
11:30 AM	58	164	17	3	0	0	242	14	148	28	22	0	1	212	34	70	16	14	1	0	135	71	71	60	9	0	0	211	800
11:45 AM	55	196	14	12	0	0	277	19	127	27	26	0	0	199	45	80	15	11	0	0	151	74	92	71	4	0	0	241	868
Hourly Total	237	730	74	22	1	0	1064	54	557	131	81	0	1	823	134	287	56	48	3	0	528	266	299	222	49	0	0	836	3251
12:00 PM	76	204	16	5	1	0	302	19	170	45	17	0	0	251	41	98	30	14	2	0	185	87	95	40	17	0	0	239	977
12:15 PM	72	157	16	6	1	0	252	22	147	42	17	0	0	228	46	98	26	23	2	0	195	81	83	64	13	0	0	241	916
12:30 PM	73	194	17	3	0	0	287	29	205	58	14	1	0	307	34	99	21	6	0	0	160	68	72	51	17	0	0	208	962
12:45 PM	70	163	22	3	0	0	258	22	170	46	26	0	0	264	39	90	15	14	2	0	160	57	70	62	21	0	0	210	892
Hourly Total	291	718	71	17	2	0	1099	92	692	191	74	1	0	1050	160	385	92	57	6	0	700	293	320	217	68	0	0	898	3747
1:00 PM	85	197	21	4	0	0	307	23	202	34	27	0	1	286	40	79	16	9	2	0	146	54	73	57	15	0	0	199	938
1:15 PM	82	185	15	1	0	0	283	11	141	41	25	1	5	219	26	107	19	12	2	0	166	66	76	59	9	0	0	210	878
1:30 PM	47	203	20	2	0	0	272	16	175	48	18	1	0	258	27	79	12	9	0	0	127	63	59	48	12	0	0	182	839
1:45 PM	62	171	15	8	1	4	257	16	182	40	27	0	1	265	26	103	12	4	1	2	146	69	71	51	6	1	0	198	866
Hourly Total	276	756	71	15	1	4	1119	66	700	163	97	2	7	1028	119	368	59	34	5	2	585	252	279	215	42	1	0	789	3521
2:00 PM	57	184	16	3	0	3	260	13	153	39	25	0	0	230	31	54	9	9	0	2	103	64	81	57	11	0	0	213	806
2:15 PM	68	163	18	6	0	0	255	8	155	29	15	1	0	208	39	51	10	13	0	0	113	60	67	55	9	0	1	191	767
2:30 PM	64	184	17	3	0	0	268	7	192	48	17	0	0	264	29	54	9	13	1	0	106	49	60	58	16	0	1	183	821
2:45 PM	60	155	6	2	0	0	223	12	190	33	18	0	0	253	36	95	5	14	0	0	150	71	57	87	12	0	1	227	853

Hourly Total	249	686	57	14	0	3	1006	40	690	149	75	1	0	955	135	254	33	49	1	2	472	244	265	257	48	0	3	814	3247
3:00 PM	88	249	19	6	0	0	362	17	168	20	29	1	2	235	32	68	14	8	0	0	122	81	62	71	18	0	0	232	951
3:15 PM	73	283	19	3	0	1	378	8	199	30	45	0	1	282	21	74	16	6	0	1	117	69	69	68	10	0	0	216	993
3:30 PM	91	185	16	4	1	0	297	11	218	29	21	1	0	280	28	80	13	14	0	0	135	65	75	64	11	0	0	215	927
3:45 PM	54	202	11	1	0	1	268	8	239	22	33	1	1	303	26	65	8	8	0	0	107	70	85	67	11	0	1	233	911
Hourly Total	306	919	65	14	1	2	1305	44	824	101	128	3	4	1100	107	287	51	36	0	1	481	285	291	270	50	0	1	896	3782
4:00 PM	77	263	18	8	0	0	366	11	177	24	22	0	2	234	25	86	13	12	0	0	136	72	79	61	12	0	0	224	960
4:15 PM	57	203	16	5	0	0	281	15	173	14	25	1	1	228	40	69	9	18	0	0	136	71	90	56	4	0	0	221	866
4:30 PM	60	205	8	3	0	0	276	9	220	27	31	0	0	287	35	118	33	14	0	0	200	70	73	54	11	0	0	208	971
4:45 PM	60	208	17	3	1	0	289	9	193	20	31	1	0	254	42	92	11	19	0	0	164	69	74	54	8	0	0	205	912
Hourly Total	254	879	59	19	1	0	1212	44	763	85	109	2	3	1003	142	365	66	63	0	0	636	282	316	225	35	0	0	858	3709
5:00 PM	66	266	16	1	0	0	349	9	216	30	20	0	0	275	29	116	26	15	0	0	186	82	96	66	19	0	1	263	1073
5:15 PM	54	231	13	2	1	0	301	8	210	22	18	0	0	258	51	69	10	14	0	0	144	93	102	69	23	0	0	287	990
5:30 PM	46	200	18	4	0	0	268	12	205	26	23	0	0	266	38	70	6	6	0	1	120	58	53	49	15	0	1	175	829
5:45 PM	40	147	18	2	1	0	208	9	183	13	29	1	0	235	30	65	12	7	0	0	114	34	56	47	6	0	0	143	700
Hourly Total	206	844	65	9	2	0	1126	38	814	91	90	1	0	1034	148	320	54	42	0	1	564	267	307	231	63	0	2	868	3592
Grand Total	2469	7288	657	160	8	12	10582	542	7042	1425	927	12	18	9948	1199	2852	466	362	15	8	4894	2391	2849	2096	442	3	10	7781	33205
Approach %	23.3	68.9	6.2	1.5	0.1	-	-	5.4	70.8	14.3	9.3	0.1	-	-	24.5	58.3	9.5	7.4	0.3	-	-	30.7	36.6	26.9	5.7	0.0	-	-	-
Total %	7.4	21.9	2.0	0.5	0.0	-	31.9	1.6	21.2	4.3	2.8	0.0	-	30.0	3.6	8.6	1.4	1.1	0.0	-	14.7	7.2	8.6	6.3	1.3	0.0	-	23.4	-
Lights	2329	6914	614	155	8	-	10020	527	6692	1357	908	12	-	9496	1166	2786	457	357	15	-	4781	2334	2772	1993	415	3	-	7517	31814
% Lights	94.3	94.9	93.5	96.9	100.0	-	94.7	97.2	95.0	95.2	98.0	100.0	-	95.5	97.2	97.7	98.1	98.6	100.0	-	97.7	97.6	97.3	95.1	93.9	100.0	-	96.6	95.8
Buses	60	232	23	3	0	-	318	1	177	30	9	0	-	217	6	2	0	0	0	-	8	22	7	42	7	0	-	78	621
% Buses	2.4	3.2	3.5	1.9	0.0	-	3.0	0.2	2.5	2.1	1.0	0.0	-	2.2	0.5	0.1	0.0	0.0	0.0	-	0.2	0.9	0.2	2.0	1.6	0.0	-	1.0	1.9
Trucks	80	142	20	2	0	-	244	14	173	37	10	0	-	234	27	62	9	5	0	-	103	35	68	61	17	0	-	181	762
% Trucks	3.2	1.9	3.0	1.3	0.0	-	2.3	2.6	2.5	2.6	1.1	0.0	-	2.4	2.3	2.2	1.9	1.4	0.0	-	2.1	1.5	2.4	2.9	3.8	0.0	-	2.3	2.3
Bicycles on Road	0	0	0	0	0	-	0	0	0	1	0	0	-	1	0	2	0	0	0	-	2	0	2	0	3	0	-	5	8
% Bicycles on Road	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.1	0.0	0.0	-	0.0	0.0	0.1	0.0	0.0	0.0	-	0.0	0.0	0.1	0.0	0.7	0.0	-	0.1	0.0
Bicycles on Crosswalk	-	-	-	-	-	0	-	-	-	-	-	-	3	-	-	-	-	-	-	0	-	-	-	-	-	-	3	-	-
% Bicycles on Crosswalk	-	-	-	-	-	0.0	-	-	-	-	-	-	16.7	-	-	-	-	-	-	0.0	-	-	-	-	-	-	30.0	-	-
Pedestrians	-	-	-	-	-	12	-	-	-	-	-	-	15	-	-	-	-	-	-	8	-	-	-	-	-	-	7	-	-
% Pedestrians	-	-	-	-	-	100.0	-	-	-	-	-	-	83.3	-	-	-	-	-	-	100.0	-	-	-	-	-	-	70.0	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Jefferson St [SB]

Out	In	Total
7383	7517	14900
101	78	179
189	181	370
3	5	8
0	0	0
7676	**7781**	**15457**

R	T	L	U	P
2408	2772	2334	3	0
49	7	22	0	0
78	68	35	0	0
3	2	0	0	0
0	0	0	0	10
2538	**2849**	**2391**	**3**	**10**

Osuna Rd [EB]

Out	In	Total
10274	10020	20294
232	318	550
278	244	522
3	0	3
0	0	0
10787	**10582**	**21369**

U	L	T	R	P
8	2329	6914	769	0
0	60	232	26	0
0	80	142	22	0
0	0	0	0	0
0	0	0	0	12
8	**2469**	**7288**	**817**	**12**

08/17/2022 6:00 AM
Ending At
08/17/2022 6:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Osuna Rd [WB]

Out	In	Total
10074	9496	19570
254	217	471
191	234	425
0	1	1
0	0	0
10519	**9948**	**20467**

R	T	L	U	P
2265	6692	527	12	0
39	177	1	0	0
47	173	14	0	0
1	0	0	0	0
0	0	0	0	18
2352	**7042**	**542**	**12**	**18**

U	L	T	R	P
15	1166	2786	814	0
0	6	2	0	0
0	27	62	14	0
0	0	2	0	0
0	0	0	0	8
15	**1199**	**2852**	**828**	**8**

Out	In	Total
4083	4781	8864
34	8	42
104	103	207
2	2	4
0	0	0
4223	**4894**	**9117**

Jefferson St [NB]

Turning Movement Data Plot

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Peak Hour Data (7:45 AM)

Start Time	Osuna Rd Eastbound Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total
7:45 AM	83	218	28	6	0	0	335
8:00 AM	86	193	24	8	0	0	311
8:15 AM	59	162	19	6	0	0	246
8:30 AM	95	160	21	7	0	0	283
Total	323	733	92	27	0	0	1175
Approach %	27.5	62.4	7.8	2.3	0.0	-	-
Total %	8.8	19.9	2.5	0.7	0.0	-	31.9
PHF	0.850	0.841	0.821	0.844	0.000	-	0.877
Lights	294	706	87	25	0	-	1112
% Lights	91.0	96.3	94.6	92.6	-	-	94.6
Buses	17	4	1	1	0	-	23
% Buses	5.3	0.5	1.1	3.7	-	-	2.0
Trucks	12	23	4	1	0	-	40
% Trucks	3.7	3.1	4.3	3.7	-	-	3.4
Bicycles on Road	0	0	0	0	0	-	0
% Bicycles on Road	0.0	0.0	0.0	0.0	-	-	0.0
Bicycles on Crosswalk	-	-	-	-	-	0	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	-	0	-
% Pedestrians	-	-	-	-	-	-	-

Start Time	Osuna Rd Westbound Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total
7:45 AM	18	253	72	26	0	2	369
8:00 AM	27	216	49	40	1	0	333
8:15 AM	15	210	56	29	0	0	310
8:30 AM	14	223	42	21	0	0	300
Total	74	902	219	116	1	2	1312
Approach %	5.6	68.8	16.7	8.8	0.1	-	-
Total %	2.0	24.5	5.9	3.2	0.0	-	35.6
PHF	0.685	0.891	0.760	0.725	0.250	-	0.889
Lights	73	843	211	116	1	-	1244
% Lights	98.6	93.5	96.3	100.0	100.0	-	94.8
Buses	0	37	3	0	0	-	40
% Buses	0.0	4.1	1.4	0.0	0.0	-	3.0
Trucks	1	22	4	0	0	-	27
% Trucks	1.4	2.4	1.8	0.0	0.0	-	2.1
Bicycles on Road	0	0	1	0	0	-	1
% Bicycles on Road	0.0	0.0	0.5	0.0	0.0	-	0.1
Bicycles on Crosswalk	-	-	-	-	-	0	-
% Bicycles on Crosswalk	-	-	-	-	-	0.0	-
Pedestrians	-	-	-	-	-	2	-
% Pedestrians	-	-	-	-	-	100.0	-

Start Time	Jefferson St Northbound Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total
7:45 AM	27	70	8	2	0	0	107
8:00 AM	34	64	8	2	0	1	108
8:15 AM	29	51	12	3	0	0	95
8:30 AM	24	60	5	3	0	0	92
Total	114	245	33	10	0	1	402
Approach %	28.4	60.9	8.2	2.5	0.0	-	-
Total %	3.1	6.7	0.9	0.3	0.0	-	10.9
PHF	0.838	0.875	0.688	0.833	0.000	-	0.931
Lights	113	238	31	9	0	-	391
% Lights	99.1	97.1	93.9	90.0	-	-	97.3
Buses	1	0	0	0	0	-	1
% Buses	0.9	0.0	0.0	0.0	-	-	0.2
Trucks	0	7	2	1	0	-	10
% Trucks	0.0	2.9	6.1	10.0	-	-	2.5
Bicycles on Road	0	0	0	0	0	-	0
% Bicycles on Road	0.0	0.0	0.0	0.0	-	-	0.0
Bicycles on Crosswalk	-	-	-	-	-	0	-
% Bicycles on Crosswalk	-	-	-	-	-	0.0	-
Pedestrians	-	-	-	-	-	1	-
% Pedestrians	-	-	-	-	-	100.0	-

Start Time	Jefferson St Southbound Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Int. Total
7:45 AM	50	85	77	5	0	0	217	1028
8:00 AM	37	82	49	13	1	1	182	934
8:15 AM	59	82	43	15	0	0	199	850
8:30 AM	60	76	51	8	0	1	195	870
Total	206	325	220	41	1	2	793	3682
Approach %	26.0	41.0	27.7	5.2	0.1	-	-	-
Total %	5.6	8.8	6.0	1.1	0.0	-	21.5	-
PHF	0.858	0.956	0.714	0.683	0.250	-	0.914	0.895
Lights	198	313	208	36	1	-	756	3503
% Lights	96.1	96.3	94.5	87.8	100.0	-	95.3	95.1
Buses	5	1	4	0	0	-	10	74
% Buses	2.4	0.3	1.8	0.0	0.0	-	1.3	2.0
Trucks	3	11	8	2	0	-	24	101
% Trucks	1.5	3.4	3.6	4.9	0.0	-	3.0	2.7
Bicycles on Road	0	0	0	3	0	-	3	4
% Bicycles on Road	0.0	0.0	0.0	7.3	0.0	-	0.4	0.1
Bicycles on Crosswalk	-	-	-	-	-	1	-	-
% Bicycles on Crosswalk	-	-	-	-	-	50.0	-	-
Pedestrians	-	-	-	-	-	1	-	-
% Pedestrians	-	-	-	-	-	50.0	-	-

Lee Engineering, LLC
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Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Peak Hour Data

08/17/2022 7:45 AM
Ending At
08/17/2022 8:45 AM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
860	756	1616
20	10	30
23	24	47
1	3	4
0	0	0
904	**793**	**1697**

R	T	L	U	P
244	313	198	1	0
4	1	5	0	0
10	11	3	0	0
3	0	0	0	0
0	0	0	0	2
261	**325**	**206**	**1**	**2**

Osuna Rd [EB]

Out	In	Total
1200	1112	2312
42	23	65
32	40	72
3	0	3
0	0	0
1277	**1175**	**2452**

U	L	T	R	P
0	294	706	112	0
0	17	4	2	0
0	12	23	5	0
0	0	0	0	0
0	0	0	0	0
0	**323**	**733**	**119**	**0**

Osuna Rd [WB]

Out	In	Total
945	1244	2189
9	40	49
29	27	56
0	1	1
0	0	0
983	**1312**	**2295**

R	T	L	U	P
327	843	73	1	0
3	37	0	0	0
4	22	1	0	0
1	0	0	0	0
0	0	0	0	2
335	**902**	**74**	**1**	**2**

Jefferson St [NB]

U	L	T	R	P
0	113	238	40	0
0	1	0	0	0
0	0	7	3	0
0	0	0	0	0
0	0	0	0	1
0	**114**	**245**	**43**	**1**

Out	In	Total
498	391	889
3	1	4
17	10	27
0	0	0
0	0	0
518	**402**	**920**

Turning Movement Peak Hour Data Plot (7:45 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022
Page No: 6

Turning Movement Peak Hour Data (11:00 AM)

	Osuna Rd Eastbound							Osuna Rd Westbound							Jefferson St Northbound							Jefferson St Southbound							
Start Time	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Int. Total
11:00 AM	60	189	17	5	0	0	271	10	152	32	11	0	0	205	33	63	17	10	1	0	124	53	61	46	9	0	0	169	769
11:15 AM	64	181	26	2	1	0	274	11	130	44	22	0	0	207	22	74	8	13	1	0	118	68	75	45	27	0	0	215	814
11:30 AM	58	164	17	3	0	0	242	14	148	28	22	0	1	212	34	70	16	14	1	0	135	71	71	60	9	0	0	211	800
11:45 AM	55	196	14	12	0	0	277	19	127	27	26	0	0	199	45	80	15	11	0	0	151	74	92	71	4	0	0	241	868
Total	237	730	74	22	1	0	1064	54	557	131	81	0	1	823	134	287	56	48	3	0	528	266	299	222	49	0	0	836	3251
Approach %	22.3	68.6	7.0	2.1	0.1	-	-	6.6	67.7	15.9	9.8	0.0	-	-	25.4	54.4	10.6	9.1	0.6	-	-	31.8	35.8	26.6	5.9	0.0	-	-	-
Total %	7.3	22.5	2.3	0.7	0.0	-	32.7	1.7	17.1	4.0	2.5	0.0	-	25.3	4.1	8.8	1.7	1.5	0.1	-	16.2	8.2	9.2	6.8	1.5	0.0	-	25.7	-
PHF	0.926	0.931	0.712	0.458	0.250	-	0.960	0.711	0.916	0.744	0.779	0.000	-	0.971	0.744	0.897	0.824	0.857	0.750	-	0.874	0.899	0.813	0.782	0.454	0.000	-	0.867	0.936
Lights	217	700	70	20	1	-	1008	53	529	126	79	0	-	787	130	281	55	46	3	-	515	262	291	217	45	0	-	815	3125
% Lights	91.6	95.9	94.6	90.9	100.0	-	94.7	98.1	95.0	96.2	97.5	-	-	95.6	97.0	97.9	98.2	95.8	100.0	-	97.5	98.5	97.3	97.7	91.8	-	-	97.5	96.1
Buses	6	14	3	1	0	-	24	0	3	2	1	0	-	6	0	1	0	0	0	-	1	3	0	0	0	0	-	3	34
% Buses	2.5	1.9	4.1	4.5	0.0	-	2.3	0.0	0.5	1.5	1.2	-	-	0.7	0.0	0.3	0.0	0.0	0.0	-	0.2	1.1	0.0	0.0	0.0	-	-	0.4	1.0
Trucks	14	16	1	1	0	-	32	1	25	3	1	0	-	30	4	5	1	2	0	-	12	1	8	5	4	0	-	18	92
% Trucks	5.9	2.2	1.4	4.5	0.0	-	3.0	1.9	4.5	2.3	1.2	-	-	3.6	3.0	1.7	1.8	4.2	0.0	-	2.3	0.4	2.7	2.3	8.2	-	-	2.2	2.8
Bicycles on Road	0	0	0	0	0	-	0	0	0	0	0	0	-	0	0	0	0	0	0	-	0	0	0	0	0	0	-	0	0
% Bicycles on Road	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	-	0	-	-	-	-	-	-	1	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

LEE ENGINEERING
Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Peak Hour Data

08/17/2022 11:00 AM
Ending At
08/17/2022 12:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
703	815	1518
10	3	13
23	18	41
0	0	0
0	0	0
736	**836**	**1572**

R	T	L	U	P
262	291	262	0	0
0	0	3	0	0
9	8	1	0	0
0	0	0	0	0
0	0	0	0	0
271	**299**	**266**	**0**	**0**

Osuna Rd [EB]

Out	In	Total
922	1008	1930
3	24	27
38	32	70
0	0	0
0	0	0
963	**1064**	**2027**

U	L	T	R	P
1	217	700	90	0
0	6	14	4	0
0	14	16	2	0
0	0	0	0	0
0	0	0	0	0
1	**237**	**730**	**96**	**0**

Osuna Rd [WB]

Out	In	Total
1063	787	1850
17	6	23
20	30	50
0	0	0
0	0	0
1100	**823**	**1923**

R	T	L	U	P
205	529	53	0	0
3	3	0	0	0
4	25	1	0	0
0	0	0	0	0
0	0	0	0	1
212	**557**	**54**	**0**	**1**

U	L	T	R	P
3	130	281	101	0
0	0	1	0	0
0	4	5	3	0
0	0	0	0	0
0	0	0	0	0
3	**134**	**287**	**104**	**0**

Out	In	Total
437	515	952
4	1	5
11	12	23
0	0	0
0	0	0
452	**528**	**980**

Jefferson St [NB]

Turning Movement Peak Hour Data Plot (11:00 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Peak Hour Data (4:30 PM)

Start Time	Osuna Rd Eastbound							Osuna Rd Westbound							Jefferson St Northbound							Jefferson St Southbound							
	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Left	Thru	Right	Right on Red	U-Turn	Peds	App. Total	Int. Total
4:30 PM	60	205	8	3	0	0	276	9	220	27	31	0	0	287	35	118	33	14	0	0	200	70	73	54	11	0	0	208	971
4:45 PM	60	208	17	3	1	0	289	9	193	20	31	1	0	254	42	92	11	19	0	0	164	69	74	54	8	0	0	205	912
5:00 PM	66	266	16	1	0	0	349	9	216	30	20	0	0	275	29	116	26	15	0	0	186	82	96	66	19	0	1	263	1073
5:15 PM	54	231	13	2	1	0	301	8	210	22	18	0	0	258	51	69	10	14	0	0	144	93	102	69	23	0	0	287	990
Total	240	910	54	9	2	0	1215	35	839	99	100	1	0	1074	157	395	80	62	0	0	694	314	345	243	61	0	1	963	3946
Approach %	19.8	74.9	4.4	0.7	0.2	-	-	3.3	78.1	9.2	9.3	0.1	-	-	22.6	56.9	11.5	8.9	0.0	-	-	32.6	35.8	25.2	6.3	0.0	-	-	-
Total %	6.1	23.1	1.4	0.2	0.1	-	30.8	0.9	21.3	2.5	2.5	0.0	-	27.2	4.0	10.0	2.0	1.6	0.0	-	17.6	8.0	8.7	6.2	1.5	0.0	-	24.4	-
PHF	0.909	0.855	0.794	0.750	0.500	-	0.870	0.972	0.953	0.825	0.806	0.250	-	0.936	0.770	0.837	0.606	0.816	0.000	-	0.868	0.844	0.846	0.880	0.663	0.000	-	0.839	0.919
Lights	234	902	54	9	2	-	1201	34	790	93	97	1	-	1015	154	388	79	61	0	-	682	310	337	232	60	0	-	939	3837
% Lights	97.5	99.1	100.0	100.0	100.0	-	98.8	97.1	94.2	93.9	97.0	100.0	-	94.5	98.1	98.2	98.8	98.4	-	-	98.3	98.7	97.7	95.5	98.4	-	-	97.5	97.2
Buses	0	0	0	0	0	-	0	0	34	1	1	0	-	36	0	1	0	0	0	-	1	2	0	3	0	0	-	5	42
% Buses	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	4.1	1.0	1.0	0.0	-	3.4	0.0	0.3	0.0	0.0	-	-	0.1	0.6	0.0	1.2	0.0	-	-	0.5	1.1
Trucks	6	8	0	0	0	-	14	1	15	5	2	0	-	23	3	5	1	1	0	-	10	2	6	8	1	0	-	17	64
% Trucks	2.5	0.9	0.0	0.0	0.0	-	1.2	2.9	1.8	5.1	2.0	0.0	-	2.1	1.9	1.3	1.3	1.6	-	-	1.4	0.6	1.7	3.3	1.6	-	-	1.8	1.6
Bicycles on Road	0	0	0	0	0	-	0	0	0	0	0	0	-	0	0	1	0	0	0	-	1	0	2	0	0	0	-	2	3
% Bicycles on Road	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.3	0.0	0.0	-	-	0.1	0.0	0.6	0.0	0.0	-	-	0.2	0.1
Bicycles on Crosswalk	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	1	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100.0	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Peak Hour Data

08/17/2022 4:30 PM
Ending At
08/17/2022 5:30 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
812	939	1751
3	5	8
18	17	35
1	2	3
0	0	0
834	**963**	**1797**

R	T	L	U	P
292	337	310	0	0
3	0	2	0	0
9	6	2	0	0
0	2	0	0	0
0	0	0	0	1
304	**345**	**314**	**0**	**1**

Osuna Rd [EB]

Out	In	Total
1238	1201	2439
37	0	37
27	14	41
0	0	0
0	0	0
1302	**1215**	**2517**

U	L	T	R	P
2	234	902	63	0
0	0	0	0	0
0	6	8	0	0
0	0	0	0	0
0	0	0	0	0
2	**240**	**910**	**63**	**0**

Osuna Rd [WB]

Out	In	Total
1353	1015	2368
2	36	38
12	23	35
0	0	0
0	0	0
1367	**1074**	**2441**

R	T	L	U	P
190	790	34	1	0
2	34	0	0	0
7	15	1	0	0
0	0	0	0	0
0	0	0	0	0
199	**839**	**35**	**1**	**0**

U	L	T	R	P
0	154	388	140	0
0	0	1	0	0
0	3	5	2	0
0	0	1	0	0
0	0	0	0	0
0	**157**	**395**	**142**	**0**

Out	In	Total
434	682	1116
0	1	1
7	10	17
2	1	3
0	0	0
443	**694**	**1137**

Jefferson St [NB]

Turning Movement Peak Hour Data Plot (4:30 PM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School
NIA
Site Code:
Start Date: 08/31/2022
Page No: 1

Turning Movement Data

Start Time	Business Park Driveway Eastbound						Presidential Dr North Westbound						Jefferson St Northbound						Jefferson St Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
6:00 AM	0	0	0	0	0	0	0	0	4	0	0	4	1	25	0	0	0	26	0	30	0	5	0	35	65
6:15 AM	0	0	1	0	0	1	1	0	3	0	0	4	1	25	0	0	0	26	0	45	0	3	0	48	79
6:30 AM	0	0	0	0	1	0	1	0	3	0	0	4	0	37	0	0	1	37	4	63	1	2	0	70	111
6:45 AM	0	0	0	0	1	0	3	0	9	0	0	12	0	61	2	0	0	63	1	92	0	6	0	99	174
Hourly Total	0	0	1	0	2	1	5	0	19	0	0	24	2	148	2	0	1	152	5	230	1	16	0	252	429
7:00 AM	0	0	0	0	2	0	1	0	11	0	0	12	0	55	1	0	0	56	1	79	1	7	0	88	156
7:15 AM	0	0	1	1	0	2	2	1	13	0	0	16	0	55	1	0	0	56	3	85	3	2	0	93	167
7:30 AM	1	0	0	0	0	1	0	2	15	0	0	17	3	66	0	0	0	69	3	113	4	8	0	128	215
7:45 AM	1	0	3	0	0	4	3	0	13	0	1	16	4	98	2	0	0	104	6	168	5	12	0	191	315
Hourly Total	2	0	4	1	2	7	6	3	52	0	1	61	7	274	4	0	0	285	13	445	13	29	0	500	853
8:00 AM	1	0	1	0	0	2	2	0	16	0	0	18	3	77	3	0	0	83	2	155	9	12	0	178	281
8:15 AM	0	0	0	0	0	0	2	1	12	0	0	15	1	66	1	0	0	68	2	146	6	5	0	159	242
8:30 AM	0	0	0	0	0	0	0	0	11	0	0	11	3	76	1	0	0	80	3	120	1	4	0	128	219
8:45 AM	1	0	0	0	0	1	2	0	7	0	0	9	3	86	1	0	0	90	6	114	6	3	0	129	229
Hourly Total	2	0	1	0	0	3	6	1	46	0	0	53	10	305	6	0	0	321	13	535	22	24	0	594	971
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11:00 AM	1	0	6	0	0	7	0	0	2	0	0	2	0	100	1	1	0	102	2	91	0	6	1	99	210
11:15 AM	1	0	4	0	0	5	1	1	7	0	0	9	2	98	1	1	0	102	2	96	2	2	0	102	218
11:30 AM	4	0	1	0	0	5	4	0	9	0	0	13	0	116	1	3	0	120	2	108	1	11	1	122	260
11:45 AM	2	0	1	0	0	3	2	0	9	0	0	11	1	147	3	1	0	152	5	121	0	14	0	140	306
Hourly Total	8	0	12	0	0	20	7	1	27	0	0	35	3	461	6	6	0	476	11	416	3	33	2	463	994
12:00 PM	0	0	2	0	0	2	3	0	16	0	0	19	2	173	3	1	0	179	7	123	2	23	0	155	355
12:15 PM	3	0	3	0	1	6	2	0	28	0	1	30	1	116	0	0	0	117	7	138	3	19	0	167	320
12:30 PM	2	0	0	0	0	2	3	0	16	0	0	19	1	152	1	1	0	155	10	124	1	15	0	150	326
12:45 PM	1	0	2	0	1	3	1	0	17	0	1	18	1	136	0	0	0	137	4	132	6	13	0	155	313
Hourly Total	6	0	7	0	2	13	9	0	77	0	2	86	5	577	4	2	0	588	28	517	12	70	0	627	1314
1:00 PM	3	0	1	0	0	4	3	0	13	0	0	16	1	138	0	1	0	140	5	107	3	6	0	121	281
1:15 PM	3	0	3	0	0	6	1	0	12	0	0	13	1	132	2	0	0	135	3	116	3	3	0	125	279
1:30 PM	1	0	2	0	1	3	3	1	13	0	0	17	2	126	1	0	0	129	3	110	2	4	0	119	268
1:45 PM	1	0	0	0	0	1	0	0	8	0	0	8	2	130	2	0	0	134	0	110	0	3	0	113	256
Hourly Total	8	0	6	0	1	14	7	1	46	0	0	54	6	526	5	1	0	538	11	443	8	16	0	478	1084
2:00 PM	3	0	2	0	0	5	0	0	7	0	0	7	2	136	0	0	0	138	5	105	2	10	0	122	272
2:15 PM	1	0	1	0	0	2	2	0	4	0	0	6	0	135	1	0	0	136	2	101	1	10	0	114	258
2:30 PM	2	0	0	0	0	2	1	0	7	0	0	8	2	132	1	0	0	135	1	100	1	4	0	106	251
2:45 PM	2	0	3	0	0	5	1	0	7	0	0	8	0	120	1	0	0	121	2	116	0	8	0	126	260

Hourly Total	8	0	6	0	0	14	4	0	25	0	0	29	4	523	3	0	0	530	10	422	4	32	0	468	1041
3:00 PM	2	0	0	0	0	2	0	1	7	0	0	8	3	146	0	2	1	151	0	111	2	5	0	118	279
3:15 PM	1	0	4	0	1	5	0	0	6	0	0	6	1	87	1	0	0	89	1	97	1	8	0	107	207
3:30 PM	2	0	0	0	1	2	1	0	7	0	0	8	1	145	0	0	0	146	3	113	0	7	0	123	279
3:45 PM	0	0	1	0	0	1	0	0	3	0	1	3	0	128	1	0	0	129	3	118	0	3	0	124	257
Hourly Total	5	0	5	0	2	10	1	1	23	0	1	25	5	506	2	2	1	515	7	439	3	23	0	472	1022
4:00 PM	1	0	6	0	0	7	2	0	5	0	0	7	0	146	2	0	0	148	3	158	0	4	0	165	327
4:15 PM	1	0	1	0	0	2	1	0	5	0	0	6	1	150	0	0	0	151	2	82	0	4	0	88	247
4:30 PM	2	0	3	0	0	5	1	0	4	0	0	5	0	171	2	0	0	173	1	117	1	6	0	125	308
4:45 PM	2	0	2	0	0	4	0	0	2	0	0	2	0	150	0	0	0	150	1	102	0	5	0	108	264
Hourly Total	6	0	12	0	0	18	4	0	16	0	0	20	1	617	4	0	0	622	7	459	1	19	0	486	1146
5:00 PM	2	0	7	0	0	9	1	0	3	0	1	4	0	183	0	0	0	183	3	121	0	4	0	128	324
5:15 PM	0	0	3	1	0	4	1	0	3	0	0	4	0	110	0	0	0	110	0	108	0	9	0	117	235
5:30 PM	0	0	3	0	0	3	1	0	6	0	0	7	1	113	0	0	0	114	1	84	1	6	0	92	216
5:45 PM	2	0	1	0	1	3	0	0	1	0	0	1	0	75	0	1	0	76	1	61	0	0	0	62	142
Hourly Total	4	0	14	1	1	19	3	0	13	0	1	16	1	481	0	1	0	483	5	374	1	19	0	399	917
Grand Total	49	0	68	2	10	119	52	7	344	0	5	403	44	4418	36	12	2	4510	110	4280	68	281	2	4739	9771
Approach %	41.2	0.0	57.1	1.7	-	-	12.9	1.7	85.4	0.0	-	-	1.0	98.0	0.8	0.3	-	-	2.3	90.3	1.4	5.9	-	-	-
Total %	0.5	0.0	0.7	0.0	-	1.2	0.5	0.1	3.5	0.0	-	4.1	0.5	45.2	0.4	0.1	-	46.2	1.1	43.8	0.7	2.9	-	48.5	-
Lights	47	0	67	2	-	116	51	7	335	0	-	393	44	4321	33	11	-	4409	103	4128	68	281	-	4580	9498
% Lights	95.9	-	98.5	100.0	-	97.5	98.1	100.0	97.4	-	-	97.5	100.0	97.8	91.7	91.7	-	97.8	93.6	96.4	100.0	100.0	-	96.6	97.2
Buses	0	0	0	0	-	0	0	0	3	0	-	3	0	11	0	0	-	11	2	37	0	0	-	39	53
% Buses	0.0	-	0.0	0.0	-	0.0	0.0	0.0	0.9	-	-	0.7	0.0	0.2	0.0	0.0	-	0.2	1.8	0.9	0.0	0.0	-	0.8	0.5
Trucks	2	0	0	0	-	2	1	0	6	0	-	7	0	84	3	1	-	88	4	113	0	0	-	117	214
% Trucks	4.1	-	0.0	0.0	-	1.7	1.9	0.0	1.7	-	-	1.7	0.0	1.9	8.3	8.3	-	2.0	3.6	2.6	0.0	0.0	-	2.5	2.2
Bicycles on Road	0	0	1	0	-	1	0	0	0	0	-	0	0	2	0	0	-	2	1	2	0	0	-	3	6
% Bicycles on Road	0.0	-	1.5	0.0	-	0.8	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.9	0.0	0.0	0.0	-	0.1	0.1
Bicycles on Crosswalk	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	10.0	-	-	-	-	-	20.0	-	-	-	-	-	50.0	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	9	-	-	-	-	-	4	-	-	-	-	-	1	-	-	-	-	-	2	-	-
% Pedestrians	-	-	-	-	90.0	-	-	-	-	-	80.0	-	-	-	-	-	50.0	-	-	-	-	-	100.0	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/31/2022

Jefferson St [SB]

Out	In	Total
4984	4580	9564
14	39	53
92	117	209
2	3	5
0	0	0
5092	**4739**	**9831**

R	T	L	U	P
68	4128	103	281	0
0	37	2	0	0
0	113	4	0	0
0	2	1	0	0
0	0	0	0	2
68	**4280**	**110**	**281**	**2**

Business Park Driveway [E

Out	In	Total
121	116	237
0	0	0
0	2	2
0	1	1
0	0	0
121	**119**	**240**

U	L	T	R	P
2	47	0	67	0
0	0	0	0	0
0	2	0	0	0
0	0	0	1	0
0	0	0	0	10
2	**49**	**0**	**68**	**10**

08/31/2022 6:00 AM
Ending At
08/31/2022 6:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

R	T	L	U	P
335	7	51	0	0
3	0	0	0	0
6	0	1	0	0
0	0	0	0	0
0	0	0	0	5
344	**7**	**52**	**0**	**5**

Presidential Dr North [WB]

Out	In	Total
136	393	529
2	3	5
7	7	14
1	0	1
0	0	0
146	**403**	**549**

U	L	T	R	P
11	44	4321	33	0
0	0	11	0	0
1	0	84	3	0
0	0	2	0	0
0	0	0	0	2
12	**44**	**4418**	**36**	**2**

Out	In	Total
4257	4409	8666
37	11	48
115	88	203
3	2	5
0	0	0
4412	**4510**	**8922**

Jefferson St [NB]

Turning Movement Data Plot

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/31/2022

Turning Movement Peak Hour Data (7:45 AM)

Start Time	Business Park Driveway Eastbound						Presidential Dr North Westbound						Jefferson St Northbound						Jefferson St Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
7:45 AM	1	0	3	0	0	4	3	0	13	0	1	16	4	98	2	0	0	104	6	168	5	12	0	191	315
8:00 AM	1	0	1	0	0	2	2	0	16	0	0	18	3	77	3	0	0	83	2	155	9	12	0	178	281
8:15 AM	0	0	0	0	0	0	2	1	12	0	0	15	1	66	1	0	0	68	2	146	6	5	0	159	242
8:30 AM	0	0	0	0	0	0	0	0	11	0	0	11	3	76	1	0	0	80	3	120	1	4	0	128	219
Total	2	0	4	0	0	6	7	1	52	0	1	60	11	317	7	0	0	335	13	589	21	33	0	656	1057
Approach %	33.3	0.0	66.7	0.0	-	-	11.7	1.7	86.7	0.0	-	-	3.3	94.6	2.1	0.0	-	-	2.0	89.8	3.2	5.0	-	-	-
Total %	0.2	0.0	0.4	0.0	-	0.6	0.7	0.1	4.9	0.0	-	5.7	1.0	30.0	0.7	0.0	-	31.7	1.2	55.7	2.0	3.1	-	62.1	-
PHF	0.500	0.000	0.333	0.000	-	0.375	0.583	0.250	0.813	0.000	-	0.833	0.688	0.809	0.583	0.000	-	0.805	0.542	0.876	0.583	0.688	-	0.859	0.839
Lights	2	0	4	0	-	6	7	1	52	0	-	60	11	311	6	0	-	328	11	570	21	33	-	635	1029
% Lights	100.0	-	100.0	-	-	100.0	100.0	100.0	100.0	-	-	100.0	100.0	98.1	85.7	-	-	97.9	84.6	96.8	100.0	100.0	-	96.8	97.4
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	1	1	1	0	0	-	2	3
% Buses	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.3	0.0	-	-	0.3	7.7	0.2	0.0	0.0	-	0.3	0.3
Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	5	1	0	-	6	1	18	0	0	-	19	25
% Trucks	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	1.6	14.3	-	-	1.8	7.7	3.1	0.0	0.0	-	2.9	2.4
Bicycles on Road	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0
% Bicycles on Road	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

LEE ENGINEERING
Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Peak Hour Data

08/31/2022 7:45 AM
Ending At
08/31/2022 8:45 AM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

	Out	In	Total
Lights	398	635	1033
Buses	1	2	3
Trucks	5	19	24
Bicycles on Road	0	0	0
Other	0	0	0
Total	**404**	**656**	**1060**

	R	T	L	U	P
Lights	21	570	11	33	0
Buses	0	1	1	0	0
Trucks	0	18	1	0	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	0
Total	**21**	**589**	**13**	**33**	**0**

Business Park Driveway [EB]

	Out	In	Total
Lights	33	6	39
Buses	0	0	0
Trucks	0	0	0
Bicycles on Road	0	0	0
Other	0	0	0
Total	**33**	**6**	**39**

	U	L	T	R	P
Lights	0	2	0	4	0
Buses	0	0	0	0	0
Trucks	0	0	0	0	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	0
Total	**0**	**2**	**0**	**4**	**0**

Presidential Dr North [WB]

	Out	In	Total
Lights	17	60	77
Buses	1	0	1
Trucks	2	0	2
Bicycles on Road	0	0	0
Other	0	0	0
Total	**20**	**60**	**80**

	R	T	L	U	P
Lights	52	1	7	0	0
Buses	0	0	0	0	0
Trucks	0	0	0	0	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	1
Total	**52**	**1**	**7**	**0**	**1**

Jefferson St [NB]

	U	L	T	R	P
Lights	0	11	311	6	0
Buses	0	0	1	0	0
Trucks	0	0	5	1	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	0
Total	**0**	**11**	**317**	**7**	**0**

	Out	In	Total
Lights	581	328	909
Buses	1	1	2
Trucks	18	6	24
Bicycles on Road	0	0	0
Other	0	0	0
Total	**600**	**335**	**935**

Turning Movement Peak Hour Data Plot (7:45 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Turning Movement Peak Hour Data (11:00 AM)

Start Time	Business Park Driveway Eastbound						Presidential Dr North Westbound						Jefferson St Northbound						Jefferson St Southbound						Int. Total
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	
11:00 AM	1	0	6	0	0	7	0	0	2	0	0	2	0	100	1	1	0	102	2	91	0	6	1	99	210
11:15 AM	1	0	4	0	0	5	1	1	7	0	0	9	2	98	1	1	0	102	2	96	2	2	0	102	218
11:30 AM	4	0	1	0	0	5	4	0	9	0	0	13	0	116	1	3	0	120	2	108	1	11	1	122	260
11:45 AM	2	0	1	0	0	3	2	0	9	0	0	11	1	147	3	1	0	152	5	121	0	14	0	140	306
Total	8	0	12	0	0	20	7	1	27	0	0	35	3	461	6	6	0	476	11	416	3	33	2	463	994
Approach %	40.0	0.0	60.0	0.0	-	-	20.0	2.9	77.1	0.0	-	-	0.6	96.8	1.3	1.3	-	-	2.4	89.8	0.6	7.1	-	-	-
Total %	0.8	0.0	1.2	0.0	-	2.0	0.7	0.1	2.7	0.0	-	3.5	0.3	46.4	0.6	0.6	-	47.9	1.1	41.9	0.3	3.3	-	46.6	-
PHF	0.500	0.000	0.500	0.000	-	0.714	0.438	0.250	0.750	0.000	-	0.673	0.375	0.784	0.500	0.500	-	0.783	0.550	0.860	0.375	0.589	-	0.827	0.812
Lights	8	0	12	0	-	20	7	1	27	0	-	35	3	449	5	5	-	462	10	398	3	33	-	444	961
% Lights	100.0	-	100.0	-	-	100.0	100.0	100.0	100.0	-	-	100.0	100.0	97.4	83.3	83.3	-	97.1	90.9	95.7	100.0	100.0	-	95.9	96.7
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	1	0	3	0	0	-	3	4
% Buses	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	0.0	-	0.2	0.0	0.7	0.0	0.0	-	0.6	0.4
Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	11	1	1	-	13	1	15	0	0	-	16	29
% Trucks	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	2.4	16.7	16.7	-	2.7	9.1	3.6	0.0	0.0	-	3.5	2.9
Bicycles on Road	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0
% Bicycles on Road	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	2	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100.0	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Peak Hour Data

08/31/2022 11:00 AM
Ending At
08/31/2022 12:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
517	444	961
1	3	4
11	16	27
0	0	0
0	0	0
529	**463**	**992**

R	T	L	U	P
3	398	10	33	0
0	3	0	0	0
0	15	1	0	0
0	0	0	0	0
0	0	0	0	2
3	**416**	**11**	**33**	**2**

Business Park Driveway [EB]

Out	In	Total
7	20	27
0	0	0
0	0	0
0	0	0
0	0	0
7	**20**	**27**

U	L	T	R	P
0	8	0	12	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	**8**	**0**	**12**	**0**

Presidential Dr North [WB]

Out	In	Total
15	35	50
0	0	0
2	0	2
0	0	0
0	0	0
17	**35**	**52**

R	T	L	U	P
27	1	7	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
27	**1**	**7**	**0**	**0**

Jefferson St [NB]

U	L	T	R	P
5	3	449	5	0
0	0	1	0	0
1	0	11	1	0
0	0	0	0	0
0	0	0	0	0
6	**3**	**461**	**6**	**0**

Out	In	Total
422	462	884
3	1	4
16	13	29
0	0	0
0	0	0
441	**476**	**917**

Turning Movement Peak Hour Data Plot (11:00 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Turning Movement Peak Hour Data (12:00 PM)

	Business Park Driveway						Presidential Dr North						Jefferson St						Jefferson St						
	Eastbound						Westbound						Northbound						Southbound						
Start Time	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
12:00 PM	0	0	2	0	0	2	3	0	16	0	0	19	2	173	3	1	0	179	7	123	2	23	0	155	355
12:15 PM	3	0	3	0	1	6	2	0	28	0	1	30	1	116	0	0	0	117	7	138	3	19	0	167	320
12:30 PM	2	0	0	0	0	2	3	0	16	0	0	19	1	152	1	1	0	155	10	124	1	15	0	150	326
12:45 PM	1	0	2	0	1	3	1	0	17	0	1	18	1	136	0	0	0	137	4	132	6	13	0	155	313
Total	6	0	7	0	2	13	9	0	77	0	2	86	5	577	4	2	0	588	28	517	12	70	0	627	1314
Approach %	46.2	0.0	53.8	0.0	-	-	10.5	0.0	89.5	0.0	-	-	0.9	98.1	0.7	0.3	-	-	4.5	82.5	1.9	11.2	-	-	-
Total %	0.5	0.0	0.5	0.0	-	1.0	0.7	0.0	5.9	0.0	-	6.5	0.4	43.9	0.3	0.2	-	44.7	2.1	39.3	0.9	5.3	-	47.7	-
PHF	0.500	0.000	0.583	0.000	-	0.542	0.750	0.000	0.688	0.000	-	0.717	0.625	0.834	0.333	0.500	-	0.821	0.700	0.937	0.500	0.761	-	0.939	0.925
Lights	6	0	7	0	-	13	9	0	75	0	-	84	5	565	4	2	-	576	27	502	12	70	-	611	1284
% Lights	100.0	-	100.0	-	-	100.0	100.0	-	97.4	-	-	97.7	100.0	97.9	100.0	100.0	-	98.0	96.4	97.1	100.0	100.0	-	97.4	97.7
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	1	0	3	0	0	-	3	4
% Buses	0.0	-	0.0	-	-	0.0	0.0	-	0.0	-	-	0.0	0.0	0.2	0.0	0.0	-	0.2	0.0	0.6	0.0	0.0	-	0.5	0.3
Trucks	0	0	0	0	-	0	0	0	2	0	-	2	0	11	0	0	-	11	1	12	0	0	-	13	26
% Trucks	0.0	-	0.0	-	-	0.0	0.0	-	2.6	-	-	2.3	0.0	1.9	0.0	0.0	-	1.9	3.6	2.3	0.0	0.0	-	2.1	2.0
Bicycles on Road	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0
% Bicycles on Road	0.0	-	0.0	-	-	0.0	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/31/2022

Peak Hour Data

08/31/2022 12:00 PM
Ending At
08/31/2022 1:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
716	611	1327
1	3	4
13	13	26
0	0	0
0	0	0
730	**627**	**1357**

R	T	L	U	P
12	502	27	70	0
0	3	0	0	0
0	12	1	0	0
0	0	0	0	0
0	0	0	0	0
12	**517**	**28**	**70**	**0**

Business Park Driveway [E

Out	In	Total
17	13	30
0	0	0
0	0	0
0	0	0
0	0	0
17	**13**	**30**

U	L	T	R	P
0	6	0	7	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	2
0	**6**	**0**	**7**	**2**

Presidential Dr North [WB]

Out	In	Total
31	84	115
0	0	0
1	2	3
0	0	0
0	0	0
32	**86**	**118**

R	T	L	U	P
75	0	9	0	0
0	0	0	0	0
2	0	0	0	0
0	0	0	0	0
0	0	0	0	2
77	**0**	**9**	**0**	**2**

Jefferson St [NB]

U	L	T	R	P
2	5	565	4	0
0	0	1	0	0
0	0	11	0	0
0	0	0	0	0
0	0	0	0	0
2	**5**	**577**	**4**	**0**

Out	In	Total
520	576	1096
3	1	4
12	11	23
0	0	0
0	0	0
535	**588**	**1123**

Turning Movement Peak Hour Data Plot (12:00 PM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022
Page No: 1

Turning Movement Data

Start Time	Presidential Dr Westbound					Jefferson St Northbound					Jefferson St Southbound					
	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	U-Turn	Peds	App. Total	Int. Total
6:00 AM	1	0	0	0	1	26	1	0	0	27	0	24	0	0	24	52
6:15 AM	5	0	0	0	5	26	1	0	0	27	0	51	0	0	51	83
6:30 AM	6	1	0	0	7	34	0	0	0	34	0	63	0	0	63	104
6:45 AM	6	0	0	0	6	15	0	0	0	15	1	95	0	0	96	117
Hourly Total	18	1	0	0	19	101	2	0	0	103	1	233	0	0	234	356
7:00 AM	6	3	0	0	9	60	1	0	0	61	2	87	0	0	89	159
7:15 AM	9	0	0	0	9	74	1	0	0	75	2	75	1	0	78	162
7:30 AM	5	1	0	0	6	62	2	0	0	64	1	92	0	0	93	163
7:45 AM	12	1	0	0	13	77	2	0	0	79	0	109	0	0	109	201
Hourly Total	32	5	0	0	37	273	6	0	0	279	5	363	1	0	369	685
8:00 AM	5	2	0	0	7	83	0	1	0	84	4	137	0	0	141	232
8:15 AM	9	2	0	0	11	71	2	0	0	73	4	91	0	0	95	179
8:30 AM	9	4	0	1	13	77	5	0	0	82	6	112	1	0	119	214
8:45 AM	7	2	0	0	9	71	3	0	0	74	5	109	0	0	114	197
Hourly Total	30	10	0	1	40	302	10	1	0	313	19	449	1	0	469	822
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11:00 AM	8	3	0	2	11	119	2	0	0	121	2	103	0	0	105	237
11:15 AM	9	4	0	0	13	108	4	0	0	112	0	119	0	0	119	244
11:30 AM	9	3	0	1	12	134	6	0	0	140	2	97	0	0	99	251
11:45 AM	6	6	0	0	12	123	1	0	0	124	0	110	2	0	112	248
Hourly Total	32	16	0	3	48	484	13	0	0	497	4	429	2	0	435	980
12:00 PM	9	6	0	0	15	154	4	0	0	158	0	134	2	0	136	309
12:15 PM	8	2	0	1	10	137	3	1	0	141	3	100	2	0	105	256
12:30 PM	10	1	0	0	11	140	3	0	0	143	3	110	1	0	114	268
12:45 PM	4	2	0	3	6	119	5	0	0	124	1	87	1	0	89	219
Hourly Total	31	11	0	4	42	550	15	1	0	566	7	431	6	0	444	1052
1:00 PM	8	6	0	1	14	129	2	0	0	131	2	115	1	3	118	263
1:15 PM	10	2	0	2	12	125	1	0	0	126	2	95	0	0	97	235
1:30 PM	3	2	0	0	5	125	3	0	0	128	1	103	0	0	104	237
1:45 PM	5	2	0	0	7	114	3	0	0	117	2	92	0	0	94	218
Hourly Total	26	12	0	3	38	493	9	0	0	502	7	405	1	3	413	953
2:00 PM	8	1	0	1	9	94	4	0	0	98	2	99	1	0	102	209
2:15 PM	5	1	0	0	6	103	2	0	0	105	2	91	0	0	93	204
2:30 PM	5	1	0	0	6	108	3	0	0	111	3	87	0	0	90	207
2:45 PM	7	1	0	0	8	121	3	0	0	124	2	70	0	0	72	204
Hourly Total	25	4	0	1	29	426	12	0	0	438	9	347	1	0	357	824

3:00 PM	2	1	0	0	3	120	5	0	0	125	3	94	2	0	99	227
3:15 PM	2	3	0	0	5	107	1	0	0	108	2	90	0	0	92	205
3:30 PM	2	7	0	0	9	127	0	0	0	127	2	100	0	0	102	238
3:45 PM	2	2	0	0	4	91	3	2	0	96	3	89	0	0	92	192
Hourly Total	8	13	0	0	21	445	9	2	0	456	10	373	2	0	385	862
4:00 PM	2	5	0	0	7	136	2	0	0	138	0	130	0	0	130	275
4:15 PM	7	1	0	0	8	138	2	0	0	140	1	124	1	0	126	274
4:30 PM	8	4	0	0	12	169	4	0	0	173	2	102	0	0	104	289
4:45 PM	5	4	0	0	9	156	2	0	0	158	0	99	0	0	99	266
Hourly Total	22	14	0	0	36	599	10	0	0	609	3	455	1	0	459	1104
5:00 PM	1	7	0	0	8	166	3	0	0	169	1	128	1	0	130	307
5:15 PM	2	2	0	0	4	121	2	0	0	123	0	120	0	0	120	247
5:30 PM	0	2	0	0	2	107	2	0	0	109	0	97	0	0	97	208
5:45 PM	0	2	0	0	2	87	1	0	0	88	1	71	0	0	72	162
Hourly Total	3	13	0	0	16	481	8	0	0	489	2	416	1	0	419	924
Grand Total	227	99	0	12	326	4154	94	4	0	4252	67	3901	16	3	3984	8562
Approach %	69.6	30.4	0.0	-	-	97.7	2.2	0.1	-	-	1.7	97.9	0.4	-	-	-
Total %	2.7	1.2	0.0	-	3.8	48.5	1.1	0.0	-	49.7	0.8	45.6	0.2	-	46.5	-
Lights	225	96	0	-	321	4052	94	4	-	4150	66	3764	16	-	3846	8317
% Lights	99.1	97.0	-	-	98.5	97.5	100.0	100.0	-	97.6	98.5	96.5	100.0	-	96.5	97.1
Buses	0	0	0	-	0	8	0	0	-	8	0	33	0	-	33	41
% Buses	0.0	0.0	-	-	0.0	0.2	0.0	0.0	-	0.2	0.0	0.8	0.0	-	0.8	0.5
Trucks	2	3	0	-	5	85	0	0	-	85	1	100	0	-	101	191
% Trucks	0.9	3.0	-	-	1.5	2.0	0.0	0.0	-	2.0	1.5	2.6	0.0	-	2.5	2.2
Bicycles on Road	0	0	0	-	0	9	0	0	-	9	0	4	0	-	4	13
% Bicycles on Road	0.0	0.0	-	-	0.0	0.2	0.0	0.0	-	0.2	0.0	0.1	0.0	-	0.1	0.2
Bicycles on Crosswalk	-	-	-	1	-	-	-	-	0	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	8.3	-	-	-	-	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	11	-	-	-	-	0	-	-	-	-	3	-	-
% Pedestrians	-	-	-	91.7	-	-	-	-	-	-	-	-	-	100.0	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Jefferson St [SB]

Out	In	Total
4164	3846	8010
8	33	41
88	101	189
9	4	13
0	0	0
4269	**3984**	**8253**

T	L	U	P
3764	66	16	0
33	0	0	0
100	1	0	0
4	0	0	0
0	0	0	3
3901	**67**	**16**	**3**

Presidential Dr [WB]

Out	In	Total
160	321	481
0	0	0
1	5	6
0	0	0
0	0	0
161	**326**	**487**

R	L	U	P
96	225	0	0
0	0	0	0
3	2	0	0
0	0	0	0
0	0	0	12
99	**227**	**0**	**12**

08/17/2022 6:00 AM
Ending At
08/17/2022 6:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

U	T	R	P
4	4052	94	0
0	8	0	0
0	85	0	0
0	9	0	0
0	0	0	0
4	**4154**	**94**	**0**

Out	In	Total
3993	4150	8143
33	8	41
102	85	187
4	9	13
0	0	0
4132	**4252**	**8384**

Jefferson St [NB]

Turning Movement Data Plot

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022
Page No: 4

Turning Movement Peak Hour Data (7:45 AM)

	Presidential Dr Westbound					Jefferson St Northbound					Jefferson St Southbound					
Start Time	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	U-Turn	Peds	App. Total	Int. Total
7:45 AM	12	1	0	0	13	77	2	0	0	79	0	109	0	0	109	201
8:00 AM	5	2	0	0	7	83	0	1	0	84	4	137	0	0	141	232
8:15 AM	9	2	0	0	11	71	2	0	0	73	4	91	0	0	95	179
8:30 AM	9	4	0	1	13	77	5	0	0	82	6	112	1	0	119	214
Total	35	9	0	1	44	308	9	1	0	318	14	449	1	0	464	826
Approach %	79.5	20.5	0.0	-	-	96.9	2.8	0.3	-	-	3.0	96.8	0.2	-	-	-
Total %	4.2	1.1	0.0	-	5.3	37.3	1.1	0.1	-	38.5	1.7	54.4	0.1	-	56.2	-
PHF	0.729	0.563	0.000	-	0.846	0.928	0.450	0.250	-	0.946	0.583	0.819	0.250	-	0.823	0.890
Lights	35	8	0	-	43	301	9	1	-	311	14	428	1	-	443	797
% Lights	100.0	88.9	-	-	97.7	97.7	100.0	100.0	-	97.8	100.0	95.3	100.0	-	95.5	96.5
Buses	0	0	0	-	0	1	0	0	-	1	0	3	0	-	3	4
% Buses	0.0	0.0	-	-	0.0	0.3	0.0	0.0	-	0.3	0.0	0.7	0.0	-	0.6	0.5
Trucks	0	1	0	-	1	6	0	0	-	6	0	17	0	-	17	24
% Trucks	0.0	11.1	-	-	2.3	1.9	0.0	0.0	-	1.9	0.0	3.8	0.0	-	3.7	2.9
Bicycles on Road	0	0	0	-	0	0	0	0	-	0	0	1	0	-	1	1
% Bicycles on Road	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	0.0	0.0	0.2	0.0	-	0.2	0.1
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	1	-	-	-	-	0	-	-	-	-	0	-	-
% Pedestrians	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Jefferson St [SB]

Out	In	Total
310	443	753
1	3	4
7	17	24
0	1	1
0	0	0
318	**464**	**782**

T	L	U	P
428	14	1	0
3	0	0	0
17	0	0	0
1	0	0	0
0	0	0	0
449	**14**	**1**	**0**

Peak Hour Data

08/17/2022 7:45 AM
Ending At
08/17/2022 8:45 AM

Lights
Buses
Trucks
Bicycles on Road
Other

Presidential Dr [WB]

Out	In	Total
23	43	66
0	0	0
0	1	1
0	0	0
0	0	0
23	**44**	**67**

R	L	U	P
8	35	0	0
0	0	0	0
1	0	0	0
0	0	0	0
0	0	0	1
9	**35**	**0**	**1**

U	T	R	P
1	301	9	0
0	1	0	0
0	6	0	0
0	0	0	0
0	0	0	0
1	**308**	**9**	**0**

Out	In	Total
464	311	775
3	1	4
17	6	23
1	0	1
0	0	0
485	**318**	**803**

Jefferson St [NB]

Turning Movement Peak Hour Data Plot (7:45 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Turning Movement Peak Hour Data (11:00 AM)

	Presidential Dr Westbound					Jefferson St Northbound					Jefferson St Southbound					
Start Time	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	U-Turn	Peds	App. Total	Int. Total
11:00 AM	8	3	0	2	11	119	2	0	0	121	2	103	0	0	105	237
11:15 AM	9	4	0	0	13	108	4	0	0	112	0	119	0	0	119	244
11:30 AM	9	3	0	1	12	134	6	0	0	140	2	97	0	0	99	251
11:45 AM	6	6	0	0	12	123	1	0	0	124	0	110	2	0	112	248
Total	32	16	0	3	48	484	13	0	0	497	4	429	2	0	435	980
Approach %	66.7	33.3	0.0	-	-	97.4	2.6	0.0	-	-	0.9	98.6	0.5	-	-	-
Total %	3.3	1.6	0.0	-	4.9	49.4	1.3	0.0	-	50.7	0.4	43.8	0.2	-	44.4	-
PHF	0.889	0.667	0.000	-	0.923	0.903	0.542	0.000	-	0.888	0.500	0.901	0.250	-	0.914	0.976
Lights	32	16	0	-	48	473	13	0	-	486	4	415	2	-	421	955
% Lights	100.0	100.0	-	-	100.0	97.7	100.0	-	-	97.8	100.0	96.7	100.0	-	96.8	97.4
Buses	0	0	0	-	0	1	0	0	-	1	0	4	0	-	4	5
% Buses	0.0	0.0	-	-	0.0	0.2	0.0	-	-	0.2	0.0	0.9	0.0	-	0.9	0.5
Trucks	0	0	0	-	0	10	0	0	-	10	0	9	0	-	9	19
% Trucks	0.0	0.0	-	-	0.0	2.1	0.0	-	-	2.0	0.0	2.1	0.0	-	2.1	1.9
Bicycles on Road	0	0	0	-	0	0	0	0	-	0	0	1	0	-	1	1
% Bicycles on Road	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	-	0.2	0.1
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	3	-	-	-	-	0	-	-	-	-	0	-	-
% Pedestrians	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-

Lee Engineering, LLC
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Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Jefferson St [SB]

Out	In	Total
491	421	912
1	4	5
10	9	19
0	1	1
0	0	0
502	**435**	**937**

T	L	U	P
415	4	2	0
4	0	0	0
9	0	0	0
1	0	0	0
0	0	0	0
429	**4**	**2**	**0**

Peak Hour Data

08/17/2022 11:00 AM
Ending At
08/17/2022 12:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Presidential Dr [WB]

R	L	U	P
16	32	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	3
16	**32**	**0**	**3**

Out	In	Total
17	48	65
0	0	0
0	0	0
0	0	0
0	0	0
17	**48**	**65**

U	T	R	P
0	473	13	0
0	1	0	0
0	10	0	0
0	0	0	0
0	0	0	0
0	**484**	**13**	**0**

Jefferson St [NB]

Out	In	Total
447	486	933
4	1	5
9	10	19
1	0	1
0	0	0
461	**497**	**958**

Turning Movement Peak Hour Data Plot (11:00 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Turning Movement Peak Hour Data (4:15 PM)

Start Time	Presidential Dr Westbound					Jefferson St Northbound					Jefferson St Southbound					
	Left	Right	U-Turn	Peds	App. Total	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	U-Turn	Peds	App. Total	Int. Total
4:15 PM	7	1	0	0	8	138	2	0	0	140	1	124	1	0	126	274
4:30 PM	8	4	0	0	12	169	4	0	0	173	2	102	0	0	104	289
4:45 PM	5	4	0	0	9	156	2	0	0	158	0	99	0	0	99	266
5:00 PM	1	7	0	0	8	166	3	0	0	169	1	128	1	0	130	307
Total	21	16	0	0	37	629	11	0	0	640	4	453	2	0	459	1136
Approach %	56.8	43.2	0.0	-	-	98.3	1.7	0.0	-	-	0.9	98.7	0.4	-	-	-
Total %	1.8	1.4	0.0	-	3.3	55.4	1.0	0.0	-	56.3	0.4	39.9	0.2	-	40.4	-
PHF	0.656	0.571	0.000	-	0.771	0.930	0.688	0.000	-	0.925	0.500	0.885	0.500	-	0.883	0.925
Lights	20	16	0	-	36	620	11	0	-	631	4	441	2	-	447	1114
% Lights	95.2	100.0	-	-	97.3	98.6	100.0	-	-	98.6	100.0	97.4	100.0	-	97.4	98.1
Buses	0	0	0	-	0	2	0	0	-	2	0	0	0	-	0	2
% Buses	0.0	0.0	-	-	0.0	0.3	0.0	-	-	0.3	0.0	0.0	0.0	-	0.0	0.2
Trucks	1	0	0	-	1	6	0	0	-	6	0	11	0	-	11	18
% Trucks	4.8	0.0	-	-	2.7	1.0	0.0	-	-	0.9	0.0	2.4	0.0	-	2.4	1.6
Bicycles on Road	0	0	0	-	0	1	0	0	-	1	0	1	0	-	1	2
% Bicycles on Road	0.0	0.0	-	-	0.0	0.2	0.0	-	-	0.2	0.0	0.2	0.0	-	0.2	0.2
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Jefferson St [SB]

Out	In	Total
638	447	1085
2	0	2
6	11	17
1	1	2
0	0	0
647	**459**	**1106**

441	4	2	0
0	0	0	0
11	0	0	0
1	0	0	0
0	0	0	0
453	**4**	**2**	**0**
T	L	U	P

Peak Hour Data

08/17/2022 4:15 PM
Ending At
08/17/2022 5:15 PM

Lights
Buses
Trucks
Bicycles on Road
Other

R	L	U	P
16	**21**	**0**	**0**
0	0	0	0
0	0	0	0
0	1	0	0
0	0	0	0
16	20	0	0

Presidential Dr [WB]

Out	In	Total
15	36	51
0	0	0
0	1	1
0	0	0
0	0	0
15	**37**	**52**

U	T	R	P
0	620	11	0
0	2	0	0
0	6	0	0
0	1	0	0
0	0	0	0
0	**629**	**11**	**0**

461	631	1092
0	2	2
12	6	18
1	1	2
0	0	0
474	**640**	**1114**
Out	In	Total

Jefferson St [NB]

Turning Movement Peak Hour Data Plot (4:15 PM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School
NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Data

Start Time	Jefferson Plaza Eastbound						Business Park Driveway Westbound						Jefferson St Northbound						Jefferson St Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
6:00 AM	3	0	1	0	0	4	0	1	0	0	0	1	3	29	3	0	0	35	0	26	3	0	0	29	69
6:15 AM	1	0	1	0	0	2	0	0	0	0	0	0	6	32	2	0	0	40	2	44	5	0	0	51	93
6:30 AM	0	0	0	0	0	0	0	0	1	0	0	1	5	47	1	0	0	53	1	50	7	0	0	58	112
6:45 AM	0	0	2	0	1	2	0	0	0	0	0	0	9	51	0	0	0	60	1	92	9	0	0	102	164
Hourly Total	4	0	4	0	1	8	0	1	1	0	0	2	23	159	6	0	0	188	4	212	24	0	0	240	438
7:00 AM	0	0	0	0	0	0	1	0	0	0	0	1	9	62	1	0	0	72	0	73	8	0	0	81	154
7:15 AM	0	0	1	0	0	1	0	0	1	0	0	1	7	75	0	0	0	82	2	75	8	1	0	86	170
7:30 AM	2	0	0	0	0	2	0	1	0	0	0	1	5	64	0	0	0	69	2	94	6	0	0	102	174
7:45 AM	0	0	2	0	0	2	2	0	0	0	0	2	8	79	3	0	0	90	3	106	11	0	0	120	214
Hourly Total	2	0	3	0	0	5	3	1	1	0	0	5	29	280	4	0	0	313	7	348	33	1	0	389	712
8:00 AM	3	1	2	0	0	6	0	0	1	0	0	1	10	86	0	0	0	96	4	109	17	0	0	130	233
8:15 AM	6	0	19	0	0	25	0	2	0	0	0	2	6	71	1	0	0	78	1	94	11	1	0	107	212
8:30 AM	1	0	1	0	0	2	1	0	0	0	1	1	8	86	0	0	0	94	1	93	15	1	0	110	207
8:45 AM	5	1	2	0	0	8	0	0	1	0	0	1	5	72	3	0	0	80	2	120	7	1	0	130	219
Hourly Total	15	2	24	0	0	41	1	2	2	0	1	5	29	315	4	0	0	348	8	416	50	3	0	477	871
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11:00 AM	2	0	6	0	1	8	2	0	3	0	0	5	2	107	1	0	0	110	2	105	4	1	0	112	235
11:15 AM	6	1	6	0	0	13	0	0	2	0	0	2	3	107	2	0	0	112	1	130	3	0	0	134	261
11:30 AM	10	0	2	0	0	12	2	0	0	0	1	2	6	130	1	1	0	138	5	101	5	0	1	111	263
11:45 AM	4	1	5	0	0	10	1	0	5	0	0	6	4	113	2	0	0	119	2	116	4	1	0	123	258
Hourly Total	22	2	19	0	1	43	5	0	10	0	1	15	15	457	6	1	0	479	10	452	16	2	1	480	1017
12:00 PM	11	0	7	0	0	18	1	0	3	0	0	4	8	147	1	0	0	156	2	128	5	2	0	137	315
12:15 PM	3	0	2	0	1	5	1	0	0	0	0	1	7	136	1	0	0	144	2	115	7	1	0	125	275
12:30 PM	10	0	6	0	0	16	1	1	4	0	0	6	5	125	2	0	0	132	0	115	7	1	1	123	277
12:45 PM	6	0	3	0	1	9	2	0	4	0	0	6	2	120	1	0	0	123	3	92	10	0	0	105	243
Hourly Total	30	0	18	0	2	48	5	1	11	0	0	17	22	528	5	0	0	555	7	450	29	4	1	490	1110
1:00 PM	2	0	1	0	0	3	1	2	1	0	0	4	6	125	0	0	0	131	3	99	10	3	0	115	253
1:15 PM	3	0	0	0	0	3	1	0	1	0	1	2	3	127	2	1	0	133	1	108	6	0	0	115	253
1:30 PM	5	0	5	0	0	10	1	0	0	0	0	1	5	122	1	0	0	128	6	96	3	3	0	108	247
1:45 PM	1	0	1	0	0	2	0	0	2	0	0	2	1	113	3	1	0	118	6	92	7	0	0	105	227
Hourly Total	11	0	7	0	0	18	3	2	4	0	1	9	15	487	6	2	0	510	16	395	26	6	0	443	980
2:00 PM	5	0	2	0	0	7	1	0	6	0	0	7	4	91	0	1	0	96	1	107	2	1	1	111	221
2:15 PM	4	0	2	0	0	6	0	0	1	0	0	1	5	95	1	0	0	101	1	96	2	1	0	100	208
2:30 PM	3	0	4	0	0	7	2	0	1	0	0	3	1	110	2	1	0	114	0	93	1	0	0	94	218
2:45 PM	4	0	2	0	0	6	1	0	3	0	0	4	0	119	4	0	0	123	4	77	7	0	0	88	221

Hourly Total	16	0	10	0	0	26	4	0	11	0	0	15	10	415	7	2	0	434	6	373	12	2	1	393	868
3:00 PM	6	0	11	0	1	17	3	1	4	0	0	8	0	118	0	0	0	118	1	95	2	0	0	98	241
3:15 PM	1	0	4	0	0	5	0	0	0	0	0	0	0	106	2	0	0	108	0	96	2	1	0	99	212
3:30 PM	8	0	5	0	0	13	2	0	1	0	0	3	1	112	2	0	0	115	0	90	3	4	0	97	228
3:45 PM	9	0	7	0	0	16	1	0	2	0	0	3	0	87	2	0	0	89	3	100	4	0	0	107	215
Hourly Total	24	0	27	0	1	51	6	1	7	0	0	14	1	423	6	0	0	430	4	381	11	5	0	401	896
4:00 PM	5	0	12	0	0	17	0	0	5	0	0	5	0	113	4	1	0	118	6	124	0	2	0	132	272
4:15 PM	9	0	9	0	0	18	1	0	10	0	0	11	1	118	1	0	0	120	0	138	5	2	0	145	294
4:30 PM	7	0	10	0	2	17	2	0	7	0	0	9	1	147	3	0	0	151	1	99	1	1	0	102	279
4:45 PM	12	0	5	0	0	17	1	1	5	0	0	7	0	132	0	0	0	132	4	113	2	4	0	123	279
Hourly Total	33	0	36	0	2	69	4	1	27	0	0	32	2	510	8	1	0	521	11	474	8	9	0	502	1124
5:00 PM	8	0	11	0	0	19	2	0	10	0	0	12	0	143	1	1	0	145	1	123	2	1	0	127	303
5:15 PM	9	0	7	0	1	16	0	0	4	0	0	4	2	109	2	0	0	113	3	134	0	0	0	137	270
5:30 PM	3	0	2	1	0	6	0	2	7	0	0	9	1	94	0	0	0	95	2	92	0	4	0	98	208
5:45 PM	4	0	4	0	1	8	1	1	2	0	0	4	0	79	1	0	0	80	0	79	0	0	0	79	171
Hourly Total	24	0	24	1	2	49	3	3	23	0	0	29	3	425	4	1	0	433	6	428	2	5	0	441	952
Grand Total	181	4	172	1	9	358	34	12	97	0	3	143	149	3999	56	7	0	4211	79	3929	211	37	3	4256	8968
Approach %	50.6	1.1	48.0	0.3	-	-	23.8	8.4	67.8	0.0	-	-	3.5	95.0	1.3	0.2	-	-	1.9	92.3	5.0	0.9	-	-	-
Total %	2.0	0.0	1.9	0.0	-	4.0	0.4	0.1	1.1	0.0	-	1.6	1.7	44.6	0.6	0.1	-	47.0	0.9	43.8	2.4	0.4	-	47.5	-
Lights	174	4	161	1	-	340	33	8	96	0	-	137	143	3906	54	7	-	4110	76	3790	200	37	-	4103	8690
% Lights	96.1	100.0	93.6	100.0	-	95.0	97.1	66.7	99.0	-	-	95.8	96.0	97.7	96.4	100.0	-	97.6	96.2	96.5	94.8	100.0	-	96.4	96.9
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	11	0	0	-	11	0	33	0	0	-	33	44
% Buses	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.3	0.0	0.0	-	0.3	0.0	0.8	0.0	0.0	-	0.8	0.5
Trucks	6	0	11	0	-	17	1	1	1	0	-	3	6	74	2	0	-	82	3	101	10	0	-	114	216
% Trucks	3.3	0.0	6.4	0.0	-	4.7	2.9	8.3	1.0	-	-	2.1	4.0	1.9	3.6	0.0	-	1.9	3.8	2.6	4.7	0.0	-	2.7	2.4
Bicycles on Road	1	0	0	0	-	1	0	3	0	0	-	3	0	8	0	0	-	8	0	5	1	0	-	6	18
% Bicycles on Road	0.6	0.0	0.0	0.0	-	0.3	0.0	25.0	0.0	-	-	2.1	0.0	0.2	0.0	0.0	-	0.2	0.0	0.1	0.5	0.0	-	0.1	0.2
Bicycles on Crosswalk	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	2	-	-
% Bicycles on Crosswalk	-	-	-	-	22.2	-	-	-	-	-	33.3	-	-	-	-	-	-	-	-	-	-	-	66.7	-	-
Pedestrians	-	-	-	-	7	-	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	1	-	-
% Pedestrians	-	-	-	-	77.8	-	-	-	-	-	66.7	-	-	-	-	-	-	-	-	-	-	-	33.3	-	-

Lee Engineering, LLC
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5053380988 jpham@lee-eng.com

08/17/2022 6:00 AM
Ending At
08/17/2022 6:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
4213	4103	8316
11	33	44
81	114	195
9	6	15
0	0	0
4314	**4256**	**8570**

R	T	L	U	P
200	3790	76	37	0
0	33	0	0	0
10	101	3	0	0
1	5	0	0	0
0	0	0	0	3
211	**3929**	**79**	**37**	**3**

Jefferson Plaza [EB]

Out	In	Total
352	340	692
0	0	0
17	17	34
4	1	5
0	0	0
373	**358**	**731**

U	L	T	R	P
1	174	4	161	0
0	0	0	0	0
0	6	0	11	0
0	1	0	0	0
0	0	0	0	9
1	**181**	**4**	**172**	**9**

Business Park Driveway [W

Out	In	Total
134	137	271
0	0	0
5	3	8
0	3	3
0	0	0
139	**143**	**282**

R	T	L	U	P
96	8	33	0	0
0	0	0	0	0
1	1	1	0	0
0	3	0	0	0
0	0	0	0	3
97	**12**	**34**	**0**	**3**

U	L	T	R	P
7	143	3906	54	0
0	0	11	0	0
0	6	74	2	0
0	0	8	0	0
0	0	0	0	0
7	**149**	**3999**	**56**	**0**

Out	In	Total
3991	4110	8101
33	11	44
113	82	195
5	8	13
0	0	0
4142	**4211**	**8353**

Jefferson St [NB]

Turning Movement Data Plot

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Peak Hour Data (8:00 AM)

Start Time	Jefferson Plaza Eastbound						Business Park Driveway Westbound						Jefferson St Northbound						Jefferson St Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
8:00 AM	3	1	2	0	0	6	0	0	1	0	0	1	10	86	0	0	0	96	4	109	17	0	0	130	233
8:15 AM	6	0	19	0	0	25	0	2	0	0	0	2	6	71	1	0	0	78	1	94	11	1	0	107	212
8:30 AM	1	0	1	0	0	2	1	0	0	0	1	1	8	86	0	0	0	94	1	93	15	1	0	110	207
8:45 AM	5	1	2	0	0	8	0	0	1	0	0	1	5	72	3	0	0	80	2	120	7	1	0	130	219
Total	15	2	24	0	0	41	1	2	2	0	1	5	29	315	4	0	0	348	8	416	50	3	0	477	871
Approach %	36.6	4.9	58.5	0.0	-	-	20.0	40.0	40.0	0.0	-	-	8.3	90.5	1.1	0.0	-	-	1.7	87.2	10.5	0.6	-	-	-
Total %	1.7	0.2	2.8	0.0	-	4.7	0.1	0.2	0.2	0.0	-	0.6	3.3	36.2	0.5	0.0	-	40.0	0.9	47.8	5.7	0.3	-	54.8	-
PHF	0.625	0.500	0.316	0.000	-	0.410	0.250	0.250	0.500	0.000	-	0.625	0.725	0.916	0.333	0.000	-	0.906	0.500	0.867	0.735	0.750	-	0.917	0.935
Lights	14	2	20	0	-	36	1	1	2	0	-	4	27	307	4	0	-	338	7	393	48	3	-	451	829
% Lights	93.3	100.0	83.3	-	-	87.8	100.0	50.0	100.0	-	-	80.0	93.1	97.5	100.0	-	-	97.1	87.5	94.5	96.0	100.0	-	94.5	95.2
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	2	0	0	-	2	0	3	0	0	-	3	5
% Buses	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.6	0.0	-	-	0.6	0.0	0.7	0.0	0.0	-	0.6	0.6
Trucks	1	0	4	0	-	5	0	0	0	0	-	0	2	6	0	0	-	8	1	19	2	0	-	22	35
% Trucks	6.7	0.0	16.7	-	-	12.2	0.0	0.0	0.0	-	-	0.0	6.9	1.9	0.0	-	-	2.3	12.5	4.6	4.0	0.0	-	4.6	4.0
Bicycles on Road	0	0	0	0	-	0	0	1	0	0	-	1	0	0	0	0	-	0	0	1	0	0	-	1	2
% Bicycles on Road	0.0	0.0	0.0	-	-	0.0	0.0	50.0	0.0	-	-	20.0	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	0.0	-	0.2	0.2
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Peak Hour Data

08/17/2022 8:00 AM
Ending At
08/17/2022 9:00 AM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

	Out	In	Total
Lights	326	451	777
Buses	2	3	5
Trucks	7	22	29
Bicycles on Road	0	1	1
Other	0	0	0
Total	**335**	**477**	**812**

	R	T	L	U	P
Lights	48	393	7	3	0
Buses	0	3	0	0	0
Trucks	2	19	1	0	0
Bicycles on Road	0	1	0	0	0
Other	0	0	0	0	0
Total	**50**	**416**	**8**	**3**	**0**

Jefferson Plaza [EB]

	Out	In	Total
Lights	76	36	112
Buses	0	0	0
Trucks	4	5	9
Bicycles on Road	1	0	1
Other	0	0	0
Total	**81**	**41**	**122**

	U	L	T	R	P
Lights	0	14	2	20	0
Buses	0	0	0	0	0
Trucks	0	1	0	4	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	0
Total	**0**	**15**	**2**	**24**	**0**

Business Park Driveway [W

	Out	In	Total
Lights	13	4	17
Buses	0	0	0
Trucks	1	0	1
Bicycles on Road	0	1	1
Other	0	0	0
Total	**14**	**5**	**19**

	R	T	L	U	P
Lights	2	1	1	0	0
Buses	0	0	0	0	0
Trucks	0	0	0	0	0
Bicycles on Road	0	1	0	0	0
Other	0	0	0	0	1
Total	**2**	**2**	**1**	**0**	**1**

Jefferson St [NB]

	U	L	T	R	P
Lights	0	27	307	4	0
Buses	0	0	2	0	0
Trucks	0	2	6	0	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	0
Total	**0**	**29**	**315**	**4**	**0**

	Out	In	Total
Lights	414	338	752
Buses	3	2	5
Trucks	23	8	31
Bicycles on Road	1	0	1
Other	0	0	0
Total	**441**	**348**	**789**

Turning Movement Peak Hour Data Plot (8:00 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Peak Hour Data (11:00 AM)

Start Time	Jefferson Plaza Eastbound						Business Park Driveway Westbound						Jefferson St Northbound						Jefferson St Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
11:00 AM	2	0	6	0	1	8	2	0	3	0	0	5	2	107	1	0	0	110	2	105	4	1	0	112	235
11:15 AM	6	1	6	0	0	13	0	0	2	0	0	2	3	107	2	0	0	112	1	130	3	0	0	134	261
11:30 AM	10	0	2	0	0	12	2	0	0	0	1	2	6	130	1	1	0	138	5	101	5	0	1	111	263
11:45 AM	4	1	5	0	0	10	1	0	5	0	0	6	4	113	2	0	0	119	2	116	4	1	0	123	258
Total	22	2	19	0	1	43	5	0	10	0	1	15	15	457	6	1	0	479	10	452	16	2	1	480	1017
Approach %	51.2	4.7	44.2	0.0	-	-	33.3	0.0	66.7	0.0	-	-	3.1	95.4	1.3	0.2	-	-	2.1	94.2	3.3	0.4	-	-	-
Total %	2.2	0.2	1.9	0.0	-	4.2	0.5	0.0	1.0	0.0	-	1.5	1.5	44.9	0.6	0.1	-	47.1	1.0	44.4	1.6	0.2	-	47.2	-
PHF	0.550	0.500	0.792	0.000	-	0.827	0.625	0.000	0.500	0.000	-	0.625	0.625	0.879	0.750	0.250	-	0.868	0.500	0.869	0.800	0.500	-	0.896	0.967
Lights	19	2	18	0	-	39	5	0	10	0	-	15	13	449	6	1	-	469	9	438	13	2	-	462	985
% Lights	86.4	100.0	94.7	-	-	90.7	100.0	-	100.0	-	-	100.0	86.7	98.2	100.0	100.0	-	97.9	90.0	96.9	81.3	100.0	-	96.3	96.9
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	1	0	4	0	0	-	4	5
% Buses	0.0	0.0	0.0	-	-	0.0	0.0	-	0.0	-	-	0.0	0.0	0.2	0.0	0.0	-	0.2	0.0	0.9	0.0	0.0	-	0.8	0.5
Trucks	3	0	1	0	-	4	0	0	0	0	-	0	2	7	0	0	-	9	1	9	2	0	-	12	25
% Trucks	13.6	0.0	5.3	-	-	9.3	0.0	-	0.0	-	-	0.0	13.3	1.5	0.0	0.0	-	1.9	10.0	2.0	12.5	0.0	-	2.5	2.5
Bicycles on Road	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	1	1	0	-	2	2
% Bicycles on Road	0.0	0.0	0.0	-	-	0.0	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.2	6.3	0.0	-	0.4	0.2
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	1	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	100.0	-	-
Pedestrians	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School
NIA
Site Code:
Start Date: 08/17/2022

Peak Hour Data

08/17/2022 11:00 AM
Ending At
08/17/2022 12:00 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

	Out	In	Total
Lights	480	462	942
Buses	1	4	5
Trucks	10	12	22
Bicycles on Road	0	2	2
Other	0	0	0
Total	**491**	**480**	**971**

	R	T	L	U	P
Lights	13	438	9	2	0
Buses	0	4	0	0	0
Trucks	2	9	1	0	0
Bicycles on Road	1	1	0	0	0
Other	0	0	0	0	1
Total	**16**	**452**	**10**	**2**	**1**

Jefferson Plaza [EB]

	Out	In	Total
Lights	26	39	65
Buses	0	0	0
Trucks	4	4	8
Bicycles on Road	1	0	1
Other	0	0	0
Total	**31**	**43**	**74**

	U	L	T	R	P
Lights	0	19	2	18	0
Buses	0	0	0	0	0
Trucks	0	3	0	1	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	1
Total	**0**	**22**	**2**	**19**	**1**

Business Park Driveway [W

	Out	In	Total
Lights	17	15	32
Buses	0	0	0
Trucks	1	0	1
Bicycles on Road	0	0	0
Other	0	0	0
Total	**18**	**15**	**33**

	R	T	L	U	P
Lights	10	0	5	0	0
Buses	0	0	0	0	0
Trucks	0	0	0	0	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	1
Total	**10**	**0**	**5**	**0**	**1**

Jefferson St [NB]

	U	L	T	R	P
Lights	1	13	449	6	0
Buses	0	0	1	0	0
Trucks	0	2	7	0	0
Bicycles on Road	0	0	0	0	0
Other	0	0	0	0	0
Total	**1**	**15**	**457**	**6**	**0**

	Out	In	Total
Lights	462	469	931
Buses	4	1	5
Trucks	10	9	19
Bicycles on Road	1	0	1
Other	0	0	0
Total	**477**	**479**	**956**

Turning Movement Peak Hour Data Plot (11:00 AM)

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Count Name: NM309.02 Charter High School NIA
Site Code:
Start Date: 08/17/2022

Turning Movement Peak Hour Data (4:15 PM)

Start Time	Jefferson Plaza Eastbound						Business Park Driveway Westbound						Jefferson St Northbound						Jefferson St Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
4:15 PM	9	0	9	0	0	18	1	0	10	0	0	11	1	118	1	0	0	120	0	138	5	2	0	145	294
4:30 PM	7	0	10	0	2	17	2	0	7	0	0	9	1	147	3	0	0	151	1	99	1	1	0	102	279
4:45 PM	12	0	5	0	0	17	1	1	5	0	0	7	0	132	0	0	0	132	4	113	2	4	0	123	279
5:00 PM	8	0	11	0	0	19	2	0	10	0	0	12	0	143	1	1	0	145	1	123	2	1	0	127	303
Total	36	0	35	0	2	71	6	1	32	0	0	39	2	540	5	1	0	548	6	473	10	8	0	497	1155
Approach %	50.7	0.0	49.3	0.0	-	-	15.4	2.6	82.1	0.0	-	-	0.4	98.5	0.9	0.2	-	-	1.2	95.2	2.0	1.6	-	-	-
Total %	3.1	0.0	3.0	0.0	-	6.1	0.5	0.1	2.8	0.0	-	3.4	0.2	46.8	0.4	0.1	-	47.4	0.5	41.0	0.9	0.7	-	43.0	-
PHF	0.750	0.000	0.795	0.000	-	0.934	0.750	0.250	0.800	0.000	-	0.813	0.500	0.918	0.417	0.250	-	0.907	0.375	0.857	0.500	0.500	-	0.857	0.953
Lights	36	0	35	0	-	71	6	1	31	0	-	38	2	529	4	1	-	536	6	457	10	8	-	481	1126
% Lights	100.0	-	100.0	-	-	100.0	100.0	100.0	96.9	-	-	97.4	100.0	98.0	80.0	100.0	-	97.8	100.0	96.6	100.0	100.0	-	96.8	97.5
Buses	0	0	0	0	-	0	0	0	0	0	-	0	0	2	0	0	-	2	0	0	0	0	-	0	2
% Buses	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.4	0.0	0.0	-	0.4	0.0	0.0	0.0	0.0	-	0.0	0.2
Trucks	0	0	0	0	-	0	0	0	1	0	-	1	0	8	1	0	-	9	0	15	0	0	-	15	25
% Trucks	0.0	-	0.0	-	-	0.0	0.0	0.0	3.1	-	-	2.6	0.0	1.5	20.0	0.0	-	1.6	0.0	3.2	0.0	0.0	-	3.0	2.2
Bicycles on Road	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	1	0	1	0	0	-	1	2
% Bicycles on Road	0.0	-	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	0.0	-	0.2	0.0	0.2	0.0	0.0	-	0.2	0.2
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

LEE ENGINEERING
Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States 87113
5053380988 jpham@lee-eng.com

Peak Hour Data

08/17/2022 4:15 PM
Ending At
08/17/2022 5:15 PM

Lights
Buses
Trucks
Bicycles on Road
Other

Jefferson St [SB]

Out	In	Total
604	481	1085
2	0	2
9	15	24
1	1	2
0	0	0
616	**497**	**1113**

R	T	L	U	P
10	457	6	8	0
0	0	0	0	0
0	15	0	0	0
0	1	0	0	0
0	0	0	0	0
10	**473**	**6**	**8**	**0**

Jefferson Plaza [EB]

Out	In	Total
13	71	84
0	0	0
0	0	0
0	0	0
0	0	0
13	**71**	**84**

U	L	T	R	P
0	36	0	35	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	2
0	**36**	**0**	**35**	**2**

Business Park Driveway [W

Out	In	Total
10	38	48
0	0	0
1	1	2
0	0	0
0	0	0
11	**39**	**50**

R	T	L	U	P
31	1	6	0	0
0	0	0	0	0
1	0	0	0	0
0	0	0	0	0
0	0	0	0	0
32	**1**	**6**	**0**	**0**

U	L	T	R	P
1	2	529	4	0
0	0	2	0	0
0	0	8	1	0
0	0	1	0	0
0	0	0	0	0
1	**2**	**540**	**5**	**0**

Out	In	Total
499	536	1035
0	2	2
15	9	24
1	1	2
0	0	0
515	**548**	**1063**

Jefferson St [NB]

Turning Movement Peak Hour Data Plot (4:15 PM)

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix C

Signal Timing Sheets

Prepared for:

Wooten Engineering

Prepared By:

LEE ENGINEERING

Intersection No.:	99
Intersection Name:	OSUNA & JEFFERSON
Revision Date	9/22/2016

System:	Centracs
Address:	3

Timing Data

Phase I.D.:	1	2	3	4	5	6	7	8
Phase Dir.:	W-S	EB	S-E	NB	E-N	WB	N-W	SB
Min Grn	8	16	8	12	8	16	8	12
Walk:	0	7	0	7	0	7	0	7
Ped Clr:	0	26	0	36	0	22	0	36
Veh Ext:	1.5	4.0	1.5	4.0	1.5	4.0	1.5	4.0
Veh Ext2:								
Max 1:	12	40	16	28	16	40	16	28
Max 2:								
Max 3:								
Yellow:	3.0	4.5	3.0	4.0	3.0	4.5	3.0	4.0
Red Clr	0.5	1.5	0.5	2.0	0.5	1.5	0.5	2.0

Recall Data

Locking Memory:								
Vehicle Recall:	1.5	4	1.5	4	1.5	4	1.5	4
Ped Recall:								
Recall To Max:		X				X		

Flash Mode:	ALL RED

Start Up Mode:	ALL RED
Time:	8 SEC.
First Phases:	2 & 6
Start In:	GREEN

Overlap Phases:	NONE

Overlap	Par Ph	Grn	Yel	Red
A				
B				
C				
D				

NOTES:

1. Intersection being upgraded from 2 phase operation.
2. Phase 5 & 7 detection placed on locking, 1/31/89.
3. Phase 2 & 6 detection max recall same date as intersection upgraded to 8 phase.
4. Red clearance time change in database, 7/5/95.
5. Updated file, 8/15/00.
6. Timing sheet updated to reflect I2 changed address and controller type, 10/16/08.
7. Timing sheet updated, 12/28/11.
8. Timing sheet updated to reflect phase 5 min gree time update, 1/17/13.
9. Clearance intervals updated to NMDOT standard by BB, 12/31/13.
10. Ped cleareance times updated by RS, 2/11/14.
11. Initial left turn times increased due to peds short cycling left turns, 5/7/14.
12. Times were adusted temporaraly due to construction, 7-7-16.
13. Times set back to normal operation with phases 2 and 6 on max recall, 9/22/16.

ASC3 COORDINATION PLAN DATA

9/19/2022 1:23 PM

Intersection Name - 99 - Osuna -Jefferson

COORDINATOR OPTIONS (MM 3-1)

MANUAL PATTERN	AUTO	ECPI COORD	YES
SYSTEM SOURCE	TBC	SYSTEM FORMAT	PTN
SPLITS IN	PERCENT	OFFSET IN	PERCENT
TRANSITION	SMOOTH	MAX SELECT	MAXINH
DWELL/ADD TIME	0	ENABLE MAN SYNC	NO
DLY COORD WK-LZ	NO	FORCE OFF	FIXED
OFFSET REF	LEAD	CAL USE PED TM	NO
PED RECALL	NO	PED RESERVE	YES
LOCAL ZERO OVRD	NO	FO ADD INI GRN	NO
RE-SYNC COUNT	0	MULTISYNC	NO

COORDINATION PATTERN 21 (MM 3-2)

USE SPLIT PATTERN	21	SPLIT SUM	100%
TS2 (PAT-OFF)	6,3		
CYCLE	120s	STD (COS)	111
OFFSET VAL	79%		
ACTUATED COORD	YES	TIMING PLAN	0
ACT WALK REST	NO	SEQUENCE	0
PHASE RESRVCE	NO	ACTION PLAN	0

PHASE	1	2	3	4	5	6	7	8
DIRECTION	W-S	EB	S-E	NB	E-N	WB	N-W	SB
SPLITS	15	38	13	34	15	38	13	34

PHASE	1	2	3	4	5	6	7	8
COORD PHASE		X				X		
VEH RECALL								
MAX RECALL		X				X		

COORDINATION PATTERN 23

USE SPLIT PATTERN	23	SPLIT SUM	100%
TS2 (PAT-OFF)	7,2		
CYCLE	120s	STD (COS)	131
OFFSET VAL	20%		
ACTUATED COORD	YES	TIMING PLAN	0
ACT WALK REST	NO	SEQUENCE	0
PHASE RESRVCE	NO	ACTION PLAN	0

PHASE	1	2	3	4	5	6	7	8
DIRECTION	W-S	EB	S-E	NB	E-N	WB	N-W	SB
SPLITS	14	36	16	34	14	36	14	36

PHASE	1	2	3	4	5	6	7	8
COORD PHASE		X				X		
VEH RECALL								
MAX RECALL		X				X		

ASC3 COORDINATION PLAN DATA

9/19/2022 1:23 PM

COORDINATION PATTERN 25

USE SPLIT PATTERN	25	SPLIT SUM	100%
TS2 (PAT-OFF)	8,1		
CYCLE	120s	STD (COS)	251
OFFSET VAL	35%		
ACTUATED COORD	YES	TIMING PLAN	0
ACT WALK REST	NO	SEQUENCE	0
PHASE RESRVCE	NO	ACTION PLAN	0

PHASE	1	2	3	4	5	6	7	8
DIRECTION	W-S	EB	S-E	NB	E-N	WB	N-W	SB
SPLITS	12	36	16	36	17	31	17	35

PHASE	1	2	3	4	5	6	7	8
COORD PHASE		X				X		
VEH RECALL								
MAX RECALL		X				X		

CLOCK / CALENDAR DATA (MM 5-1)

CURRENT DATE	CURRENT DOW		CURRENT TOD
ENA ACTION PLAN	0		
SYNC REF TIME	00:00	SYNC REF	REF TIME
TIME FROM GMT	+00	DAY LIGHT SAVE	NO
TIME RESET INPUT SET TIME		3:30:00	

ACTION PLAN 21 (MM 5-2)

PATTERN	21	SYS OVERRIDE	NO
TIMING PLAN	0	SEQUENCE	0
VEHICLE DETECTOR PLAN	0.00	DET LOG	NONE
FLASH	--	RED REST	NO
VEH DET DIAG PLN	0	PED DET DIAG PLN	0
DIMMING ENABLE	NO		

ACTION PLAN 23

PATTERN	23	SYS OVERRIDE	NO
TIMING PLAN	0	SEQUENCE	0
VEHICLE DETECTOR PLAN	0.00	DET LOG	NONE
FLASH	--	RED REST	NO
VEH DET DIAG PLN	0	PED DET DIAG PLN	0
DIMMING ENABLE	NO		

ACTION PLAN 25

PATTERN	25	SYS OVERRIDE	NO
TIMING PLAN	0	SEQUENCE	0
VEHICLE DETECTOR PLAN	0.00	DET LOG	NONE
FLASH	--	RED REST	NO
VEH DET DIAG PLN	0	PED DET DIAG PLN	0
DIMMING ENABLE	NO		

ASC3 COORDINATION PLAN DATA

9/19/2022 1:23 PM

ACTION PLAN 100

PATTERN	254	SYS OVERRIDE	NO
TIMING PLAN	0	SEQUENCE	0
VEHICLE DETECTOR PLAN	0.00	DET LOG	NONE
FLASH	--	RED REST	NO
VEH DET DIAG PLN	0	PED DET DIAG PLN	0
DIMMING ENABLE	NO		

DAY PLAN/EVENT 1 (MM 5-3)

EVENT	ACTION PLAN	START TIME
1	23	7:00
2	100	22:00
3	0	00:00

DAY PLAN/EVENT 2

EVENT	ACTION PLAN	START TIME
1	21	6:30
2	23	9:00
3	25	15:00
4	23	18:30
5	100	22:00
6	0	00:00
7	0	00:00

DAY PLAN/EVENT 3

EVENT	ACTION PLAN	START TIME
1	23	7:00
2	100	22:00
3	0	00:00

SCHEDULE NUMBER 1 (MM 5-4)

SCHEDULE NUMBER	1	
DAY PLAN NO	1	CLEAR ALL FIELDS

SELECT ALL MONTHS DOW DOM

MONTH	J	F	M	A	M	J	J	A	S	O	N
	X	X	X	X	X	X	X	X	X	X	X
DAY(DOW)	SUN	MON	TUE	WED	THU	FRI	SAT				
	X	.	.	.	.	.	.				
DAY(DOM)	1	2	3	4	5	6	7	8	9	10	11
	X	X	X	X	X	X	X	X	X	X	X
	12	13	14	15	16	17	18	19	20	21	22
	X	X	X	X	X	X	X	X	X	X	X
	23	24	25	26	27	28	29	30	31		
	X	X	X	X	X	X	X	X	X		

SCHEDULE NUMBER 2

SCHEDULE NUMBER	2	
DAY PLAN NO	2	CLEAR ALL FIELDS

SELECT ALL MONTHS DOW DOM

MONTH	J	F	M	A	M	J	J	A	S	O	N
	X	X	X	X	X	X	X	X	X	X	X

ASC3 COORDINATION PLAN DATA

DAY(DOW)	SUN	MON	TUE	WED	THU	FRI	SAT				
	.	X	X	X	X	X	.				
DAY(DOM)	1	2	3	4	5	6	7	8	9	10	11
	X	X	X	X	X	X	X	X	X	X	X
	12	13	14	15	16	17	18	19	20	21	22
	X	X	X	X	X	X	X	X	X	X	X
	23	24	25	26	27	28	29	30	31		
	X	X	X	X	X	X	X	X	X		

SCHEDULE NUMBER 3

SCHEDULE NUMBER	3	
DAY PLAN NO	3	CLEAR ALL FIELDS

SELECT ALL MONTHS DOW DOM

MONTH	J	F	M	A	M	J	J	A	S	O	N
	X	X	X	X	X	X	X	X	X	X	X
DAY(DOW)	SUN	MON	TUE	WED	THU	FRI	SAT				
	.	.	.	.	.	.	X				
DAY(DOM)	1	2	3	4	5	6	7	8	9	10	11
	X	X	X	X	X	X	X	X	X	X	X
	12	13	14	15	16	17	18	19	20	21	22
	X	X	X	X	X	X	X	X	X	X	X
	23	24	25	26	27	28	29	30	31		
	X	X	X	X	X	X	X	X	X		

NOTES: 1. Coord sheet created for ASC 3, 1-16-17.

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix D

Level of Service and Capacity Output Sheets

Prepared for:

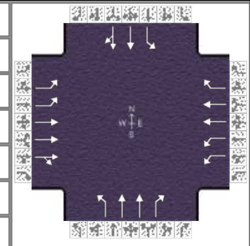
Wooten Engineering

Prepared By:

LEE ENGINEERING

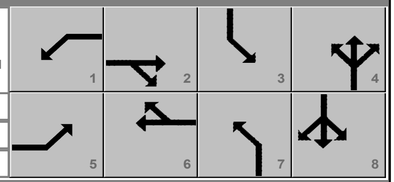
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	8/29/2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	AM Peak hour	PHF	0.90
Urban Street	Osuna Rd	Analysis Year	2022	Analysis Period	1> 7:45
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Existing AM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	323	733	119	74	902	335	114	245	43	206	325	261

Signal Information										
Cycle, s	120.0	Reference Phase	2	Green	7.5	3.8	48.8	8.5	0.5	24.9
Offset, s	0	Reference Point	End	Yellow	3.0	3.0	4.5	3.0	3.0	4.0
Uncoordinated	No	Simult. Gap E/W	On	Red	0.5	0.5	1.5	0.5	0.5	2.0
Force Mode	Fixed	Simult. Gap N/S	On							



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	18.3	62.1	11.0	54.8	12.0	30.9	16.0	34.9
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.2	2.6	5.2
Queue Clearance Time (g_s), s	14.4		4.7		8.6	9.8	13.9	23.6
Green Extension Time (g_e), s	0.4	0.0	0.1	0.0	0.0	6.3	0.0	5.3
Phase Call Probability	1.00		0.94		0.99	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.15	0.07	1.00	0.26

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	359	623	293	82	1002	243	127	272	37	229	353	297
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1702	1856	1732	1743	1781	1556	1810	1766	1520	1795	1856	1529
Queue Service Time (g_s), s	12.4	9.2	9.3	2.7	23.5	10.3	6.6	7.8	2.3	11.9	21.0	21.6
Cycle Queue Clearance Time (g_c), s	12.4	9.2	9.3	2.7	23.5	10.3	6.6	7.8	2.3	11.9	21.0	21.6
Green Ratio (*g/C*)	0.12	0.48	0.48	0.06	0.42	0.42	0.27	0.22	0.22	0.32	0.26	0.26
Capacity (*c*), veh/h	406	1798	839	203	1508	659	216	792	341	394	477	362
Volume-to-Capacity Ratio (*X*)	0.884	0.347	0.350	0.405	0.665	0.369	0.588	0.344	0.108	0.581	0.740	0.820
Back of Queue (*Q*), ft/ln (95 th percentile)	228.6	157.9	151.6	52.6	331.3	161.4	132.4	156.6	41.5	227.9	388.8	353
Back of Queue (*Q*), veh/ln (95 th percentile)	8.9	6.2	6.1	2.1	13.0	6.4	5.3	6.1	1.6	9.0	15.2	14.1
Queue Storage Ratio (*RQ*) (95 th percentile)	0.57	0.00	0.00	0.15	0.00	0.50	0.76	0.00	0.32	1.14	0.00	0.00
Uniform Delay (d_1), s/veh	49.6	13.0	12.6	53.4	20.8	17.3	36.2	39.9	37.0	32.3	41.8	42.3
Incremental Delay (d_2), s/veh	4.1	0.5	1.2	0.5	2.4	1.6	1.0	0.4	0.2	1.4	4.1	10.0
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	53.8	13.5	13.8	53.8	23.1	18.9	37.1	40.3	37.2	33.8	45.9	52.2
Level of Service (LOS)	D	B	B	D	C	B	D	D	D	C	D	D
Approach Delay, s/veh / LOS	24.9	C		24.2	C		39.1	D		44.9	D	
Intersection Delay, s/veh / LOS	30.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.44	B	2.28	B	2.89	C	2.63	C
Bicycle LOS Score / LOS	1.19	A	1.58	B	0.85	A	1.21	A

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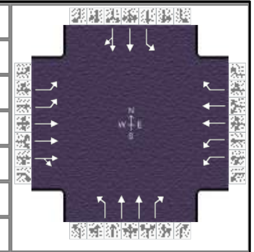
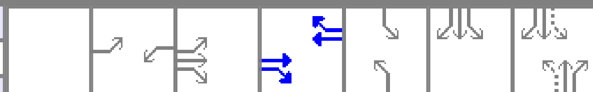
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	8/29/2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	PM Peak Hour	PHF	0.92
Urban Street	Osuna Rd	Analysis Year	2022	Analysis Period	1> 16:30
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Existing PM.xus		
Project Description	Charter High School TIS				

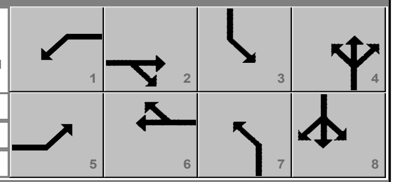


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	240	910	63	35	839	199	157	395	142	314	345	304

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	5.7	2.0	49.0	11.0	1.0	25.2
Yellow	3.0	3.0	4.5	3.0	3.0	4.0
Red	0.5	0.5	1.5	0.5	0.5	2.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	14.8	60.6	9.2	55.0	14.5	31.2	19.0	35.6
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (g_s), s	10.9		3.3		11.0	14.6	17.0	22.6
Green Extension Time (g_e), s	0.3	0.0	0.0	0.0	0.1	7.6	0.0	7.0
Phase Call Probability	1.00		0.72		1.00	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.02	0.17	1.00	0.25

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (v), veh/h	261	705	343	38	912	108	171	429	87	341	345	294
Adjusted Saturation Flow Rate (s), veh/h/ln	1716	1885	1829	1716	1781	1547	1781	1795	1577	1795	1870	1569
Queue Service Time (g_s), s	8.9	11.1	11.1	1.3	20.2	4.0	9.0	12.6	5.4	15.0	20.0	20.6
Cycle Queue Clearance Time (g_c), s	8.9	11.1	11.1	1.3	20.2	4.0	9.0	12.6	5.4	15.0	20.0	20.6
Green Ratio (g/C)	0.09	0.47	0.47	0.04	0.43	0.43	0.29	0.23	0.23	0.35	0.26	0.26
Capacity (c), veh/h	308	1778	862	150	1515	658	263	813	357	381	493	381
Volume-to-Capacity Ratio (X)	0.846	0.397	0.398	0.253	0.602	0.163	0.649	0.528	0.244	0.895	0.699	0.773
Back of Queue (Q), ft/ln (95 th percentile)	172.9	189.1	189.8	25	290.3	66.4	179.4	239.6	96.8	238.9	367.4	334.5
Back of Queue (Q), veh/ln (95 th percentile)	6.8	7.5	7.6	1.0	11.4	2.6	7.1	9.5	3.8	9.5	14.5	13.4
Queue Storage Ratio (RQ) (95 th percentile)	0.43	0.00	0.00	0.07	0.00	0.20	1.02	0.00	0.74	1.19	0.00	0.00
Uniform Delay (d_1), s/veh	52.0	14.2	13.8	54.6	19.8	15.8	34.8	41.6	38.0	35.8	40.7	41.1
Incremental Delay (d_2), s/veh	2.5	0.7	1.4	0.3	1.8	0.5	1.0	0.8	0.5	28.1	2.7	6.0
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	54.5	14.9	15.2	55.0	21.6	16.3	35.8	42.4	38.5	63.9	43.4	47.1
Level of Service (LOS)	D	B	B	D	C	B	D	D	D	E	D	D
Approach Delay, s/veh / LOS	22.9	C		22.3	C		40.3	D		51.7	D	
Intersection Delay, s/veh / LOS	32.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.51	C	2.37	B	2.87	C	2.61	C
Bicycle LOS Score / LOS	1.21	A	1.36	A	1.05	A	1.30	A

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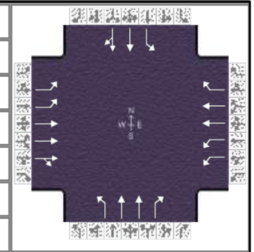
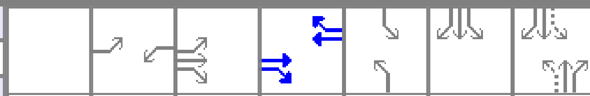
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	AM Peak Hour	PHF	0.90
Urban Street	Osuna Rd	Analysis Year	2023	Analysis Period	1> 7:45
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Build-Out BG AM.xus		
Project Description	Charter High Scchool TIS				

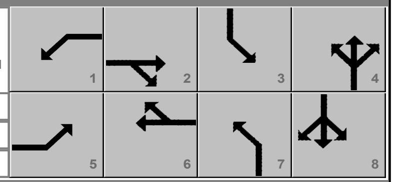


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	329	748	121	75	920	342	116	250	44	210	332	266

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	7.5	4.0	48.0	8.6	0.4	25.4
Yellow	3.0	3.0	4.5	3.0	3.0	4.0
Red	0.5	0.5	1.5	0.5	0.5	2.0



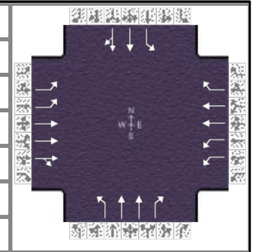
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	18.5	61.6	11.0	54.0	12.1	31.4	16.0	35.3
Change Period, (*Y+R c*), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.2	2.6	5.2
Queue Clearance Time (*g s*), s	14.6		4.7		8.7	9.9	14.0	24.0
Green Extension Time (*g e*), s	0.4	0.0	0.1	0.0	0.0	6.5	0.0	5.3
Phase Call Probability	1.00		0.94		0.99	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.17	0.08	1.00	0.29

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	366	636	299	83	1022	251	129	278	38	233	361	302
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1702	1856	1732	1743	1781	1556	1810	1766	1520	1795	1856	1529
Queue Service Time (*g s*), s	12.6	9.6	9.7	2.7	24.8	11.0	6.7	7.9	2.4	12.0	21.4	22.0
Cycle Queue Clearance Time (*g c*), s	12.6	9.6	9.7	2.7	24.8	11.0	6.7	7.9	2.4	12.0	21.4	22.0
Green Ratio (*g/C*)	0.12	0.48	0.48	0.06	0.42	0.42	0.28	0.23	0.23	0.32	0.26	0.26
Capacity (*c*), veh/h	412	1781	831	203	1485	649	217	807	347	397	484	367
Volume-to-Capacity Ratio (*X*)	0.886	0.357	0.360	0.410	0.688	0.387	0.595	0.344	0.109	0.588	0.745	0.823
Back of Queue (*Q*), ft/ln (95 th percentile)	234.4	164.9	158.5	53.3	349.2	171.4	133.9	158.8	42.4	230.9	396.2	359.5
Back of Queue (*Q*), veh/ln (95 th percentile)	9.1	6.4	6.3	2.1	13.7	6.8	5.4	6.2	1.6	9.2	15.5	14.4
Queue Storage Ratio (*RQ*) (95 th percentile)	0.59	0.00	0.00	0.16	0.00	0.53	0.77	0.00	0.33	1.15	0.00	0.00
Uniform Delay (*d 1*), s/veh	49.5	13.4	13.0	53.4	21.6	18.0	35.9	39.6	36.6	32.1	41.6	42.0
Incremental Delay (*d 2*), s/veh	5.5	0.6	1.2	0.5	2.7	1.7	1.0	0.4	0.2	1.6	4.4	10.4
Initial Queue Delay (*d 3*), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	55.0	13.9	14.2	53.9	24.3	19.7	36.8	39.9	36.8	33.6	45.9	52.5
Level of Service (LOS)	D	B	B	D	C	B	D	D	D	C	D	D
Approach Delay, s/veh / LOS	25.5	C		25.3	C		38.8	D		44.9	D	
Intersection Delay, s/veh / LOS	31.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.44	B	2.28	B	2.89	C	2.63	C
Bicycle LOS Score / LOS	1.20	A	1.61	B	0.85	A	1.23	A

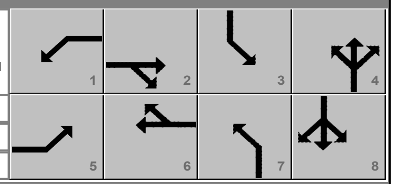
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	PM Peak Hour	PHF	0.92
Urban Street	Osuna Rd	Analysis Year	2023	Analysis Period	1> 16:30
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Build-Out BG PM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	245	928	64	36	856	203	160	403	145	320	352	310

Signal Information										
Cycle, s	120.0	Reference Phase	2	Green	5.8	2.1	48.2	11.2	0.8	25.8
Offset, s	0	Reference Point	End	Yellow	3.0	3.0	4.5	3.0	3.0	4.0
Uncoordinated	No	Simult. Gap E/W	On	Red	0.5	0.5	1.5	0.5	0.5	2.0
Force Mode	Fixed	Simult. Gap N/S	On							



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	15.0	59.9	9.3	54.2	14.7	31.8	19.0	36.1
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (g_s), s	11.1		3.3		11.1	14.8	17.0	23.0
Green Extension Time (g_e), s	0.4	0.0	0.0	0.0	0.1	7.7	0.0	7.1
Phase Call Probability	1.00		0.73		1.00	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.03	0.19	1.00	0.28

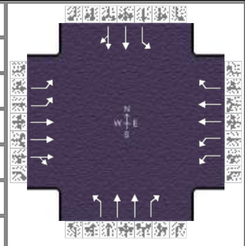
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	266	719	350	39	930	112	174	438	90	348	353	301
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1716	1885	1829	1716	1781	1547	1781	1795	1577	1795	1870	1568
Queue Service Time (g_s), s	9.1	11.6	11.7	1.3	21.3	4.2	9.1	12.8	5.6	15.0	20.4	21.0
Cycle Queue Clearance Time (g_c), s	9.1	11.6	11.7	1.3	21.3	4.2	9.1	12.8	5.6	15.0	20.4	21.0
Green Ratio (*g/C*)	0.09	0.47	0.47	0.04	0.42	0.42	0.30	0.23	0.23	0.35	0.27	0.27
Capacity (*c*), veh/h	314	1756	852	152	1491	648	264	831	365	384	501	387
Volume-to-Capacity Ratio (*X*)	0.849	0.410	0.410	0.257	0.624	0.173	0.658	0.527	0.247	0.906	0.704	0.776
Back of Queue (*Q*), ft/ln (95 th percentile)	176.4	196.7	197.1	25.7	305.7	70.9	182	242.3	99.9	259.9	374.7	340.6
Back of Queue (*Q*), veh/ln (95 th percentile)	6.9	7.8	7.9	1.0	12.0	2.7	7.2	9.6	4.0	10.3	14.8	13.6
Queue Storage Ratio (*RQ*) (95 th percentile)	0.44	0.00	0.00	0.08	0.00	0.22	1.04	0.00	0.77	1.30	0.00	0.00
Uniform Delay (d_1), s/veh	51.9	14.8	14.4	54.6	20.7	16.4	34.4	41.2	37.6	35.8	40.5	40.9
Incremental Delay (d_2), s/veh	2.5	0.7	1.5	0.3	2.0	0.6	1.2	0.7	0.5	31.4	2.9	6.3
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	54.4	15.5	15.8	54.9	22.7	16.9	35.6	41.9	38.1	67.1	43.4	47.1
Level of Service (LOS)	D	B	B	D	C	B	D	D	D	E	D	D
Approach Delay, s/veh / LOS	23.3		C	23.2		C	39.9		D	52.8		D
Intersection Delay, s/veh / LOS	33.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.51	C	2.37	B	2.87	C	2.61	C
Bicycle LOS Score / LOS	1.22	A	1.38	A	1.07	A	1.31	A

 HCS™ Streets Version 7.8.5 Generated: 8/31/2022 3:06:37 PM

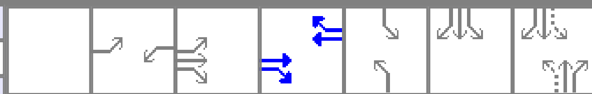
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	AM Peak Hour	PHF	0.90
Urban Street	Osuna Rd	Analysis Year	2023	Analysis Period	1> 7:45
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Build-Out Total AM.xus		
Project Description	Charter High School TIS				

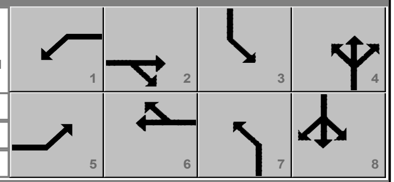


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	329	748	143	108	920	342	130	274	64	210	371	266

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	7.9	3.6	46.1	9.3	3.2	27.4
Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Red	0.5	0.5	1.5	0.5	0.0	2.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	18.5	59.2	11.4	52.1	12.8	33.4	16.0	36.6
Change Period, (*Y+R c*), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (*g s*), s	14.6		6.0		9.3	10.5	13.9	25.3
Green Extension Time (*g e*), s	0.4	0.0	0.1	0.0	0.0	7.2	0.0	5.4
Phase Call Probability	1.00		0.98		0.99	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.45	0.12	1.00	0.42

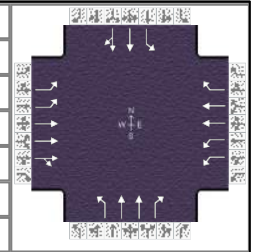
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	366	655	305	120	1022	251	144	304	60	233	383	323
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1702	1856	1710	1743	1781	1556	1810	1766	1520	1795	1856	1546
Queue Service Time (*g s*), s	12.6	10.7	10.8	4.0	26.0	11.5	7.3	8.5	3.7	11.9	22.8	23.3
Cycle Queue Clearance Time (*g c*), s	12.6	10.7	10.8	4.0	26.0	11.5	7.3	8.5	3.7	11.9	22.8	23.3
Green Ratio (*g/C*)	0.12	0.46	0.46	0.06	0.40	0.40	0.30	0.25	0.25	0.33	0.27	0.27
Capacity (*c*), veh/h	411	1708	787	214	1427	624	226	866	373	406	505	388
Volume-to-Capacity Ratio (*X*)	0.889	0.384	0.387	0.562	0.716	0.403	0.639	0.351	0.161	0.575	0.760	0.832
Back of Queue (*Q*), ft/ln (95 th percentile)	241	185.5	176.1	77.5	371.2	181.3	148.2	171	66.7	227	419.6	383.1
Back of Queue (*Q*), veh/ln (95 th percentile)	9.3	7.2	7.0	3.1	14.6	7.2	5.9	6.7	2.5	9.0	16.4	15.3
Queue Storage Ratio (*RQ*) (95 th percentile)	0.60	0.00	0.00	0.23	0.00	0.56	0.85	0.00	0.51	1.13	0.00	0.00
Uniform Delay (*d 1*), s/veh	49.5	15.0	14.6	53.5	23.4	19.4	34.6	38.2	35.6	31.0	41.0	41.3
Incremental Delay (*d 2*), s/veh	8.7	0.7	1.4	0.9	3.2	1.9	1.8	0.3	0.3	1.3	5.2	11.9
Initial Queue Delay (*d 3*), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	58.2	15.7	16.1	54.4	26.6	21.4	36.4	38.5	35.9	32.4	46.2	53.2
Level of Service (LOS)	E	B	B	D	C	C	D	D	D	C	D	D
Approach Delay, s/veh / LOS	27.5	C		28.1	C		37.6	D		45.2	D	
Intersection Delay, s/veh / LOS	32.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.44	B	2.28	B	2.89	C	2.63	C
Bicycle LOS Score / LOS	1.22	A	1.64	B	0.91	A	1.26	A

 HCS™ Streets Version 7.8.5 Generated: 9/13/2022 12:19:18 PM

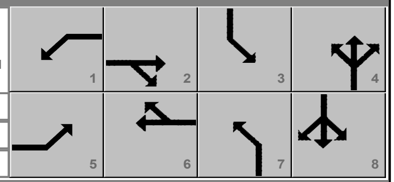
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engeering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	PM Peak Hour	PHF	0.92
Urban Street	Osuna Rd	Analysis Year	2023	Analysis Period	1> 16:30
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Build-Out Total PM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	245	928	72	47	856	203	172	424	163	320	365	310

Signal Information										
Cycle, s	120.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	6.5	1.4	47.1	11.7	0.3	26.9
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	4.5	3.0	3.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.5	0.5	1.5	0.5	0.5	2.0



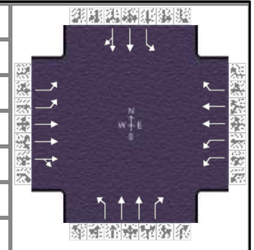
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	15.0	58.0	10.0	53.1	15.2	32.9	19.0	36.7
Change Period, (Y+R_c), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (g_s), s	11.1		3.7		11.7	15.4	17.0	23.4
Green Extension Time (g_e), s	0.3	0.0	0.0	0.0	0.1	8.1	0.0	7.3
Phase Call Probability	1.00		0.82		1.00	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.06	0.23	1.00	0.33

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (v), veh/h	266	726	351	51	930	112	187	461	110	348	360	307
Adjusted Saturation Flow Rate (s), veh/h/ln	1716	1885	1821	1716	1781	1547	1781	1795	1577	1795	1870	1574
Queue Service Time (g_s), s	9.1	12.4	12.5	1.7	21.9	4.4	9.7	13.4	6.8	15.0	20.8	21.4
Cycle Queue Clearance Time (g_c), s	9.1	12.4	12.5	1.7	21.9	4.4	9.7	13.4	6.8	15.0	20.8	21.4
Green Ratio (g/C)	0.09	0.45	0.45	0.05	0.41	0.41	0.31	0.24	0.24	0.36	0.27	0.27
Capacity (c), veh/h	314	1698	820	173	1458	633	273	865	380	386	509	396
Volume-to-Capacity Ratio (X)	0.849	0.427	0.428	0.296	0.638	0.177	0.684	0.533	0.289	0.901	0.707	0.777
Back of Queue (Q), ft/ln (95 th percentile)	176.4	208.3	208.2	33.3	316.2	73.2	195.2	250.8	121.5	253.1	381.4	347.5
Back of Queue (Q), veh/ln (95 th percentile)	6.9	8.3	8.3	1.3	12.5	2.8	7.7	10.0	4.8	10.0	15.0	13.9
Queue Storage Ratio (RQ) (95 th percentile)	0.44	0.00	0.00	0.10	0.00	0.23	1.12	0.00	0.93	1.27	0.00	0.00
Uniform Delay (d_1), s/veh	51.9	16.1	15.7	53.9	21.6	17.1	33.6	40.5	37.2	34.9	40.2	40.5
Incremental Delay (d_2), s/veh	2.6	0.8	1.6	0.3	2.2	0.6	2.3	0.7	0.6	29.8	3.1	6.6
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	54.4	16.9	17.3	54.3	23.8	17.7	35.8	41.2	37.8	64.7	43.3	47.1
Level of Service (LOS)	D	B	B	D	C	B	D	D	D	E	D	D
Approach Delay, s/veh / LOS	24.4	C		24.6	C		39.4	D		51.8	D	
Intersection Delay, s/veh / LOS	33.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.52	C	2.37	B	2.87	C	2.60	C
Bicycle LOS Score / LOS	1.23	A	1.39	A	1.11	A	1.33	A

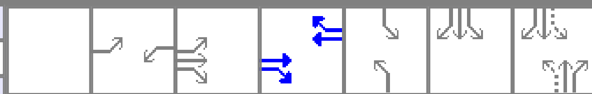
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	AM Peak Hour	PHF	0.90
Urban Street	Osuna Rd	Analysis Year	2033	Analysis Period	1> 7:45
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Horizon BG AM.xus		
Project Description	Charter High School TIS				

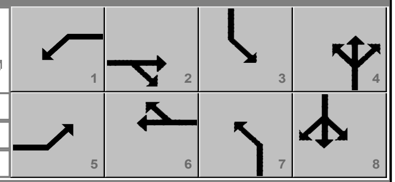


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	401	909	148	92	1118	415	141	304	53	255	403	324

Signal Information			
Cycle, s	120.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	7.7	6.3	40.3	9.6	2.9	30.7
Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Red	0.5	0.5	1.5	0.5	0.0	2.0

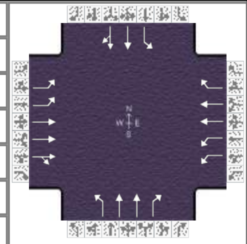


Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	21.1	56.1	11.2	46.3	13.1	36.7	16.0	39.5
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.2	2.6	5.2
Queue Clearance Time (g_s), s	17.4		5.4		9.6	11.2	14.0	28.7
Green Extension Time (g_e), s	0.1	0.0	0.1	0.0	0.0	8.1	0.0	4.8
Phase Call Probability	1.00		0.97		0.99	1.00	1.00	1.00
Max Out Probability	1.00		0.00		0.73	0.18	1.00	0.69

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (v), veh/h	446	780	364	102	1242	332	157	338	48	283	441	365
Adjusted Saturation Flow Rate (s), veh/h/ln	1702	1856	1726	1743	1781	1556	1810	1766	1521	1795	1856	1528
Queue Service Time (g_s), s	15.4	14.8	14.8	3.4	41.5	19.0	7.6	9.2	2.8	12.0	26.4	26.7
Cycle Queue Clearance Time (g_c), s	15.4	14.8	14.8	3.4	41.5	19.0	7.6	9.2	2.8	12.0	26.4	26.7
Green Ratio (g/C)	0.14	0.43	0.43	0.06	0.35	0.35	0.33	0.27	0.27	0.36	0.30	0.30
Capacity (c), veh/h	484	1611	749	210	1254	548	225	962	414	423	549	420
Volume-to-Capacity Ratio (X)	0.920	0.484	0.486	0.486	0.990	0.606	0.695	0.351	0.115	0.670	0.804	0.869
Back of Queue (Q), ft/ln (95 th percentile)	319.5	239.1	229.5	65.6	767.1	278.2	160.6	183.9	50.5	75.6	484.2	444.2
Back of Queue (Q), veh/ln (95 th percentile)	12.4	9.3	9.2	2.6	30.2	11.0	6.4	7.2	1.9	3.0	18.9	17.8
Queue Storage Ratio (*RQ*) (95 th percentile)	0.80	0.00	0.00	0.19	0.00	0.86	0.92	0.00	0.39	0.38	0.00	0.00
Uniform Delay (d_1), s/veh	48.0	17.9	17.4	53.4	31.8	25.6	33.1	35.9	32.8	31.5	39.9	40.3
Incremental Delay (d_2), s/veh	26.7	1.0	2.3	0.6	42.5	5.0	4.2	0.3	0.2	3.4	8.0	17.9
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	74.6	18.9	19.7	54.0	74.3	30.7	37.3	36.2	33.0	34.9	47.9	58.2
Level of Service (LOS)	E	B	B	D	E	C	D	D	C	C	D	E
Approach Delay, s/veh / LOS	34.7	C		64.5	E		36.2	D		47.9	D	
Intersection Delay, s/veh / LOS	48.0						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.45	B	2.29	B	2.89	C	2.63	C
Bicycle LOS Score / LOS	1.36	A	1.87	B	0.93	A	1.39	A

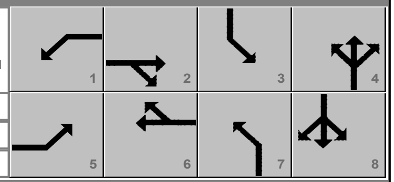
HCS7 Signalized Intersection Results Summary



General Information				Intersection Information	
Agency				Duration, h	0.999
Analyst		Analysis Date	8/29/2022	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Urban Street	Osuna Rd	Analysis Year	2033	Analysis Period	1> 16:30
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Horizon BG PM.xus		
Project Description	Charter High School TIS				

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	298	1128	78	43	1040	247	195	490	176	389	428	377

Signal Information										
Cycle, s	120.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	6.3	3.6	40.2	12.5	3.0	31.8
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.5	0.5	1.5	0.5	0.0	2.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	16.9	53.3	9.8	46.2	16.0	37.8	19.0	40.9
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (g_s), s	13.1		3.6		12.4	17.0	17.0	27.9
Green Extension Time (g_e), s	0.4	0.0	0.0	0.0	0.1	9.4	0.0	7.0
Phase Call Probability	1.00		0.79		1.00	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.16	0.38	1.00	0.63

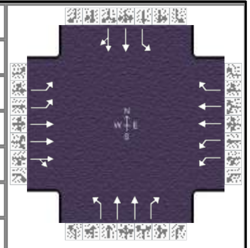
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	324	876	425	47	1130	160	212	533	124	423	440	369
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1716	1885	1827	1716	1781	1547	1781	1795	1577	1795	1870	1561
Queue Service Time (g_s), s	11.1	18.3	18.3	1.6	35.1	7.6	10.4	15.0	7.3	15.0	25.6	25.9
Cycle Queue Clearance Time (g_c), s	11.1	18.3	18.3	1.6	35.1	7.6	10.4	15.0	7.3	15.0	25.6	25.9
Green Ratio (*g/C*)	0.11	0.41	0.41	0.05	0.35	0.35	0.36	0.28	0.28	0.39	0.31	0.31
Capacity (*c*), veh/h	370	1550	751	166	1253	544	277	1012	445	404	575	447
Volume-to-Capacity Ratio (*X*)	0.875	0.565	0.565	0.281	0.902	0.294	0.766	0.526	0.279	1.047	0.765	0.824
Back of Queue (*Q*), ft/ln (95 th percentile)	211.9	282.1	283.9	30.5	537.1	129.3	216.1	272.3	129.6	726.7	460.9	418.6
Back of Queue (*Q*), veh/ln (95 th percentile)	8.3	11.2	11.4	1.2	21.1	5.0	8.5	10.8	5.1	28.8	18.1	16.7
Queue Storage Ratio (*RQ*) (95 th percentile)	0.53	0.00	0.00	0.09	0.00	0.40	1.23	0.00	1.00	3.63	0.00	0.00
Uniform Delay (d_1), s/veh	50.6	20.6	20.1	54.1	30.8	22.7	31.3	37.1	33.6	35.4	38.5	38.8
Incremental Delay (d_2), s/veh	4.8	1.5	3.1	0.3	12.4	1.4	6.7	0.6	0.5	142.7	5.5	11.1
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	55.4	22.1	23.2	54.5	43.3	24.1	38.0	37.7	34.0	178.1	44.0	49.9
Level of Service (LOS)	E	C	C	D	D	C	D	D	C	F	D	D
Approach Delay, s/veh / LOS	29.0	C		41.4	D		37.2	D		91.8	F	
Intersection Delay, s/veh / LOS	49.0						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.52	C	2.38	B	2.86	C	2.60	C
Bicycle LOS Score / LOS	1.38	A	1.59	B	1.20	A	1.50	B

 HCS™ Streets Version 7.9 Generated: 8/31/2022 3:15:29 PM

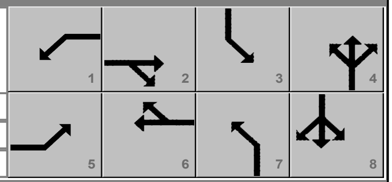
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.999
Analyst		Analysis Date	8/29/2022	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Urban Street	Osuna Rd	Analysis Year	2033	Analysis Period	1> 7:45
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Horizon Total AM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	401	909	170	125	1118	415	155	328	73	255	442	324

Signal Information										
Cycle, s	120.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	7.9	5.9	39.0	10.3	2.2	32.1
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.5	0.5	1.5	0.5	0.0	2.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	20.9	54.4	11.4	45.0	13.8	38.1	16.0	40.4
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.2	2.6	5.2
Queue Clearance Time (g_s), s	17.5		6.6		10.3	11.9	14.0	30.1
Green Extension Time (g_e), s	0.0	0.0	0.1	0.0	0.0	8.8	0.0	4.2
Phase Call Probability	1.00		0.99		1.00	1.00	1.00	1.00
Max Out Probability	1.00		0.00		1.00	0.23	1.00	0.85

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	446	800	369	139	1242	332	172	364	70	283	464	386
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1702	1856	1708	1743	1781	1556	1810	1766	1521	1795	1856	1542
Queue Service Time (g_s), s	15.5	15.9	16.0	4.6	41.0	19.5	8.3	9.9	4.1	12.0	27.9	28.1
Cycle Queue Clearance Time (g_c), s	15.5	15.9	16.0	4.6	41.0	19.5	8.3	9.9	4.1	12.0	27.9	28.1
Green Ratio (*g/C*)	0.14	0.42	0.42	0.06	0.34	0.34	0.35	0.28	0.28	0.37	0.30	0.30
Capacity (*c*), veh/h	478	1560	718	216	1217	532	231	1005	433	426	562	435
Volume-to-Capacity Ratio (*X*)	0.931	0.513	0.514	0.644	1.021	0.625	0.747	0.363	0.162	0.666	0.825	0.888
Back of Queue (*Q*), ft/ln (95 th percentile)	337.4	255.2	243.7	90.4	931.5	287.5	183.4	195.5	73.7	71.2	515	480.8
Back of Queue (*Q*), veh/ln (95 th percentile)	13.1	10.0	9.7	3.6	36.7	11.4	7.3	7.6	2.8	2.8	20.1	19.2
Queue Storage Ratio (*RQ*) (95 th percentile)	0.84	0.00	0.00	0.27	0.00	0.88	1.05	0.00	0.57	0.36	0.00	0.00
Uniform Delay (d_1), s/veh	48.2	19.3	18.8	53.8	32.7	26.8	32.3	35.0	32.2	30.8	39.7	40.0
Incremental Delay (d_2), s/veh	34.8	1.2	2.6	1.2	74.3	5.6	8.1	0.3	0.2	3.2	9.9	22.1
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	83.0	20.5	21.5	55.0	106.9	32.4	40.5	35.3	32.4	34.0	49.6	62.2
Level of Service (LOS)	F	C	C	D	F	C	D	D	C	C	D	E
Approach Delay, s/veh / LOS	38.0	D		88.3	F		36.4	D		50.0	D	
Intersection Delay, s/veh / LOS	57.5						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.45	B	2.29	B	2.89	C	2.63	C
Bicycle LOS Score / LOS	1.38	A	1.90	B	0.99	A	1.42	A

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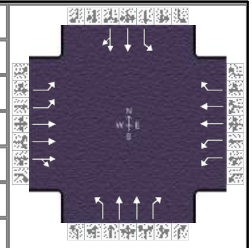
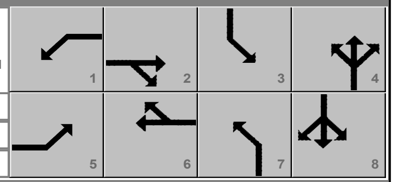
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.999
Analyst		Analysis Date	8/29/2022	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Urban Street	Osuna Rd	Analysis Year	2033	Analysis Period	1> 16:30
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna - Horizon Total PM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	298	1128	86	54	1040	247	207	511	194	389	441	377

Signal Information										
Cycle, s	120.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	6.9	3.1	39.4	13.0	2.5	32.6
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.5	0.5	1.5	0.5	0.0	2.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	16.9	52.0	10.4	45.4	16.5	38.6	19.0	41.2
Change Period, (*Y+R c*), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (*g s*), s	13.1		4.0		12.9	17.6	17.0	28.4
Green Extension Time (*g e*), s	0.3	0.0	0.0	0.0	0.1	9.7	0.0	6.8
Phase Call Probability	1.00		0.86		1.00	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.32	0.42	1.00	0.69

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	324	883	427	59	1130	160	225	555	143	423	447	376
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1716	1885	1821	1716	1781	1547	1781	1795	1577	1795	1870	1565
Queue Service Time (*g s*), s	11.1	19.1	19.1	2.0	35.6	7.8	10.9	15.6	8.5	15.0	26.0	26.4
Cycle Queue Clearance Time (*g c*), s	11.1	19.1	19.1	2.0	35.6	7.8	10.9	15.6	8.5	15.0	26.0	26.4
Green Ratio (*g/C*)	0.11	0.40	0.40	0.05	0.35	0.35	0.37	0.29	0.29	0.40	0.31	0.31
Capacity (*c*), veh/h	370	1508	728	182	1229	534	283	1036	455	403	579	452
Volume-to-Capacity Ratio (*X*)	0.876	0.586	0.586	0.322	0.919	0.299	0.795	0.536	0.315	1.050	0.772	0.831
Back of Queue (*Q*), ft/ln (95 th percentile)	214.3	295.2	296.7	38.2	559.1	131.9	231.5	280.9	150.7	739.8	469.7	428.5
Back of Queue (*Q*), veh/ln (95 th percentile)	8.4	11.7	11.9	1.5	22.0	5.1	9.1	11.1	6.0	29.4	18.5	17.1
Queue Storage Ratio (*RQ*) (95 th percentile)	0.54	0.00	0.00	0.11	0.00	0.41	1.32	0.00	1.16	3.70	0.00	0.00
Uniform Delay (*d 1*), s/veh	50.6	21.8	21.3	53.7	31.7	23.3	30.8	36.7	33.4	35.2	38.4	38.7
Incremental Delay (*d 2*), s/veh	6.1	1.7	3.5	0.4	15.1	1.4	9.5	0.6	0.6	146.9	6.0	12.0
Initial Queue Delay (*d 3*), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	56.7	23.5	24.7	54.1	46.9	24.7	40.3	37.3	34.0	182.1	44.4	50.8
Level of Service (LOS)	E	C	C	D	D	C	D	D	C	F	D	D
Approach Delay, s/veh / LOS	30.4	C		44.6	D		37.5	D		93.1	F	
Intersection Delay, s/veh / LOS	50.5						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.52	C	2.38	B	2.86	C	2.60	C
Bicycle LOS Score / LOS	1.39	A	1.60	B	1.25	A	1.52	B

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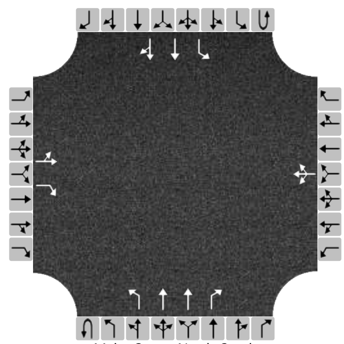
HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	Existing AM	Peak Hour Factor	0.84
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		2	0	4		7	1	52	0	11	317	7	33	13	589	21
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	8		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.26		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.28		

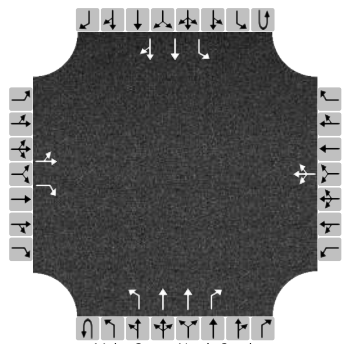
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		2		5			71			13				55		
Capacity, c (veh/h)		255		639			693			886				849		
v/c Ratio		0.01		0.01			0.10			0.01				0.06		
95% Queue Length, Q_{95} (veh)		0.0		0.0			0.3			0.0				0.2		
Control Delay (s/veh)		19.3		10.7			10.8			9.1				9.5		
Level of Service (LOS)		C		B			B			A				A		
Approach Delay (s/veh)	13.5				10.8				0.3				0.7			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	Existing PM	Peak Hour Factor	0.87
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		6	0	15		3	0	12	0	0	614	2	24	5	448	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Approach	Eastbound				Westbound				Northbound				Southbound			
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.20		

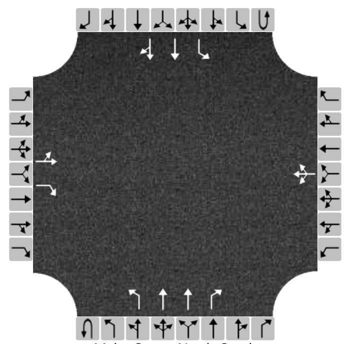
Delay, Queue Length, and Level of Service

Approach	Eastbound				Westbound				Northbound				Southbound			
Flow Rate, v (veh/h)		7		17			17			0				33		
Capacity, c (veh/h)		323		747			523			1060				550		
v/c Ratio		0.02		0.02			0.03			0.00				0.06		
95% Queue Length, Q_{95} (veh)		0.1		0.1			0.1			0.0				0.2		
Control Delay (s/veh)		16.4		9.9			12.1			8.4				12.0		
Level of Service (LOS)		C		A			B			A				B		
Approach Delay (s/veh)	11.8				12.1				0.0				0.7			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	Build-Out Background AM	Peak Hour Factor	0.84
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		2	0	4		7	1	53	0	11	323	7	34	13	601	21
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	8		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	Eastbound U	L	T	R	Westbound U	L	T	R	Northbound U	L	T	R	Southbound U	L	T	R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.26		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.28		

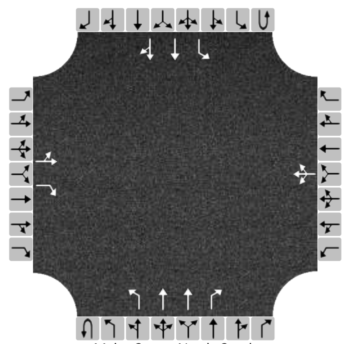
Delay, Queue Length, and Level of Service

	Eastbound U	L	T	R	Westbound U	L	T	R	Northbound U	L	T	R	Southbound U	L	T	R
Flow Rate, v (veh/h)		2		5			73			13				56		
Capacity, c (veh/h)		248		633			689			875				838		
v/c Ratio		0.01		0.01			0.11			0.01				0.07		
95% Queue Length, Q_{95} (veh)		0.0		0.0			0.4			0.0				0.2		
Control Delay (s/veh)		19.6		10.7			10.8			9.2				9.6		
Level of Service (LOS)		C		B			B			A				A		
Approach Delay (s/veh)	13.7				10.8				0.3				0.7			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2023	East/West Street	Presidential S / Site Exi
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	Build-Out Background PM	Peak Hour Factor	0.87
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		6	0	15		3	0	12	0	0	626	2	24	5	457	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.20		

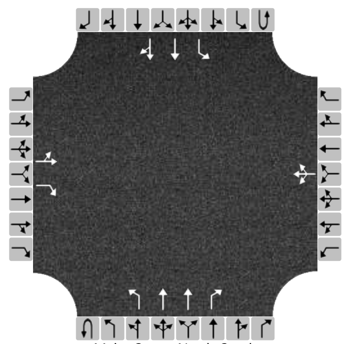
Delay, Queue Length, and Level of Service

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Flow Rate, v (veh/h)		7		17			17			0				33		
Capacity, c (veh/h)		317		741			515			1051				539		
v/c Ratio		0.02		0.02			0.03			0.00				0.06		
95% Queue Length, Q_{95} (veh)		0.1		0.1			0.1			0.0				0.2		
Control Delay (s/veh)		16.6		10.0			12.2			8.4				12.1		
Level of Service (LOS)		C		A			B			A				B		
Approach Delay (s/veh)	11.9				12.2				0.0				0.7			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	Build-Out Total AM	Peak Hour Factor	0.84
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		2	0	4		7	1	53	17	11	381	7	34	13	695	21
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	8		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90	6.40	4.10			6.40	4.26		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30	2.50	2.20			2.50	2.28		

Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)		2		5			73			33				56		
Capacity, c (veh/h)		202		582			625			512				762		
v/c Ratio		0.01		0.01			0.12			0.07				0.07		
95% Queue Length, Q_{95} (veh)		0.0		0.0			0.4			0.2				0.2		
Control Delay (s/veh)		23.0		11.2			11.5			12.5				10.1		
Level of Service (LOS)		C		B			B			B				B		
Approach Delay (s/veh)	15.2				11.5				0.8				0.6			
Approach LOS	C				B											

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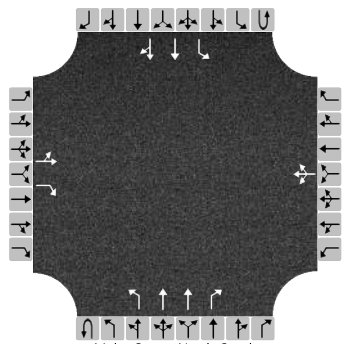
Presidential Dr North Build-Out Total AM.xtw

HCS7 Two-Way Stop-Control Report

General Information / Site Information

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	Build-Out Total PM	Peak Hour Factor	0.87
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		6	0	15		3	0	12	0	0	677	2	24	5	489	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.20		

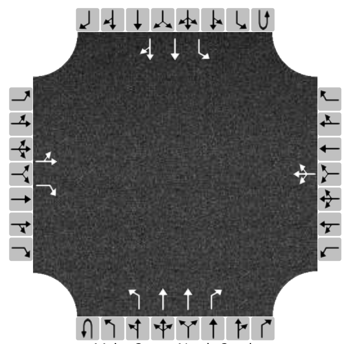
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		7		17			17			0				33		
Capacity, c (veh/h)		296		721			487			1018				496		
v/c Ratio		0.02		0.02			0.04			0.00				0.07		
95% Queue Length, Q_{95} (veh)		0.1		0.1			0.1			0.0				0.2		
Control Delay (s/veh)		17.4		10.1			12.7			8.5				12.8		
Level of Service (LOS)		C		B			B			A				B		
Approach Delay (s/veh)	12.2				12.7				0.0				0.7			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	Horizon Background AM	Peak Hour Factor	0.84
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		2	0	5		9	1	64	0	14	393	9	41	16	730	21
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	8		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.26		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.28		

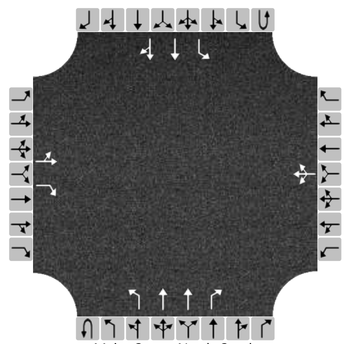
Delay, Queue Length, and Level of Service

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Flow Rate, v (veh/h)		2		6			88			17				68		
Capacity, c (veh/h)		187		564			617			767				737		
v/c Ratio		0.01		0.01			0.14			0.02				0.09		
95% Queue Length, Q_{95} (veh)		0.0		0.0			0.5			0.1				0.3		
Control Delay (s/veh)		24.5		11.4			11.8			9.8				10.4		
Level of Service (LOS)		C		B			B			A				B		
Approach Delay (s/veh)	15.2				11.8				0.3				0.7			
Approach LOS	C				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	Horizon Background PM	Peak Hour Factor	0.87
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		7	0	19		4	0	15	0	0	761	2	30	6	556	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		8		22			22			0				41		
Capacity, c (veh/h)		250		682			432			954				429		
v/c Ratio		0.03		0.03			0.05			0.00				0.10		
95% Queue Length, Q_{95} (veh)		0.1		0.1			0.2			0.0				0.3		
Control Delay (s/veh)		19.9		10.5			13.8			8.8				14.3		
Level of Service (LOS)		C		B			B			A				B		
Approach Delay (s/veh)	13.0				13.8				0.0				0.9			
Approach LOS	B				B											

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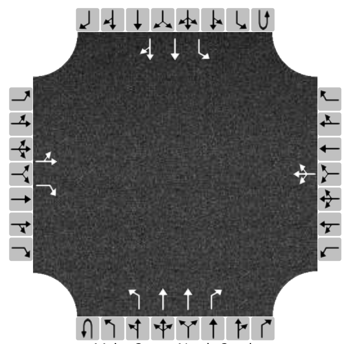
Presidential Dr North Horizon Background PM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	Horizon Total AM	Peak Hour Factor	0.84
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		2	0	5		9	1	64	17	14	451	9	41	16	824	26
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	8		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90	6.40	4.10			6.40	4.26		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30	2.50	2.20			2.50	2.28		

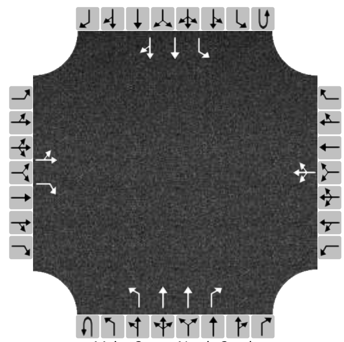
Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)		2		6			88			37				68		
Capacity, c (veh/h)		151		517			555			430				668		
v/c Ratio		0.02		0.01			0.16			0.09				0.10		
95% Queue Length, Q_{95} (veh)		0.0		0.0			0.6			0.3				0.3		
Control Delay (s/veh)		29.2		12.0			12.7			14.2				11.0		
Level of Service (LOS)		D		B			B			B				B		
Approach Delay (s/veh)	16.9				12.7				0.9				0.7			
Approach LOS	C				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	Horizon Total PM	Peak Hour Factor	0.87
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		7	0	19		4	0	15	6	0	812	2	30	6	588	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	Eastbound				Westbound				Northbound				Southbound			
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90	6.40	4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30	2.50	2.20			2.50	2.20		

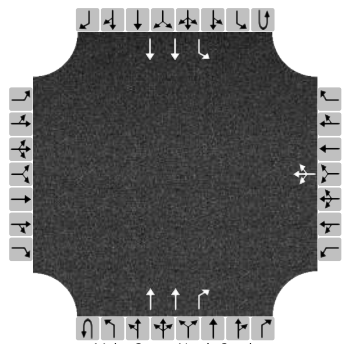
Delay, Queue Length, and Level of Service

	Eastbound				Westbound				Northbound				Southbound			
Flow Rate, v (veh/h)		8		22			22			7				41		
Capacity, c (veh/h)		229		663			403			524				394		
v/c Ratio		0.04		0.03			0.05			0.01				0.10		
95% Queue Length, Q_{95} (veh)		0.1		0.1			0.2			0.0				0.4		
Control Delay (s/veh)		21.3		10.6			14.5			12.0				15.2		
Level of Service (LOS)		C		B			B			B				C		
Approach Delay (s/veh)	13.5				14.5				0.1				0.9			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	2	1	0	1	2	0
Configuration							LTR				T	R		L	T	
Volume (veh/h)						35	0	9			308	9	1	14	449	
Percent Heavy Vehicles (%)						0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)						7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)						7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)						3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)						3.50	4.00	3.41					2.50	2.20		

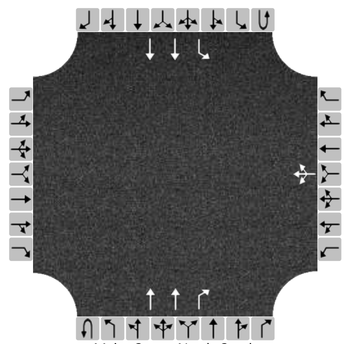
Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)							49							17		
Capacity, c (veh/h)							515							1180		
v/c Ratio							0.10							0.01		
95% Queue Length, Q_{95} (veh)							0.3							0.0		
Control Delay (s/veh)							12.7							8.1		
Level of Service (LOS)							B							A		
Approach Delay (s/veh)					12.7								0.3			
Approach LOS					B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	2	1	0	1	2	0
Configuration							LTR				T	R		L	T	
Volume (veh/h)						16	0	17			612	11	1	3	449	
Percent Heavy Vehicles (%)						0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)						7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)						7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)						3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)						3.50	4.00	3.41					2.50	2.20		

Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)							37							4		
Capacity, c (veh/h)							436							769		
v/c Ratio							0.08							0.01		
95% Queue Length, Q_{95} (veh)							0.3							0.0		
Control Delay (s/veh)							14.0							9.7		
Level of Service (LOS)							B							A		
Approach Delay (s/veh)					14.0								0.1			
Approach LOS					B											

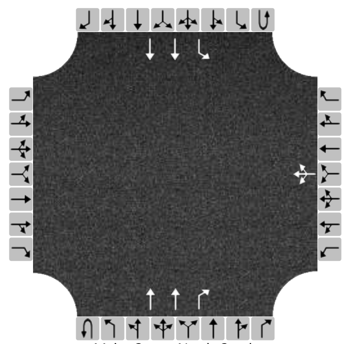
 HCS™ TWSC Version 7.9 Generated: 8/31/2022 4:43:32 PM

Presidential Dr S & Jefferson Existing PM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	2	1	0	1	2	0
Configuration							LTR				T	R		L	T	
Volume (veh/h)						36	0	9			314	9	1	14	458	
Percent Heavy Vehicles (%)						0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)						7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)						7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)						3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)						3.50	4.00	3.41					2.50	2.20		

Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)							51							17		
Capacity, c (veh/h)							508							1173		
v/c Ratio							0.10							0.01		
95% Queue Length, Q_{95} (veh)							0.3							0.0		
Control Delay (s/veh)							12.9							8.1		
Level of Service (LOS)							B							A		
Approach Delay (s/veh)					12.9								0.3			
Approach LOS					B											

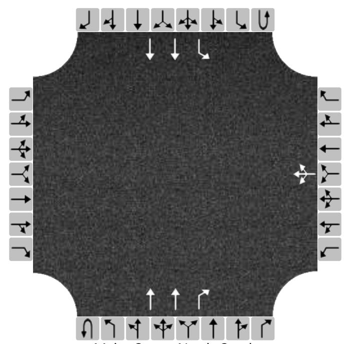
 HCS™ TWSC Version 7.9 Generated: 8/31/2022 4:38:36 PM

Presidential Dr S & Jefferson Build-Out Background AM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	2	1	0	1	2	0
Configuration							LTR				T	R		L	T	
Volume (veh/h)						16	0	17			624	11	1	3	458	
Percent Heavy Vehicles (%)						0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)						7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)						7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)						3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)						3.50	4.00	3.41					2.50	2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							37							4		
Capacity, c (veh/h)							429							758		
v/c Ratio							0.09							0.01		
95% Queue Length, Q_{95} (veh)							0.3							0.0		
Control Delay (s/veh)							14.2							9.8		
Level of Service (LOS)							B							A		
Approach Delay (s/veh)					14.2								0.1			
Approach LOS					B											

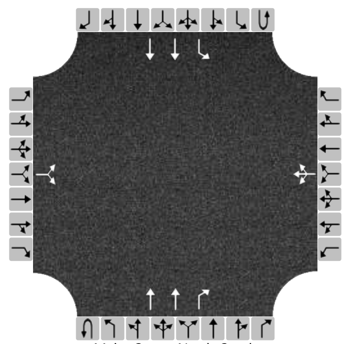
 HCS™ TWSC Version 7.9 Generated: 8/31/2022 4:40:43 PM

Presidential Dr S & Jefferson Build-Out Background PM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	2	1	0	1	2	0
Configuration			LR				LTR				T	R		L	T	
Volume (veh/h)		58		10		36	0	9			331	9	1	14	458	
Percent Heavy Vehicles (%)		3		3		0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Base Critical Headway (sec)		7.5		6.9		7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)		7.56		6.96		7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)		3.53		3.33		3.50	4.00	3.41					2.50	2.20		

Delay, Queue Length, and Level of Service

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Flow Rate, v (veh/h)			76				51							17		
Capacity, c (veh/h)			420				494							1153		
v/c Ratio			0.18				0.10							0.01		
95% Queue Length, Q_{95} (veh)			0.7				0.3							0.0		
Control Delay (s/veh)			15.5				13.1							8.2		
Level of Service (LOS)			C				B							A		
Approach Delay (s/veh)	15.5				13.1								0.3			
Approach LOS	C				B											

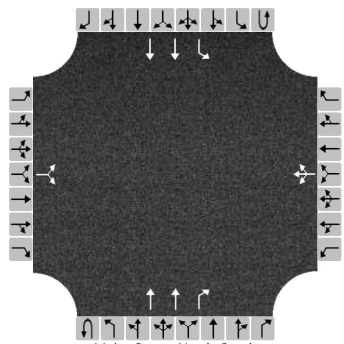
 HCS™ TWSC Version 7.9 Generated: 8/31/2022 4:41:11 PM

Presidential Dr S & Jefferson Build-Out Total AM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	2	1	0	1	2	0
Configuration			LR				LTR				T	R		L	T	
Volume (veh/h)		51		9		16	0	17			630	11	1	3	458	
Percent Heavy Vehicles (%)		3		3		0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5		6.9		7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)		7.56		6.96		7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)		3.53		3.33		3.50	4.00	3.41					2.50	2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			67				37							4		
Capacity, c (veh/h)			388				424							753		
v/c Ratio			0.17				0.09							0.01		
95% Queue Length, Q_{95} (veh)			0.6				0.3							0.0		
Control Delay (s/veh)			16.2				14.3							9.8		
Level of Service (LOS)			C				B							A		
Approach Delay (s/veh)	16.2				14.3								0.1			
Approach LOS	C				B											

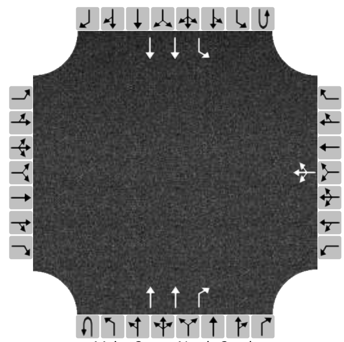
 HCS™ TWSC Version 7.9 Generated: 8/31/2022 4:42:02 PM

Presidential Dr S & Jefferson Build-Out Total PM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	2	1	0	1	2	0
Configuration							LTR				T	R		L	T	
Volume (veh/h)						43	0	11			382	11	1	17	557	
Percent Heavy Vehicles (%)						0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)						7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)						7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)						3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)						3.50	4.00	3.41					2.50	2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							61							20		
Capacity, c (veh/h)							447							1098		
v/c Ratio							0.14							0.02		
95% Queue Length, Q_{95} (veh)							0.5							0.1		
Control Delay (s/veh)							14.3							8.3		
Level of Service (LOS)							B							A		
Approach Delay (s/veh)					14.3								0.3			
Approach LOS					B											

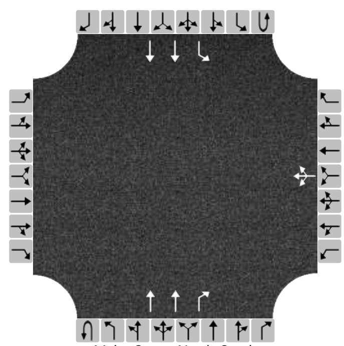
 HCS™ TWSC Version 7.9 Generated: 8/31/2022 4:45:01 PM

Presidential Dr S & Jefferson Horizon Background AM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	2	1	0	1	2	0
Configuration							LTR				T	R		L	T	
Volume (veh/h)						20	0	21			759	14	1	4	557	
Percent Heavy Vehicles (%)						0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)					0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)						7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)						7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)						3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)						3.50	4.00	3.41					2.50	2.20		

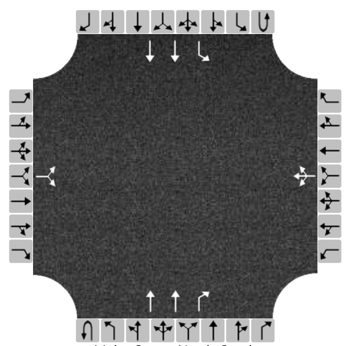
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							46							6		
Capacity, c (veh/h)							356							665		
v/c Ratio							0.13							0.01		
95% Queue Length, Q_{95} (veh)							0.4							0.0		
Control Delay (s/veh)							16.6							10.5		
Level of Service (LOS)							C							B		
Approach Delay (s/veh)					16.6								0.1			
Approach LOS					C											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	2	1	0	1	2	0
Configuration			LR				LTR				T	R		L	T	
Volume (veh/h)		58		10		43	0	11			399	11	1	17	557	
Percent Heavy Vehicles (%)		3		3		0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Base Critical Headway (sec)		7.5		6.9		7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)		7.56		6.96		7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)		3.53		3.33		3.50	4.00	3.41					2.50	2.20		

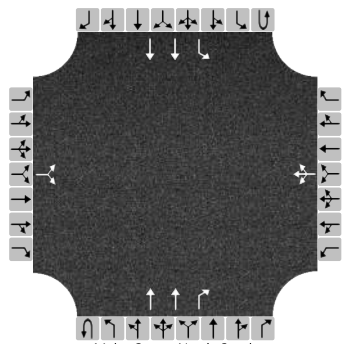
Delay, Queue Length, and Level of Service

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Flow Rate, v (veh/h)			76				61							20		
Capacity, c (veh/h)			354				434							1079		
v/c Ratio			0.22				0.14							0.02		
95% Queue Length, Q_{95} (veh)			0.8				0.5							0.1		
Control Delay (s/veh)			18.0				14.6							8.4		
Level of Service (LOS)			C				B							A		
Approach Delay (s/veh)	18.0				14.6								0.3			
Approach LOS	C				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Site Exit & Jefferson
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/29/2022	East/West Street	Presidential S/Site Exit
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	2	1	0	1	2	0
Configuration			LR				LTR				T	R		L	T	
Volume (veh/h)		51		9		20	0	21			765	14	1	4	557	
Percent Heavy Vehicles (%)		3		3		0	0	11					0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized									No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5		6.9		7.5	6.5	6.9					6.4	4.1		
Critical Headway (sec)		7.56		6.96		7.50	6.50	7.12					6.40	4.10		
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3					2.5	2.2		
Follow-Up Headway (sec)		3.53		3.33		3.50	4.00	3.41					2.50	2.20		

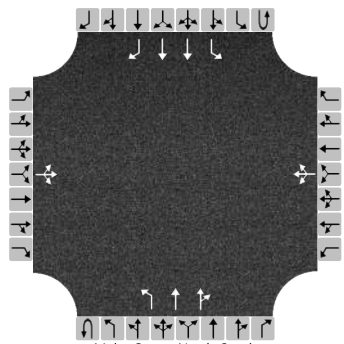
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			67				46							6		
Capacity, c (veh/h)			323				352							661		
v/c Ratio			0.21				0.13							0.01		
95% Queue Length, Q_{95} (veh)			0.8				0.4							0.0		
Control Delay (s/veh)			19.0				16.7							10.5		
Level of Service (LOS)			C				C							B		
Approach Delay (s/veh)	19.0				16.7								0.1			
Approach LOS	C				C											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		10	1	24		3	2	1	0	32	322	4	2	9	402	54
Percent Heavy Vehicles (%)		7	0	17		0	0	0	7	2			13	5		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.64	6.50	7.24		7.50	6.50	6.90		4.14			6.66	4.20		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.57	4.00	3.47		3.50	4.00	3.30		2.22			2.63	2.25		

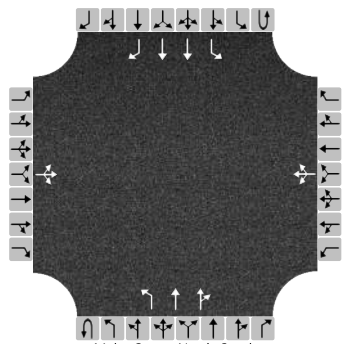
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			38				6			34				12		
Capacity, c (veh/h)			590				438			1069				1092		
v/c Ratio			0.06				0.01			0.03				0.01		
95% Queue Length, Q_{95} (veh)			0.2				0.0			0.1				0.0		
Control Delay (s/veh)			11.5				13.3			8.5				8.3		
Level of Service (LOS)			B				B			A				A		
Approach Delay (s/veh)	11.5				13.3				0.8				0.2			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2022	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		36	0	33		5	1	26	1	3	531	6	6	9	469	5
Percent Heavy Vehicles (%)		0	0	0		0	0	3	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.96	6.40	4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.33	2.50	2.20			2.50	2.20		

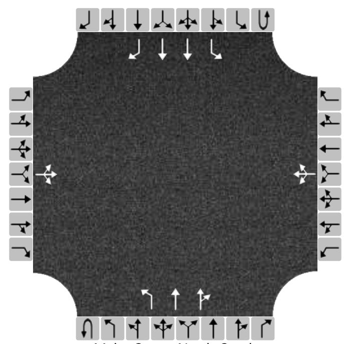
Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)			74				34			4				16		
Capacity, c (veh/h)			484				590			926				793		
v/c Ratio			0.15				0.06			0.00				0.02		
95% Queue Length, Q_{95} (veh)			0.5				0.2			0.0				0.1		
Control Delay (s/veh)			13.8				11.5			8.9				9.6		
Level of Service (LOS)			B				B			A				A		
Approach Delay (s/veh)	13.8				11.5				0.1				0.3			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		10	1	24		3	2	1	0	33	328	4	2	9	410	55
Percent Heavy Vehicles (%)		7	0	17		0	0	0	7	2			13	5		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.64	6.50	7.24		7.50	6.50	6.90		4.14			6.66	4.20		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.57	4.00	3.47		3.50	4.00	3.30		2.22			2.63	2.25		

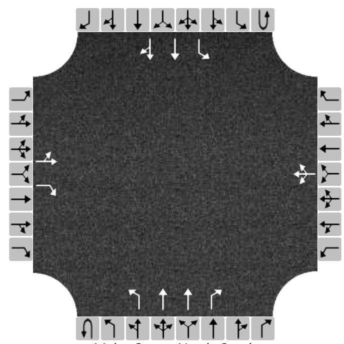
Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)			38				6			35				12		
Capacity, c (veh/h)			584				431			1060				1085		
v/c Ratio			0.06				0.01			0.03				0.01		
95% Queue Length, Q_{95} (veh)			0.2				0.0			0.1				0.0		
Control Delay (s/veh)			11.6				13.5			8.5				8.4		
Level of Service (LOS)			B				B			A				A		
Approach Delay (s/veh)	11.6				13.5				0.8				0.2			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Presidential Dr North
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	9/9/2022	East/West Street	Presidential Dr North
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	Build-Out Background PM	Peak Hour Factor	0.87
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	1		0	1	0	0	1	2	1	0	1	2	0
Configuration		LT		R			LTR			L	T	R		L	T	TR
Volume (veh/h)		6	0	15		3	0	12	0	0	626	2	24	5	457	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No								No							
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Approach	Eastbound				Westbound				Northbound				Southbound			
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.90		4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20			2.50	2.20		

Delay, Queue Length, and Level of Service

Approach	Eastbound				Westbound				Northbound				Southbound			
Flow Rate, v (veh/h)		7		17			17			0				33		
Capacity, c (veh/h)		317		741			515			1051				539		
v/c Ratio		0.02		0.02			0.03			0.00				0.06		
95% Queue Length, Q_{95} (veh)		0.1		0.1			0.1			0.0				0.2		
Control Delay (s/veh)		16.6		10.0			12.2			8.4				12.1		
Level of Service (LOS)		C		A			B			A				B		
Approach Delay (s/veh)	11.9				12.2				0.0				0.7			
Approach LOS	B				B											

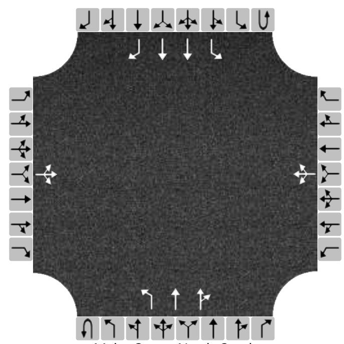
 HCS™ TWSC Version 7.8.5 Generated: 9/9/2022 3:38:13 PM

Presidential Dr North Build-Out Background PM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		10	1	24		3	2	1	0	33	345	4	2	9	420	55
Percent Heavy Vehicles (%)		7	0	17		0	0	0	7	2			13	5		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.64	6.50	7.24		7.50	6.50	6.90		4.14			6.66	4.20		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.57	4.00	3.47		3.50	4.00	3.30		2.22			2.63	2.25		

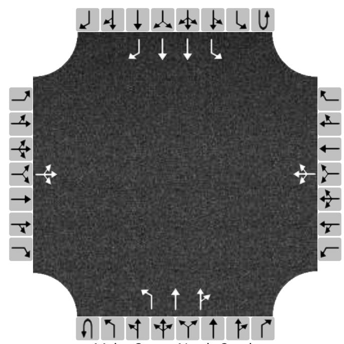
Delay, Queue Length, and Level of Service

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Flow Rate, v (veh/h)			38				6			35				12		
Capacity, c (veh/h)			576				421			1051				1065		
v/c Ratio			0.07				0.02			0.03				0.01		
95% Queue Length, Q_{95} (veh)			0.2				0.0			0.1				0.0		
Control Delay (s/veh)			11.7				13.7			8.5				8.4		
Level of Service (LOS)			B				B			A				A		
Approach Delay (s/veh)	11.7				13.7				0.7				0.2			
Approach LOS	B				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2023	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		37	0	34		5	1	27	1	3	548	6	6	9	487	5
Percent Heavy Vehicles (%)		0	0	0		0	0	3	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.96	6.40	4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.33	2.50	2.20			2.50	2.20		

Delay, Queue Length, and Level of Service

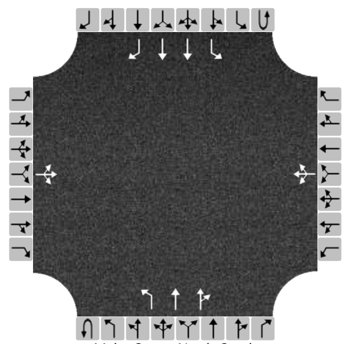
Flow Rate, v (veh/h)			76				35			4				16		
Capacity, c (veh/h)			472				582			906				775		
v/c Ratio			0.16				0.06			0.00				0.02		
95% Queue Length, Q_{95} (veh)			0.6				0.2			0.0				0.1		
Control Delay (s/veh)			14.1				11.6			9.0				9.7		
Level of Service (LOS)			B				B			A				A		
Approach Delay (s/veh)	14.1				11.6				0.1				0.3			
Approach LOS	B				B											

HCS™ TWSC Version 7.9
Jefferson Plaza - Build-Out Total PM.xtw
Generated: 9/1/2022 8:36:31 AM

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		12	1	30		4	2	1	0	40	399	5	2	11	498	67
Percent Heavy Vehicles (%)		7	0	17		0	0	0	7	2			13	5		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.64	6.50	7.24		7.50	6.50	6.90		4.14			6.66	4.20		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.57	4.00	3.47		3.50	4.00	3.30		2.22			2.63	2.25		

Delay, Queue Length, and Level of Service

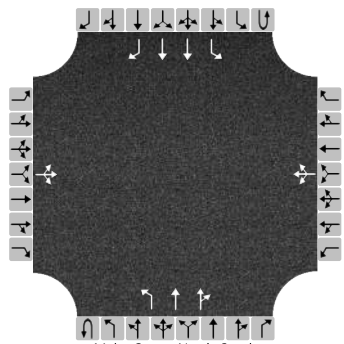
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Flow Rate, v (veh/h)			46				8			43				14		
Capacity, c (veh/h)			525				366			967				1016		
v/c Ratio			0.09				0.02			0.04				0.01		
95% Queue Length, Q_{95} (veh)			0.3				0.1			0.1				0.0		
Control Delay (s/veh)			12.5				15.1			8.9				8.6		
Level of Service (LOS)			B				C			A				A		
Approach Delay (s/veh)	12.5				15.1				0.8				0.2			
Approach LOS	B				C											

 HCS™ TWSC Version 7.9 Generated: 9/1/2022 8:38:28 AM
Jefferson Plaza - Horizon Background AM.xtw

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		45	0	41		6	1	32	1	4	658	7	7	11	582	6
Percent Heavy Vehicles (%)		0	0	0		0	0	3	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.96	6.40	4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.33	2.50	2.20			2.50	2.20		

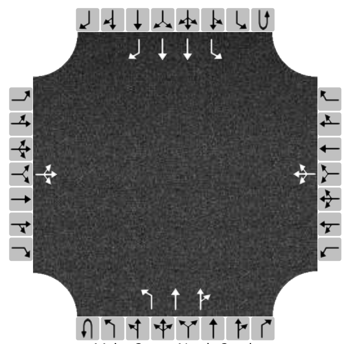
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			92				42			5				19		
Capacity, c (veh/h)			405				517			834				673		
v/c Ratio			0.23				0.08			0.01				0.03		
95% Queue Length, Q_{95} (veh)			0.9				0.3			0.0				0.1		
Control Delay (s/veh)			16.5				12.6			9.3				10.5		
Level of Service (LOS)			C				B			A				B		
Approach Delay (s/veh)	16.5				12.6				0.1				0.3			
Approach LOS	C				B											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		12	1	30		4	2	1	0	40	416	5	2	11	508	67
Percent Heavy Vehicles (%)		7	0	17		0	0	0	7	2			13	5		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9		4.1			6.4	4.1		
Critical Headway (sec)		7.64	6.50	7.24		7.50	6.50	6.90		4.14			6.66	4.20		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2			2.5	2.2		
Follow-Up Headway (sec)		3.57	4.00	3.47		3.50	4.00	3.30		2.22			2.63	2.25		

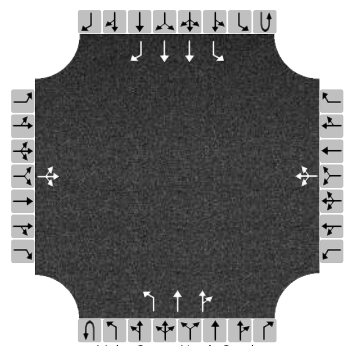
Delay, Queue Length, and Level of Service

	EB U	EB L	EB T	EB R	WB U	WB L	WB T	WB R	NB U	NB L	NB T	NB R	SB U	SB L	SB T	SB R
Flow Rate, v (veh/h)			46				8			43				14		
Capacity, c (veh/h)			517				357			958				997		
v/c Ratio			0.09				0.02			0.04				0.01		
95% Queue Length, Q_{95} (veh)			0.3				0.1			0.1				0.0		
Control Delay (s/veh)			12.6				15.3			8.9				8.7		
Level of Service (LOS)			B				C			A				A		
Approach Delay (s/veh)	12.6				15.3				0.8				0.2			
Approach LOS	B				C											

HCS7 Two-Way Stop-Control Report

General Information		Site Information	
Analyst	Michael Policastro	Intersection	Jefferson Plaza & Jeffers
Agency/Co.	Lee Engineering	Jurisdiction	City of Albuquerque
Date Performed	8/26/2022	East/West Street	Jefferson Plaza
Analysis Year	2033	North/South Street	Jefferson St
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.93
Intersection Orientation	North-South	Analysis Time Period (hrs)	1.00
Project Description	Jefferson Charter High School		

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	2	0	0	1	2	1
Configuration			LTR				LTR			L	T	TR		L	T	R
Volume (veh/h)		45	0	41		6	1	32	1	4	664	7	7	11	591	6
Percent Heavy Vehicles (%)		0	0	0		0	0	3	0	0			0	0		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized													No			
Median Type | Storage	Left + Thru								1							

Critical and Follow-up Headways

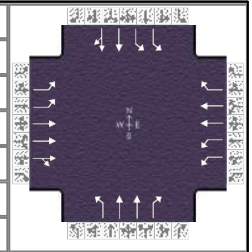
	Eastbound U	EB L	EB T	EB R	Westbound U	WB L	WB T	WB R	Northbound U	NB L	NB T	NB R	Southbound U	SB L	SB T	SB R
Base Critical Headway (sec)		7.5	6.5	6.9		7.5	6.5	6.9	6.4	4.1			6.4	4.1		
Critical Headway (sec)		7.50	6.50	6.90		7.50	6.50	6.96	6.40	4.10			6.40	4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3	2.5	2.2			2.5	2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.33	2.50	2.20			2.50	2.20		

Delay, Queue Length, and Level of Service

	Eastbound U	EB L	EB T	EB R	Westbound U	WB L	WB T	WB R	Northbound U	NB L	NB T	NB R	Southbound U	SB L	SB T	SB R
Flow Rate, v (veh/h)			92				42			5				19		
Capacity, c (veh/h)			400				513			825				668		
v/c Ratio			0.23				0.08			0.01				0.03		
95% Queue Length, Q_{95} (veh)			0.9				0.3			0.0				0.1		
Control Delay (s/veh)			16.7				12.6			9.4				10.5		
Level of Service (LOS)			C				B			A				B		
Approach Delay (s/veh)	16.7				12.6				0.1				0.3			
Approach LOS	C				B											

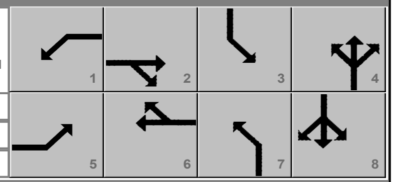
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engineering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	AM Peak Hour	PHF	0.90
Urban Street	Osuna Rd	Analysis Year	2023	Analysis Period	1> 7:45
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna -BO Total Mit AM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	329	748	143	108	920	342	130	274	64	210	371	266

Signal Information										
Cycle, s	120.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	7.9	3.7	46.2	8.1	1.0	30.7
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.5	0.5	1.5	0.5	0.0	2.0



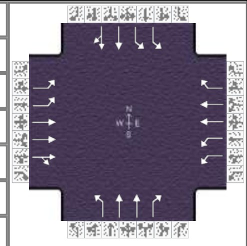
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	18.5	59.4	11.4	52.2	12.5	37.7	11.6	36.7
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (g_s), s	14.6		6.0		9.1	10.1	7.9	25.3
Green Extension Time (g_e), s	0.4	0.0	0.1	0.0	0.1	7.5	0.2	5.4
Phase Call Probability	1.00		0.98		0.99	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.31	0.07	0.07	0.41

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	366	655	305	120	1022	251	144	304	60	233	383	323
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1702	1856	1710	1743	1781	1556	1810	1766	1521	1743	1856	1546
Queue Service Time (g_s), s	12.6	10.6	10.8	4.0	25.9	11.4	7.1	8.1	3.5	5.9	22.7	23.3
Cycle Queue Clearance Time (g_c), s	12.6	10.6	10.8	4.0	25.9	11.4	7.1	8.1	3.5	5.9	22.7	23.3
Green Ratio (*g/C*)	0.12	0.46	0.46	0.06	0.40	0.40	0.32	0.28	0.28	0.31	0.27	0.27
Capacity (*c*), veh/h	413	1714	790	214	1432	626	232	991	427	728	506	389
Volume-to-Capacity Ratio (*X*)	0.886	0.382	0.386	0.562	0.714	0.401	0.622	0.307	0.141	0.320	0.759	0.831
Back of Queue (*Q*), ft/ln (95 th percentile)	233.9	184.1	175	77.5	369.2	180.7	140.7	161.7	63.1	112.1	419.2	382.3
Back of Queue (*Q*), veh/ln (95 th percentile)	9.1	7.2	7.0	3.1	14.5	7.2	5.6	6.3	2.4	4.5	16.4	15.3
Queue Storage Ratio (*RQ*) (95 th percentile)	0.58	0.00	0.00	0.23	0.00	0.56	0.70	0.00	0.49	0.56	0.00	0.00
Uniform Delay (d_1), s/veh	49.5	14.9	14.5	53.5	23.3	19.3	32.7	34.7	32.3	30.6	40.9	41.3
Incremental Delay (d_2), s/veh	5.2	0.6	1.4	0.9	3.1	1.9	1.2	0.2	0.2	0.1	5.1	11.6
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	54.7	15.5	15.9	54.4	26.4	21.2	33.9	35.0	32.5	30.7	46.0	52.9
Level of Service (LOS)	D	B	B	D	C	C	C	C	C	C	D	D
Approach Delay, s/veh / LOS	26.4	C		27.9	C		34.4	C		44.6	D	
Intersection Delay, s/veh / LOS	32.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.44	B	2.44	B	2.89	C	2.63	C
Bicycle LOS Score / LOS	1.22	A	1.64	B	0.91	A	1.26	A

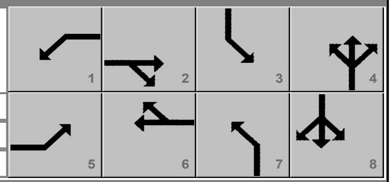
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	Lee Engeering			Duration, h	0.999
Analyst	Michael Policastro	Analysis Date	Aug 31, 2022	Area Type	Other
Jurisdiction	City of Albuquerque	Time Period	PM Peak Hour	PHF	0.92
Urban Street	Osuna Rd	Analysis Year	2023	Analysis Period	1> 16:30
Intersection	Jefferson St & Osuna Rd	File Name	Jefferson & Osuna -BO Total Mit PM.xus		
Project Description	Charter High School TIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	245	928	72	47	856	203	172	424	163	320	365	310

Signal Information										
Cycle, s	120.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	6.5	1.4	47.5	11.1	0.3	30.7
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.0	3.0	4.5	3.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.5	0.5	1.5	0.5	0.0	2.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	7	4	3	8
Case Number	2.0	4.0	2.0	3.0	1.1	3.0	1.1	4.0
Phase Duration, s	15.0	58.4	10.0	53.5	14.8	37.0	14.6	36.7
Change Period, ($Y+R_c$), s	3.5	6.0	3.5	6.0	3.5	6.0	3.5	6.0
Max Allow Headway (*MAH*), s	2.5	0.0	2.5	0.0	2.6	5.1	2.6	5.1
Queue Clearance Time (g_s), s	11.1		3.7		11.3	14.8	10.8	23.4
Green Extension Time (g_e), s	0.3	0.0	0.0	0.0	0.1	8.7	0.3	7.4
Phase Call Probability	1.00		0.82		1.00	1.00	1.00	1.00
Max Out Probability	0.00		0.00		0.04	0.14	0.10	0.32

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (*v*), veh/h	266	726	351	51	930	112	187	461	110	348	360	307
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1716	1885	1821	1716	1781	1547	1781	1795	1577	1743	1870	1574
Queue Service Time (g_s), s	9.1	12.3	12.3	1.7	21.7	4.3	9.3	12.8	6.5	8.8	20.8	21.4
Cycle Queue Clearance Time (g_c), s	9.1	12.3	12.3	1.7	21.7	4.3	9.3	12.8	6.5	8.8	20.8	21.4
Green Ratio (*g/C*)	0.09	0.45	0.45	0.05	0.41	0.41	0.34	0.28	0.28	0.34	0.27	0.27
Capacity (*c*), veh/h	314	1708	825	173	1468	638	278	987	434	680	510	397
Volume-to-Capacity Ratio (*X*)	0.849	0.425	0.426	0.296	0.634	0.176	0.673	0.467	0.253	0.511	0.705	0.775
Back of Queue (*Q*), ft/ln (95 th percentile)	176.4	206.5	206.4	33.3	313.1	72.5	185.4	239.9	2.4	166.2	380.7	346.4
Back of Queue (*Q*), veh/ln (95 th percentile)	6.9	8.2	8.3	1.3	12.3	2.8	7.3	9.5	0.1	6.6	15.0	13.9
Queue Storage Ratio (*RQ*) (95 th percentile)	0.44	0.00	0.00	0.10	0.00	0.22	0.93	0.00	0.02	0.83	0.00	0.00
Uniform Delay (d_1), s/veh	51.9	15.9	15.4	53.9	21.3	16.9	31.5	36.9	33.9	30.0	40.1	40.5
Incremental Delay (d_2), s/veh	2.6	0.8	1.6	0.3	2.1	0.6	1.7	0.5	0.4	0.2	3.0	6.4
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	54.4	16.6	17.0	54.3	23.5	17.5	33.2	37.4	34.3	30.3	43.1	46.8
Level of Service (LOS)	D	B	B	D	C	B	C	D	C	C	D	D
Approach Delay, s/veh / LOS	24.2	C		24.3	C		35.9	D		39.8	D	
Intersection Delay, s/veh / LOS	30.1						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.52	C	2.52	C	2.87	C	2.60	C
Bicycle LOS Score / LOS	1.23	A	1.39	A	1.11	A	1.33	A

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Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix E

ITE School Planning, Design, and Transportation Report

Prepared for:

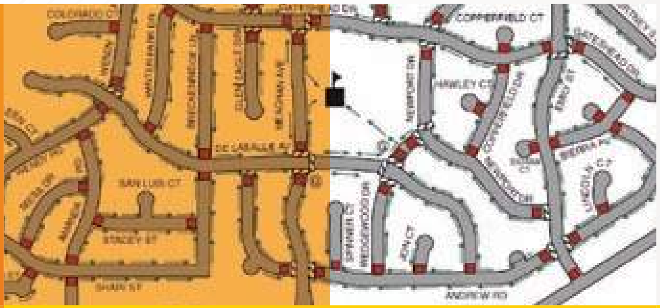
Wooten Engineering

Prepared By:

LEE ENGINEERING

SCHOOL SITE PLANNING, DESIGN, AND TRANSPORTATION

INSTITUTE OF TRANSPORTATION ENGINEERS TRAFFIC ENGINEERING COUNCIL



Traffic Engineering Council

SCHOOL SITE PLANNING, DESIGN, AND TRANSPORTATION

INSTITUTE OF TRANSPORTATION ENGINEERS TRAFFIC ENGINEERING COUNCIL

School Site Planning, Design, and Transportation
An Informational Report of the Institute of Transportation Engineers
Prepared by the ITE Traffic Engineering Council

The Institute of Transportation Engineers is an international educational and scientific association of transportation professionals who are responsible for meeting mobility and safety needs. ITE facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development, and management for any mode of ground transportation. Through its products and services, ITE promotes professional development of its members, supports and encourages education, stimulates research, develops public awareness programs, and serves as a conduit for the exchange of professional information.

Founded in 1930, ITE is a community of transportation professionals including, but not limited to transportation engineers, transportation planners, consultants, educators, and researchers. Through meetings, seminars, publications, and a network of nearly 17,000 members in more than 90 countries, ITE is your source for expertise, knowledge, and ideas.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES


MONTE VISTA SCHOOL
AED

FOREWORD

Traffic safety in and around school areas is a highly sensitive subject with the public, school officials, and local officials. Much of the traffic congestion created at schools is related to insufficient guidelines on selecting optimal school sites, improper campus design, larger school sizes (student populations), and poor connectivity to the neighborhood that the school serves. The Institute of Transportation Engineers (ITE) recognized this problem and established a technical committee to provide much-needed guidance through an informational report *School Site Planning, Design, and Transportation*. This report provides an overview and summary of the efforts undertaken by ITE Technical Committee TENC-105-01 to identify desirable practices for school site planning, design, and transportation facilities in North America.

Over the years, there has been a phenomenon of fewer children walking and bicycling to school, along with increased traffic congestion at schools. In 1969, the United States Department of Transportation (USDOT) reported almost half of all students walked to school; however, the 2001 National Household Travel Survey data found fewer than 15 percent of all school trips were made by walking or bicycling, one-quarter were made by school bus, and over half of children arrived at school in private automobiles.[1] This trend is relatively common across North America.

There are many reasons for this, including community design and school placement unfavorable to walking and biking, increased demand for "convenience," larger schools and school attendance boundaries, open enrollment policies and schools of choice that do not use traditional attendance boundaries, increased safety concerns, and many others. The increase in parents driving their children to school is one of the major factors creating traffic safety concerns at schools. This trend might also be one of many contributing factors to other concerns, such as air quality and childhood obesity.[2] Research suggests a decrease in daily energy expenditure without a simultaneous decrease in energy consumption may be a significant factor contributing to the increase in childhood obesity.[4] Personal vehicles transporting students to school accounted for as much as 10 to 14 percent of the total personal vehicle trips made during the morning peak commute, as reported by the 2011 National Center for Safe Routes to School Report.[3] Other studies have shown up to 25 percent of the morning peak commute volume can be attributed to parents driving their children to school.[5,6] It is best to select school sites and provide walkways, paths, and street access so schools can be largely (or entirely) walked and biked to. Community-based school designs help reduce parents' use of private automobiles to drive their children to school and discourage them from doing so.

(Above) Students walking to school along a street with no sidewalks
Source: Joel Cranford, North Carolina Department of Transportation

(Prior page) *Source: Michael J. Cynecki, Lee Engineering, LLC*

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6. Morris J., F. Wang, and L. Lilja. "School Children's Travel Patterns: A Look Back and a Way Forward." *Transport Engineering in Australia*, Vol. 7, No. 1/2, 2001: 15–25. Available: www.patrec.org/web_docs/atrf/papers/2001/1405_Morris,%20Wang%20&%20Lilja%20%282001%29.pdf. (April 6, 2011).

1. INTRODUCTION

1.1 SCOPE

The goal of the ITE Technical Committee is to develop an informational report (report) that can be used by local agencies, school officials, developers, and others to identify and provide safe and highly functional school sites; and to provide guidance on the layout of neighborhood street systems and school campuses with adequate sidewalk and bikeway connections, and street crossings to maximize the ability of students to walk or ride their bikes to school. This report will focus primarily on conventional public schools, particularly elementary and middle schools (grades K–8), but will also address high schools, charter schools, and magnet schools that draw students from a wider attendance area. A major emphasis will be on the design of new schools for maximum walkability, safety, and efficiency, but this report will address these issues during the redevelopment of existing school sites as well.

This report highlights desirable practices in school planning, design, and operation that can be applied during all stages of planning new schools or redeveloping existing school sites. Its primary purpose is to summarize transportation issues for consideration by policymakers, professionals, and school administrators during school planning, design, and operations.

This multifaceted compilation of experience includes:

- Best practices for school planning, design, and operations;
- Guidance for the inclusion of transportation considerations into selection of school facility sites;
- Guidance for addressing transportation issues at existing school sites and redevelopment opportunities;
- Techniques to improve safety in the vicinity of schools for all users;
- Suggestions to encourage walking and cycling to school in the interest of public health and improved daily physical activity levels; and
- Educational guidance for parents, students, and administrators.

1.2 Technical Committee

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1.3 Intended Users

This report is intended to be used by school administrators and school board representatives, developers, land use planners, architects, transportation planners, transportation engineers, and elected officials at the state, provincial, and local levels.

1.4 National Safe Routes to School Legislation in the United States

The U.S. Congress has given a high priority to school transportation safety and encouraging more children to walk to school. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users Act (SAFETEA-LU) legislation provided funding of nearly $800 million over six fiscal years (FY 2005–2010) to be administered by the State DOTs for Safe Routes to School (SRTS) projects[1]. As of the time of this publication, the legislation had been extended two additional years, through FY 2012, for a total funding in excess of $1 billion. Funding is provided to the states to improve the ability of primary and middle school students (grades K–8) to walk and bike to school safely. The purposes of the program are to:[2]

- Enable and encourage children, including those with disabilities, to walk and bicycle to school;
- Make bicycling and walking to school safer and more appealing transportation alternatives, thereby encouraging healthy and active lifestyles from an early age; and
- Facilitate the planning, development, and implementation of projects and activities that will improve safety and reduce traffic, fuel consumption, and air pollution in the vicinity of primary and middle schools.

Each state is to manage the program and apportion the funds within the federal guidelines. Each state is to have a full-time Safe Routes to School Coordinator to administer programs. Infrastructure projects (engineering improvements) are to comprise 70 to 90 percent of the annual funding, while non-infrastructure-related activities (educational, encouragement, and enforcement programs) are to receive 10 to 30 percent of the annual funding within a state. Projects must be within two miles (3.2 kilometers) of an elementary or middle school (grades K–8) to be eligible for program funding.

Infrastructure projects have included construction of sidewalks, bike lanes, safer crossings, and pathways. Non-infrastructure projects have included bike safety education, driver awareness campaigns, and increased levels of enforcement of speed limits and traffic safety laws, as well as promotional campaigns to encourage children to walk and bike more frequently. The Safe Routes to School Program has given health, education, and transportation officials an unprecedented opportunity to connect schools with the communities they serve and to increase levels of walking and bicycling. The hope is these efforts will reverse the trend of over-reliance on private automobile travel and some of the resulting health issues that have occurred over the previous couple of decades.

In addition to program funding, the federal program called for the creation of a national clearinghouse, which is the National Center for Safe Routes to School (NCSRTS). NCSRTS provides training, educational materials, promotional materials, marketing strategies, success stories, an on-line guide, assistance in evaluating SRTS programs, and webinars on selected topics. Individuals can visit the NCSRTS website at www.saferoutesinfo.org for more information. A list of state coordinators can also be found on the same National Center website.

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

Pedestrian overpasses are expensive, but can bridge gaps created by freeways, rivers, and other barriers
Source: Michael J. Cynecki, Lee Engineering, LLC

The Safe Routes to School National Partnership

The Safe Routes to School National Partnership (SRTSNP) was also established in 2005. The Partnership is a network of hundreds of organizations, government agencies, and professional groups working to set goals, share best practices, secure funding, and provide educational materials to agencies that implement Safe Routes to School programs.

SRTSNP's mission is to advocate safe walking and bicycling to and from schools, and in daily life, to improve the health and well-being of America's children and to foster the creation of livable, sustainable communities. For more information on SRTSNP, visit www.saferoutespartnership.org.

MAP-21 Legislation

A new two-year highway bill, Moving Ahead for Progress in the 21st Century (Map-21), was signed into law on July 6, 2012 and became effective October 1, 2012. Unfortunately, this bill will result in a reduction in SRTS and other dedicated bicycle and pedestrian program funding; however, it does not eliminate these important programs. According to the Safe Routes to School National Partnership assessment of the new law:

> *Under the new structure, Safe Routes to School is combined with the former Transportation Enhancements program and Recreational Trails program. Congress also added some new eligible uses, including environmental mitigation and boulevard construction. This new program is called "Transportation Alternatives." The funding level for all these uses combined is approximately $800 million per year, which is a cut of more than 30 percent from the $1.2 billion allocated in FY2011 for the three bicycling and walking programs. Plus states can opt out of using half of the Transportation Alternatives money.*[3]

Because the new law allows states considerable flexibility, it is difficult to predict how much funding will be allocated to SRTS programs during the law's two-year effective time frame. Regardless, the Safe Routes to School under SAFETEA-LU (the 2005 transportation law) will have provided states approximately $1.16 billion in Safe Routes to School funding in the U.S.

The SRTSNP assessment of the Map-21 Law with respect to the SRTS program also concludes:[3]

- the new bill includes all existing eligibilities for Safe Routes to School, including all five "E"s for Infrastructure and non-infrastructure projects (engineering, education, enforcement, encouragement, and evaluation);
- Safe Routes to School coordinators are an eligible use of Transportation Alternatives funds, but the coordinator position within each state is optional, subject to each state's priorities; and
- the new bill eliminates specific funding for the National Center for Safe Routes to School, but legislative authority for the clearinghouse remains, so its future will depend on whether the U.S. Department of Transportation has enough administrative funds to continue the clearinghouse.

Regardless, the concept of Safe Routes to School is here to stay and, while funding may be reduced, states still retain the option of continuing the program.

1.5 Terms and Definitions

Arterial Highway or **Arterial Street—**a general term denoting a highway primarily used by through traffic, usually on a continuous route or a highway designated as part of an arterial system.

Attendance Boundary—a geographic area identifying the school in which children in a specific program or age cohort are to attend.

Average Daily Traffic (ADT)—the average 24-hour volume, being the total volume during a stated period divided by the number of days in that period. Normally, this would be periodic daily traffic volumes over several days, not adjusted for days of the week or seasons of the year. ADT values represent two-way traffic flow for two-way streets.

Bicycle or **Bike—**a pedal-powered vehicle upon which the human operator sits.

Bicycle Facility—a general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking and storage facilities, and shared roadways not specifically designated for bicycle use.

Bicycle Lane or **Bike Lane—**a portion of a roadway that has been designated for preferential or exclusive use by bicyclists by pavement markings and, if used, signs.

Bicyclist or **Cyclist—**the human operator of a bicycle.

Bikeway—a generic term for any road, street, path, or way that in some manner is specifically designated for bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

By-law—a local law, used interchangeably with local or municipal code.

Catchment Area—see Attendance Boundary.

Charter School—a term used to describe a tax-supported, independently run public school, typically serving students in grades ranging K–12.

Collector Highway or **Collector Street—**a term denoting a highway that in rural areas connects small towns and local highways to arterial highways, and in urban areas provides land access and traffic circulation within residential, commercial, and business areas and connects local highways to the arterial highways.

Compulsory Education—education is compulsory for all children in the United States and Canada, but the age range for which school attendance is required varies according by state or province. It begins between ages five and eight and ends between ages 16 and 18. Education is compulsory between ages six through 16 in every province in Canada, except Ontario and New Brunswick, where the compulsory upper age is 18. In some provinces, early leaving exemptions can be granted, under certain circumstances, at 14.

Crosswalk—(a) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or (in the absence of curbs from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway) the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.

Downstream—a location that is encountered by traffic subsequent to an upstream location.

Hazard Busing—The provision of school bus transportation within the normal student walking distance, due to barriers that school officials consider too challenging for students to cross. Examples include wide, busy, or high-speed streets, railroad crossings, washes, or other barriers. This designation can vary considerably.

Highway—a general term for denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

Elementary School—a school that provides the first portion of compulsory education. Elementary schools typically include grades K–6 or K–8 or any similar combinations of grades (such as K–4 or 3–6).

High School—a school that provides all or part of the secondary education, consisting typically of grades 9–12 or grades 10–12.

Junior High School—see Middle School

Local Street—a functional classification of a street that provides the highest level of property access and typically serves the shortest trip lengths, often at lower speeds. A vast majority of the street mileage in most communities is usually comprised of local streets.

Magnet School—a school that is part of the public school system, but has no specific attendance boundary (or a very large attendance boundary within one or more school districts). Magnet schools operate under the public school administration and usually have alternative or otherwise compelling modes of instruction.

Major Street—the street normally carrying the higher volume of vehicular traffic.

Middle School—a school that serves students of the ages between the elementary and high school grades. These schools are typically any sequential combination of grades 6 through 9 (such as grades 6–8 or grades 7–8). Some school districts omit Middle/Junior High Schools and use Elementary Schools for grades K–8.

Minor Street—the street normally carrying the lower volume of vehicular traffic.

Motor Vehicle—every vehicle which is self-propelled, and every vehicle which is propelled by electric power obtained from overhead trolley wires but not operated upon rail, except vehicles moved solely by human power and motorized wheelchairs.

Parochial School—a school supported by a religious institution. In North America, such schools are maintained by a number of religious groups, including Lutherans, Seventh-day Adventists, Orthodox Jews, Muslims, evangelical Protestant churches, and Roman Catholic parishes, among others.

Pathway—a general term denoting a public way for purposes of travel by authorized users outside the traveled way and physically separated from the roadway by an open space or barrier and either within the highway right-of-way or within an independent alignment. Pathways include shared-use paths, but do not include sidewalks.

Peak Hour Factor—a measure of the fluctuation or variation of traffic within the peak traffic hour.

Pedestrian—a person on foot, in a wheelchair, on skates, or on a skateboard.

Pedestrian Clearance Interval—the time provided to allow a pedestrian crossing in a signalized crosswalk, after leaving the curb or shoulder, to travel to the far side of the traveled way or to a median. The 2009 *Manual on Uniform Traffic Control Devices* (MUTCD) requires the calculation of the pedestrian clearance time based on a walking speed of 3.5 feet (1.07 meters) per second in most cases.

Pedestrian Facility—improvements and provisions made to accommodate or encourage walking.

Pedestrian Hybrid Beacon—a special type of beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk, adopted for use in the 2009 MUTCD (see Chapter 4F).

Public Transit—(also **public transportation**) is a shared passenger transportation service available for use by the general public, distinct from taxis, car-pooling, or hired buses. Public transit modes include buses, trolleys, trams, light rail, and rapid transit such as subways. Some schools rely on these public transportation services for students, especially for high school age students.

Primary School—see Elementary School

Private School—an independent school that is not funded or administered by local, state, or federal governments; thus, it retains the right to select students and is funded in whole or in part by charging student tuition. This school can consist of any grades or grade combinations from K–12.

Right of way—a general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes, including the accommodation of sidewalks, utilities, lighting, traffic control, and shoulders, as well as the travelled way.

Right-of-way (Assignment)**—**the permitting of vehicles and/or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians by the display of a sign or signal indications or based on provisions in state or provincial law.

Roadway—that portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human-powered vehicles.

Roundabout—a circular intersection with yield control at entry, which permits a vehicle on the circulatory roadway to proceed, and with deflection of the approaching vehicle counter-clockwise around a central island.

School—a public or private educational institution recognized by the state or provincial education authority for one or more grades K through 12 or as otherwise defined by the state or province.

School Area—the geographical area surrounding a school within which motor vehicle, pedestrian, and/or bicycle traffic is substantially generated or influenced by the school.

School Bus—a type of bus designed and manufactured for transporting students to and from school and school events. School buses are distinguished from other types of buses by design characteristics necessitated by federal and state/provincial regulations. U.S. federal safety standards require school buses to be painted "school bus yellow" and equipped with specific warning and safety devices.

School Crossing—a marked crossing adjacent to a school or on a designated school pedestrian route.

School-Related Activities—Any activities resulting from the presence of a school, such as school children travelling to or from school on foot or by bicycle, school buses and other vehicles entering or leaving school property, school children being dropped off or picked up at the school, outdoor activities by school children on school grounds unprotected from an adjacent public road by space or barrier, and other activities that create an unusual risk of traffic injury to school children.

School Walk Zone—This is the walking attendance boundary for students. Walking distance typically varies by age of student and by jurisdiction, state, or province with some jurisdictions requiring elementary-aged students to walk if their homes are within a certain distance the school, typically between one-half and two miles (.8 and 3.2 kilometers). The walk zone might increase for older students, particularly high school students unless "hazard busing" is provided. Some school districts or jurisdictions may provide a school bus option for all students.

School Zone—a designated roadway segment approaching, adjacent to, and beyond school buildings or grounds, or along which school-related activities occur.

Secondary School—see High School.

Shared Roadway—a roadway that is officially designated and marked as a bicycle route, but which is open to motor vehicle travel and upon which no bicycle lane is designated.

Shared-Use Path—a bikeway outside the traveled way and physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent alignment. Shared-use paths are also used by pedestrians (including skaters, users of manual and motorized wheelchairs, and joggers) and other authorized motorized and non-motorized users.

Sidewalk—that portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property line or on easements of private property that is paved or improved and intended for use by pedestrians.

Splitter Island—a median island used to separate opposing directions of traffic entering and exiting a roundabout.

Stop Line—a solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made.

Street—see Highway.

Traffic—pedestrians, bicyclists, ridden or herded animals, vehicles, streetcars, and other conveyances either singularly or together while using, for purposes of travel, any highway or private road open to public travel.

Traffic Control Device—a sign, signal, marking, or other device used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, private road open to public travel, pedestrian facility, or shared-use path by authority of a public agency or official having jurisdiction; or, in the case of a private road open to public travel, by authority of the private owner or private official having jurisdiction.

Traffic Control Signal (Traffic Signal)—any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed.

Travelled Way—the portion of the roadway for the movement of vehicles, exclusive of the shoulders, berms, sidewalks, and parking lanes.

Turn Bay—a lane for the exclusive use of turning vehicles that is formed on the approach to the location where the turn is to be made. In most cases where turn bays are provided, drivers who desire to turn must move out of a through lane into the newly formed turn bay in order to turn.

Upstream—a location that is encountered by traffic prior to a downstream location as it flows in an "upstream to downstream" direction. For example, "the upstream end of a lane line separating the turn lane from a through lane on the approach to an intersection" is the end of the line that is furthest from the intersection.

Urban Street—a type of street normally characterized by relatively low speeds, wide ranges of traffic volumes, narrower lanes, frequent intersections and driveways, significant pedestrian traffic, and more businesses and houses.

Vehicle—every device in, upon, or by which any person or property can be transported or drawn upon a highway, except trains and light rail transit operating in exclusive or semi-exclusive alignments. Light rail transit equipment operating in a mixed-use alignment, to which other traffic is not required to yield the right-of-way by law, is a vehicle.

Yield Line—a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.

1.6 Acronyms and Abbreviations

AADT—annual average daily traffic

AASHTO—American Association of State Highway and Transportation Officials

ADA—Americans with Disabilities Act

ADAAG—Americans with Disabilities Act Accessibility Guidelines

ADT—average daily traffic

ANSI—American National Standards Institute

CDC—Centers for Disease Control and Prevention

CEFPI—Council of Educational Facility Planners International

CFR—Code of Federal Regulations

CMS—changeable message sign

EPA—Environmental Protection Agency

FHWA—Federal Highway Administration

ISEA—International Safety Equipment Association

ITE—Institute of Transportation Engineers

ITS—intelligent transportation systems

KPH or **kph**—kilometers per hour

LED—light emitting diode

MPH or **mph—**miles per hour

MUTCD—*Manual on Uniform Traffic Control Devices for Streets and Highways*

MUTCDC—*Manual on Uniform Traffic Control Devices for Canada*

NCSRTS—National Center for Safe Routes to School

PCMS—portable changeable message sign

RPM—raised pavement marker

RRPM—raised reflective pavement marker

SAFETEA-LU—The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

SRTS—Safe Routes to School

SRTSNP—Safe Routes to School National Partnership

TAC—Transportation Association of Canada

TRB—Transportation Research Board

TTC—temporary traffic control

U.S.—United States

USDOT—United States Department of Transportation

VPH or **vph—**vehicles per hour

1.7 References

1. U.S. Department of Transportation Federal Highway Administration website, www.fhwa.dot.gov/legsregs/directives/notices/n4510747.htm. (March 13, 2012).

2. National Center for Safe Routes to School website, www.apps.saferoutesinfo.org/lawenforcement/federal/federal.cfm. (May 23, 2011).

3. National Center for Safe Routes to School website, www.saferoutespartnership.org/node/914/. (July 12, 2012).

2. SCHOOL-RELATED TRANSPORTATION IMPACTS

Transportation issues influence all users of the school and affect the surrounding environment multiple times during the day. Historically, access to schools was based upon user-based modes of transportation: The majority of students walked, biked, or bused to school. In the latter half of the twentieth century, this changed to a vehicle-based delivery system that placed a massive demand on the transportation infrastructure around the school.[1] The agencies with jurisdiction over the street have competing priorities, which might not focus on the short peak-hour demands of a school. In some situations, this can create a serious issue for the roadway agency, especially when the priorities of vehicular movement and school access conflict during these short peak-hour demands.

A number of factors have led to the reduction in walking and cycling, resulting in increased vehicle trips to and from schools. This has contributed greatly to the increase of traffic congestion and safety concerns at schools. Whether problems were created due to poor community planning, older schools, societal changes, crime and safety concerns, an increased need for parental convenience, private motor vehicle dependence, open enrollment policies, or changes in enrollment, attendance boundaries, catchment areas, or busing requirements, the cumulative result is a system that discourages or outright prevents many students from walking or riding a bike to school.

Parents, school staff, district administrators, and students are concerned and often frustrated with the transportation infrastructure at new and existing facilities. Engineers and public officials recognize limited guidance is available for school site design and transportation planning.

The results are increasing traffic congestion at and around schools, and are documented as contributing toward negative impacts on students' health by reducing daily physical activity and increasing inactive transportation choices. Charged with providing education with fixed financial resources, schools are frequently sited and designed with inherent transportation problems, further limiting the ability of students to walk or bike to school.

Transportation impacts may be categorized into the following general areas:

- Pedestrians and bicyclists;
- School-related traffic congestion;
- Student drop-off and pick-up impacts;
- Parking impacts; and
- Other community impacts.

(Top) Crossing guards help regulate student crossings
Source: Michael J. Cynecki, Lee Engineering, LLC

(Bottom) Without supervision, students and their parents often choose bad locations when crossing streets
Source: Brandon Forrey, City of Peoria, Arizona

2.1 Pedestrians and Bicyclists

Pedestrian and bicycle activity at school sites is a key issue, particularly because many younger pedestrians are present.

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

Children are more likely to play around parked cars and are more difficult for motorists to see because they are smaller than adults. Other considerations related to the pedestrian-vehicle and bicycle-vehicle interaction include:

- Auto congestion, which frequently blocks visibility at crosswalks and corners;
- Student loading area congestion, which often results in parents performing these activities outside of designated areas, exposing students to added risks;
- School staff being unable to adequately manage pedestrian activity (using crossing guards or student monitoring) when it occurs over a wide area;
- Younger children, who usually lack the judgment and maturity to make safe crossing decisions or accurately judge the speed of approaching vehicles, and can be easily distracted while crossing, due to the interaction with friends or from other factors; and
- People with disabilities, who may have difficulty accessing facilities and using sidewalks and crosswalks without proper accommodations.

In order to protect these vulnerable roadway users, special considerations must be given to the following design elements:

- ADA accessibility;
- Sidewalks and paths;
- Bike lanes/routes;
- Access to controlled crossings;
- School walking and bicycle route maps; and
- Bicycle safety education and road safety education for pedestrians.

2.2 School-Related Traffic Congestion

Schools present unique trip generation characteristics, typically resulting in short periods of high demand on the transportation infrastructure. *The National Household Travel Survey 2009* strongly indicates the stiffness (strength) of the morning peak time period was directly attributable to the limited time window that student drop-offs occur.[2] This also explains why the morning peak congestion is so dramatically reduced on non-school days. Often, staff arrivals and departures are spread through the adjoining street peak hour, but may not occur within the school's peak period. Student drop-off and pick-up periods can be as short as 10 to 15 minutes, but generate high traffic volumes. Additionally, these peak periods occur over a nine-month period for schools with a traditional year, while full-year operations also have periods of little or no activity.

Student drop-off and pick-up periods can be as short as 10 to 15 minutes, but generate high traffic volumes.

Because of the short duration of the drop-off and pick-up peaks, some jurisdictions might be unable or unwilling to undertake roadway improvements solely for the benefit of a school. Therefore, school districts are often required to:

- Design sites to accommodate vehicle queues on-site;
- Construct off-site improvements, such as turn pockets, deceleration lanes, parking lanes, or other similar improvements; or
- Implement a combination of the two.

If possible, on-site vehicle queuing is preferred, although there are other ways the impact of student drop-off and pick-up can be reduced.

ITE compiles trip generation and parking generation manuals for planning use. The *ITE Trip Generation Manual*[3] was reviewed to determine what data were available from ITE. Trip generation rates at elementary, middle, and high schools (land uses 520, 522, and 530, respectively) are summarized in **Tables 2-1** through **2-3**:

The ITE trip generation data samples for elementary schools were obtained throughout the United States and Canada from

Table 2-1. ITE Trip Generation Elementary School (LAND USE 520)

	Number of Studies	Split (entry/exit)	Average Rate	Standard Deviation	Fitted Curve?
EMPLOYEES (AVERAGE: 50)					
AM Peak Hour of Generator	35	54% / 46%	5.37	3.34	7.91 (x) - 127.63
PM Peak Hour of Generator	32	44% / 56%	3.45	2.26	3.39 (x) + 2.91
STUDENTS (AVERAGE: 630 TO 642)					
AM Peak Hour of Generator	48	55% / 45%	0.45	0.70	1.14 Ln (x) – 1.86
PM Peak Hour of Generator	44	45% / 55%	0.28	0.54	1.09 Ln (x) – 1.92
1000 SQ FT* GROSS FLOOR AREA (AVERAGE: 58)					
AM Peak Hour of Generator	35	56% / 44%	5.20	3.54	1.20 Ln (x) + 0.66
PM Peak Hour of Generator	35	44% / 56%	3.11	2.17	0.89 Ln (x) + 1.50

*93 square meters

Source: ITE Trip Generation

the mid-1970s to the 2000s. The samples for middle/junior high schools were obtained throughout the United States from the mid-1990s to the 2000s. Only six of the studies referenced in the *ITE Trip Generation Manual* were performed after 1990; the most recent was made in 1996. A review of *ITE Journals* since the 1997 publication date of the *ITE Trip Generation Manual* reflected one article, published in 2000,[4] that addressed consolidated schools, often with massive service areas and one-way trip times approaching 90 minutes. Therefore, the consolidated schools study was not representative of the typical ITE rates.

Even trip generation calculated based on the numbers of employees or students is a poor predictor of travel demands for a school of any type.

Gross floor area is not considered as reliable a predictor of trip generation as the number of employees or students because floor space varied so widely, particularly among high schools. Even trip generation calculated based on the numbers of employees or students is a poor predictor of travel demands for a school of any type. There are other factors that have a greater impact on trip generation at schools, such as location of school within attendance boundary/catchment area, average walking distance to school, walking access to school, student enrollment, income level of surrounding community, and the number and types of barriers to walking students (arterial streets, rivers, railroad tracks, and similar obstacles). There are dozens of studies that take these factors into account, many of which can be found at the National Clearinghouse for Educational Facilities (NCEF) website at www.ncef.org. **Appendix B** also contains studies completed in recent years that address related topics.

School-related traffic congestion can have a major impact on nearby streets
Source: Joel Cranford, North Carolina Department of Transportation

One interesting study, published in 1996,[5] evaluated high school trip generation at several sites compared to those published in the 1991 *ITE Trip Generation Manual Fifth Edition*. The results indicated the ITE rates published in 1991 were as much as 50 percent lower than the data collected in 1996.

2.3 Student Drop-off and Pick-up Impacts

The increased presence of motor vehicles at schools requires careful thought and planning in the design of school traffic circulation, both on-site and off-site, to minimize the potential for school-related traffic congestion and safety concerns. Ample and well-designed queuing must be provided to accommodate the increased demand for all vehicle types, especially for parent vehicles during drop-off and pick-up times. School

Table 2-2. ITE Trip Generation Middle School/Junior High School (LAND USE 522).

	Number of Studies	Split (entry/exit)	Average Rate	Standard Deviation	Fitted Curve?
EMPLOYEES (AVERAGE: 75–76)					
AM Peak Hour of Generator	21	54% / 46%	5.30	3.64	9.25 (x) - 300.80
PM Peak Hour of Generator	18	38% / 62%	2.97	2.04	4.03 (x) - 79.35
STUDENTS (AVERAGE: 825 TO 876)					
AM Peak Hour of Generator	25	55% / 45%	0.54	0.80	No
PM Peak Hour of Generator	24	45% / 55%	0.31	0.57	No
1000 SQ FT* GROSS FLOOR AREA (AVERAGE: 107)					
AM Peak Hour of Generator	21	55% / 45%	4.35	4.19	No
PM Peak Hour of Generator	21	45% / 55%	2.52	2.30	No

*93 square meters

Source: ITE Trip Generation

Source: Michael J. Cynecki, Lee Engineering, LLC

designers must also consider access points carefully, separating buses and parent vehicles from pedestrian access and crossings.

2.3.1 School Bus Loading

School bus activity is a function of the planned short- and long-term attendance boundaries or catchment areas of a school. In the case of private or parochial schools, the attendance boundary of a school might cross entire communities and regions, warranting school bus services for the majority of students. Many schools are challenged to provide a balance between accessibility to the primary school entrances and facilities while attempting to separate school bus loading from other vehicles, pedestrians, cyclists, and parking access. In general, school bus areas should be separate from other access areas, parking areas, and users. Additionally, nearby residents might express concerns about heavy bus traffic, fumes, or unsupervised bus stops near residences. Therefore, bus loading areas and access routes must be chosen carefully to minimize these concerns. For more information regarding bus loading access and circulation, see **Section 6.4 Bus Loading Areas and Circulation**.

2.3.2 Student Drop-off and Pick-up Areas

For various reasons, a large percentage of students are being driven to and/or from schools than in decades past.[6] Concerns such as child abduction, road user safety, and adverse weather conditions often discourage parents from allowing their children to walk or bike to school. This attitude adds to the traffic congestion and haphazard parking activities around a school, which in turn create a poor environment for others accessing the site by bus, walking, or biking.

If sufficient on-site queuing distance is not provided for parent vehicles during drop-off and pick-up times, vehicle lines might back-up onto adjacent public streets, resulting in congested and potentially unsafe conditions around the school. Additionally, school-related congestion likely will result in complaints from nearby residents who have difficulty using the street system or who have concerns about parents parking in front of their homes. For more information regarding student drop-off and pick-up queuing and circulation, see **Section 6.5 Student Loading Areas and Circulation for Personal Vehicles**.

2.4 Parking Impacts

Schools need sufficient parking for staff, visitors, students, and parents. The primary parking challenge relates to the provision of short-term and long-term parking for parents and students.

Table 2-3. ITE Trip Generation High School (LAND USE 530).

	Number of Studies	Split (entry/exit)	Average Rate	Standard Deviation	Fitted Curve?
EMPLOYEES (AVERAGE: 118)					
AM Peak Hour of Generator	53	70% / 30%	4.68	2.88	No
PM Peak Hour of Generator	53	31% / 69%	3.23	2.08	No
STUDENTS (AVERAGE: 1292)					
AM Peak Hour of Generator	68	68% / 32%	0.42	0.68	No
PM Peak Hour of Generator	68	33% / 67%	0.29	0.55	No

Source: ITE Trip Generation

In concert with the increases in loading activities comes a greater demand for short-term parking. Some parents want to observe the safe passage of their children into the school, playground, or other supervised location, while others (in the case of kindergarten and daycare students) might be mandated through school policy to walk their children to a teacher or supervisor. Regardless of the motive, schools are challenged to provide adequate dedicated short-term, high-turnover parking.

A careful balance must be found to provide sufficient parking for a school's typical needs without overbuilding parking lots.

At high schools, many teenagers have access to vehicles and the ability to drive to school might be seen as a status symbol, while walking, biking, and riding a bus might be viewed less favorably. This places additional demand on roadways near high schools and requires additional parking on-site, on-street, or within adjacent neighborhoods. On-site parking creates further challenges when considering land availability, campus size, and site layout. Some parking needs might be mitigated through increased emphasis on transit, student parking fees, or other strategies, but these practices alone typically are not adequate to reduce parking unless they have a proven record in the community.

The ITE *Parking Generation, 4th Edition,* Informational Report[7] provides data for short-term parking demand at elementary, middle, and high schools, but these data are estimates of vehicles parked in designated parking spaces and do not necessarily include parent vehicle queues. Additionally, the general applicability of the report is limited because values of the schools studied varied so widely. For this reason, page 139 of the report states "For all school uses, it is important to collect data on the size of the building and total number of students, faculty, and employees in order to accurately measure parking demand for the site." This is a difficult task for a proposed school site or future school. Many municipalities have parking ordinances to ensure sufficient parking is provided for proposed developments; however, not all of these ordinances codify information for schools, nor are they consistent between municipalities. Therefore, school planners are left with uncertain parking requirements.

Source: Michael J. Cynecki, Lee Engineering, LLC

Similarly, some school districts include parking requirements in their recommended practices for school development and site planning. These are often empirical and might represent a worst-case scenario to ensure parking shortages experienced at other sites are not repeated. Alternately, some practices greatly underestimate parking requirements, resulting in chronic vehicle overflow into adjacent neighborhoods. A careful balance must be found to provide sufficient parking for a school's needs without overbuilding parking lots.

Douglas County School District, in Colorado, USA, applies average parking numbers based on a report developed by Carter Burgess in 1997.[8] That report indicated demand for an average of 80 spaces at elementary schools and 125 spaces at middle schools. However, these data do not reflect varying student

Table 2-4. Sample of Minimum On-site Parking Requirements.

Jurisdiction	Elementary and Junior High	Secondary School
City of Regina, SK, Canada	1 space per each teacher, employee, or administrator	5 spaces per classroom plus 1 space per 10 square meters (107.6 square feet) of assembly room floor area
Coquitlam, BC, Canada	1 space for each 10 students of school capacity	1 space for each 4.44 students of school capacity
London, ON, Canada	3 spaces plus 1 per classroom	3 spaces per classroom
Cape Breton Regional Municipality, NS, Canada	3 spaces per 2 classrooms	5 spaces per classroom
Brandon, MB, Canada	1 space for each academic staff and 1 for each 4 employees	1 space for each 2 academic staff, 1 for each 4 employees, and 1 for every 6 students
Fredericton, NB, Canada	1 space per teaching staff plus auditorium requirements	1 space per teaching staff and 1 space for every 33 students plus auditorium requirements
Strathcona County, AB, Canada	2 spaces per classroom or 1 per 10 students, whichever is higher	5 spaces per classroom or 1 per 5 students, whichever is higher
Burlington, VT, USA	1 space per 400 square feet (37.2 square meters) of gross floor area	1 space per 300 square feet (27.9 square meters) of gross floor area
Seattle, WA, USA	1 space for each 80 square feet (7.4 square meters) of all auditoria or public assembly rooms, or 1 space for every 8 fixed seats in auditoria or public assembly rooms containing fixed seats	1 space for each 80 square feet (7.4 square meters) of all auditoria or public assembly rooms, or 1 space for every 8 fixed seats in auditoria or public assembly rooms containing fixed seats
Salt Lake City, UT, USA	1 space for each 3 faculty members and other full-time employees	1 space for each 3 faculty members and full time employees plus 1 for each 10 students
Naperville, IL, USA	1 space per each employee	1 space per each employee plus 1 for each 6 students based on rated design capacity

Source: ITE TENC 105-01 Committee

populations, differing occupancy rates, differing transit characteristics, and the wide cross-section of motor vehicle ownership within the county. Because these numbers are only averages based on a limited sample, the implication is that a substantial number of sites will have parking demands above the average. One city municipal code within Adams County, Colorado, bases parking requirements on the square footage of the building and assigns schools to a general parking category. Regardless, building area is usually a poor indicator of parking demand. In many areas, no parking requirements are available at all.

Typically, on-site parking is provided at school sites for normal daily use by staff, visitors, and students, but it seems schools are rarely able to provide sufficient on-site parking to accommodate all of the parking demand for major sporting events, graduation ceremonies, parent/teacher conferences, and other major school evening events. In many cases, parking during normal school hours is available only along limited street segments near the school and in designated parking areas on campus. Outside normal school hours, additional on-site parking might be available along driveways, bus loading zones, and student drop-off and pick-up areas, depending on fire department requirements and other ordinances. Parking on adjacent streets and on nearby properties, when available and permitted, might be utilized to accommodate additional parking demands beyond normal daily school requirements. Approval of the road authority is recommended when off-site parking on adjacent streets is being considered to accommodate school parking for normal school operations.

The demand for parking at schools is influenced by many factors, including busing policies, grade levels, school size, the size of public assembly areas, the number and type of sports fields, and if the school serves urban or rural land uses. Generally, parking demand is higher at secondary schools and in suburban and rural areas where alternative travel modes might not be available, travel distances are greater, and student capacities are higher. Parking demand at a new school may be determined as part of a site transportation impact study or parking demand analysis. *Parking Generation, 4th Edition,*[9] contains information related to parking demand at elementary, middle, and high schools, but the school parking demand rates contained in this manual are based on small sample sizes and vary widely, limiting general applicability. If feasible, parking demand estimates should be based on recent parking studies at schools in the area with similar numbers of students, faculty, and employees, and of the same approximate building size. Additionally, the informational report states "Caution should be

Source: Michael J. Cynecki, Lee Engineering, LLC

exercised when using these ratios, as the parking demand data are intended to only include vehicles that are parked in designated spaces, NOT vehicles queued or backed up associated with pick up and drop off" (page 139).

To better gauge current practices, the committee conducted a survey of parking requirements and recommendations of 20 municipalities across the U.S. and Canada using web resources in 2007. The survey found on-site parking requirements at school sites often are dictated by school board policies, municipal codes/by-laws, or zoning ordinances. This survey found there was wide variation in parking requirements. Additionally, some jurisdictions have minimum requirements for bicycle parking facilities. Typically, standards for the provision of reserved parking for people with disabilities are contained in state or provincial building codes. Most frequently, minimum requirements are based on the number of full-time staff, classrooms, or students. Parking requirements might also be based on other school characteristics, such as gross floor area or the size of public assembly areas. **Table 2-4** provides examples of parking requirements contained within municipal code and by-laws of several cities and counties across North America.

School parking strategies that encourage more sustainable travel choices such as public transit, car pooling, cycling, and walking should be encouraged to promote healthier lifestyles and improve the environment. When planning a new school or school retrofit, school officials are encouraged not to overbuild parking lots for unusual or infrequent demands, but rather provide on-site parking based on daily needs. The best way to minimize daily parking needs is to build schools that encourage children to walk and bike to school, as promoted throughout this report, although measures should be taken to prevent school or student parking to overflow into adjacent neighborhoods. Parking should not be minimized if this will be the end result. For special events, additional parking demand might be accommodated by utilizing available off-site parking and establishing shared parking arrangements with adjacent land uses.

Many school sites have been developed in conjunction with or near other public facilities, such as sports fields, skating rinks, swimming pools, libraries, community centers, and parks. Peak parking demands at these other public facilities usually occur at times when school parking demand is low, thus enabling shared use of parking facilities. When shared parking is planned, it is important to consider potential problems that might occur during arrival and dismissal times and during school events on evenings and weekends.

Many school sites have been developed in conjunction with or near other public facilities [...] enabling shared use of parking facilities.

Another method of limiting on-site parking requirements at secondary schools is to require student permits to park on school property during normal school hours. If student parking demand exceeds the supply of on-site parking permits, seniors are given preference, with allocation of the remaining spaces on a first-come, first-served basis or through a lottery. Additionally, on-site parking might be a privilege for students with better grades, who have jobs, or who need transportation to another campus or facility, such as a community college. Student parking privileges are typically conditional upon adherence to specific rules related to school attendance, tardiness, and behavior.

Any strategy to reduce the requirement for on-site parking might negatively affect the adjacent neighborhood. The management of on-street parking should be discussed with the road authority during the school site planning and development process and appropriate parking controls measures implemented.

Any strategy to reduce the requirement for on-site parking might negatively impact the adjacent neighborhood.

2.5 Other Community Impacts

Many community members view their close proximity to a school as a major asset, but residents directly adjacent to a school frontage or an access point might need to contend with daily traffic and parking issues at school sites during peak periods. These ongoing issues may include:

- Temporary road or driveway blockage from parked or queued vehicles;

Gridlock caused by school-related traffic congestion can encourage unsafe driver behaviors
Source: Joel Cranford, North Carolina Department of Transportation

- Parents parking in front of homes and parking within, or turning around in, private driveways;
- High-conflict pedestrian or bicyclist environments for those students, parents, and staff members who choose to walk or ride a bike;
- Vehicles idling in front of a school or at primary pedestrian accesses into a community;
- Unsupervised school bus stops located in front of homes; and
- Unmonitored groups of students walking by homes.

Designers are challenged to anticipate the multitude of transportation-related impacts of a new school, but the payoff is well worth the initial effort. A school designed while keeping these impacts in mind might avoid many concerns that could surface after the school has been built. Not only can this minimize resource expenditures, it might also make the school a better neighbor to the community in which it is built.

2.6 Differences in Mode Split between the United States and Canada

Experience has shown there is a difference in the use of private automobiles for transport of students at U.S. schools compared to Canadian schools. There is no clear reason for the difference in mode split between the United States and Canada, but there are numerous contributing factors. The ratio of children to schools is lower in Canada than in the U.S. and school policies create more numerous schools with smaller student populations in Canada,[10] but fewer, more populous schools in the United States.[11] Additionally, the number of schools in the United States is shrinking. Between 1940 and 1990, the total number of elementary and secondary public schools in the U.S. fell by 69 percent, while the U.S. population increased by 70 percent overall.[12] School design policies that require over-sized lots to accommodate large sports fields and single-floor schools often obligate officials to build new facilities at the periphery of cities where large parcels of undeveloped land are readily available, but far from the children being served.

Long commutes for students are less common in Canada. A 1999 report on active modes of transportation stated 45 percent of school-aged children live two kilometers (1.24 miles) or less from the school they attend.[13] However, automobile trip mode split is high for U.S. children even when they live close to school.[14]

A study looking at cycling mode split for work trips in Canada cited a number of reasons why non-auto modes enjoy a higher modal split share in Canada compared to the United States. The reasons include lower levels of car ownership in Canada, higher costs to maintain and operate cars , higher densities and mixed-use zoning policies in Canadian cities, smaller cities in Canada, and more viable transportation options.[15]

2.7 References

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3. SURVEY OF SCHOOL SITE SELECTION, DESIGN, AND TRANSPORTATION ISSUES

3.1 Purpose and Overview of Survey

The intent of this report was to review and identify the optimal or the most desirable practices in school site selection and design for the purposes of creating community-based schools that are accessible to students who walk or bike to school or use public transportation. The goals are to encourage more walking and bicycling to reduce transportation costs, and improve the health of the students while improving air quality. It became difficult to identify optimal guidelines for some areas of school site selection because there were no such guidelines in widespread use.

… some agencies are still using the minimum acreage requirements no longer recommended by CEFPI.

One such guideline that does not appear to exist is a recommendation for optimal school size (acreage) for elementary, middle, and high schools. At one point in time, the Council of Educational Facility Planners International (CEFPI) published recommended guidelines for school acreage based on student enrollment and other criteria.[1] Various states adopted CEFPI's acreage recommendations. In more recent years, however, CEFPI rescinded their acreage recommendations because, in some cases, they were resulting in overly large school campuses or were forcing some school districts to select school sites far from the community they served, because there were inadequate sites within the communities that fit the recommendations. Additionally, some studies have shown the detrimental effect of arbitrary minimum acreage requirements for schools, particularly for small communities and rural areas.[2] Regardless, some agencies are still using the minimum acreage requirements no longer recommended by CEFPI.

The purposes of the survey were to gain a better understanding of current practices, what guidance was available, and what information was still needed.

Because no clear guidance was available concerning several aspects of school site location and design to create more walkable, community-based schools, the committee distributed a survey among transportation and school professionals throughout the United States and Canada between May and December, 2009. The purposes of this survey were to gain a better understanding of current practices of school site selection, acquisition, design and layout, and transportation planning. Additionally, the survey sought to help determine what guidance was available at the time and what additional information and guidance was still needed. In most cases, the survey instrument provided specific categories of responses for the participants to choose among. Opportunities were offered to allow additional responses. Three of the survey questions allowed open-ended responses with no multiple-response categories provided. Substantial time was invested in reviewing the responses and attempting to group them into specific categories. The survey results are provided in **Appendix A**.

Respondents were asked to provide examples of guidelines, policies, ordinances, and by-laws from their communities for school site selection that incorporate principles of walkable, community-based schools. The documents were reviewed by the ITE Committee which considered including them as an appendix to this report. Sixty-seven individuals provided suggestions, documents, or examples of ordinances for review. The documents were distributed among volunteers to review and identify the provisions that best encouraged good site selection, and processes to encourage walkable, community-based schools. See **Appendix B** for a list of example guidelines and additional resources.

3.2 Observations and Conclusions of Survey

While not a scientific poll of professionals from across the United States and Canada, those surveyed working in school site selection and design provided valuable input. The overall responses revealed a need for additional guidance for both transportation and school officials. Decisions concerning a school site might disrupt a community for years to come if careful thought and consideration is not given early in the process.

The overall responses reveal a need for additional guidance for both transportation and school officials.

When asked about the primary barriers to creating walkable, community-based schools, the most common response included coordination among the agencies involved in the school site selection and design (school district, developer, local government, and parents). This is a barrier agencies should be able to overcome, especially if improved guidelines are developed. The second most common response was about cost, yet the survey responses demonstrate many school districts do not consider the cost of roadway and transportation infrastructure improvements in the overall school construction cost estimate, and a large proportion do not include long-term transportation (operating) costs when evaluating a site. This is short-sighted, but common. Other barriers to good school site design that were identified by survey respondents included lack of available land parcel, existing school district policies that work counter to walkable schools, lack of good guidelines, and resistance to change.

Ultimately, the survey responses indicate a desire to implement new guidelines.

For improved school site selection and design, it is imperative school officials work closely with local agencies, especially in the development process, to identify the best school sites. However, 32 percent of the respondents reported this coordination does not take place in their communities and another 23 percent reported it only occurs sometimes. This feedback implies there remains a lack of coordination in some jurisdictions between local authorities and school officials. In some communities, local officials might consider school site selection and design the responsibility of the school district along with their design consultants and architects. Ultimately, the survey responses indicated a desire to implement new guidelines.

3.3 References

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4. SELECTING A SCHOOL SITE

Schools will typically be in operation for a very long time, serving generations of students. In many cases, schools are rebuilt on the same campus location; therefore, it is best to select a site that will function properly for many years for optimum vehicle, pedestrian, and bicycle access while allowing and encouraging most students to walk or bicycle to school. A school should be the focus of the community it serves.

A school should be the focus of the community it serves.

There are schools that were properly located and designed for the time they were built, but no longer serve students who walk or bike to school. Changes resulting from undesirable land development patterns and the increased reliance of motor vehicles have affected the ability of some schools to serve walking and bicycling students. For example, the elementary school shown in **Figure 4-1** was established in 1896. Unfortunately, it is currently at the intersection of two busy arterial streets with high volumes of truck traffic. Both arterial streets have been widened over the years and the school site is now bounded by industrial land along the south, east, and west sides. Despite the traffic signal at the adjacent intersection, school officials have decided to bus nearly all students because of traffic safety concerns. No one could have foreseen the changes since the 1890s, such as the development and impact of motor vehicles, when the school was originally built. This school is not unique in this respect.

Figure 4-1. Elementary school site established in 1896
Source: Google Earth

Regardless, engineers, planners, developers, and school officials have learned much about the appropriate location for various school types within a community and the best way to link a school to the neighborhood it serves; and all of them can work together to create a walkable and bikable community. It is the intent of this report to highlight and assemble those best practices, particularly for elementary schools, which will encourage students to walk and bike to school and provide optimal safety conditions.

Although this document is an informational report and does not provide specific guidance and design standards, local, state, or provincial guidance may be available. For example, *Traffic Operations and Safety at Schools: Recommended Guidelines* produced for the Texas Department of Transportation (TxDOT) has recommended guidelines for traffic operations and safety at schools that provide a comprehensive review of school site selection and design.[1] While this document has region-specific design standards and criteria, it may provide helpful information for any school planner or transportation engineer.

4.1 School Site Selection Overview

Many times, a conflict or inefficiency of a school site or campus layout is identified after construction is complete. Other times, officials may identify significant issues with a school during the design phase, but are unable to address those concerns because the land has already been purchased or the surrounding land uses have been established. Often, the result is a school with many transportation-related concerns that could have been avoided if critical staff from school and local agencies were involved cooperatively at every stage of school site selection and design. For these reasons, it is essential to understand when critical decisions are made about a school site and the design and layout of the campus.

Although procedures vary widely across North America, the same general format is used for land development by most

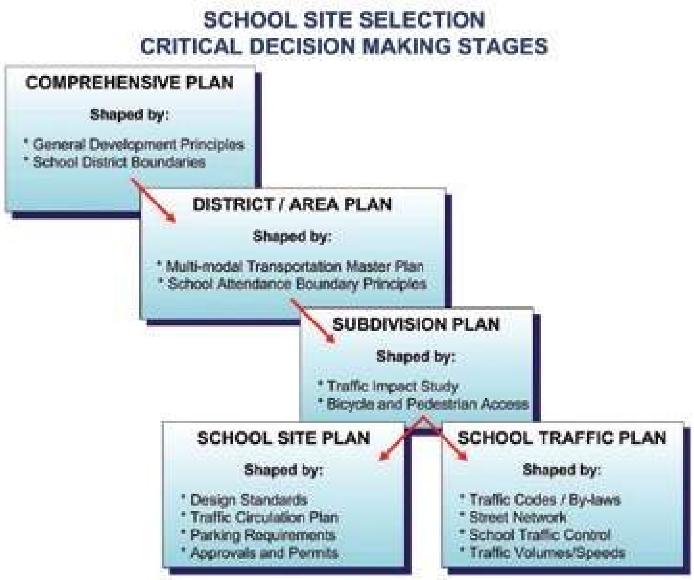


Figure 4-2. School Site Selection Critical Decision Making Stages
Source: Brandon Forrey, City of Peoria, Arizona

jurisdictions. The critical decision-making stages of school site selection include:

- Community-wide Plans;
- District/Area Plans;
- Subdivision Plans;
- School Site Plans; and
- School Transportation Plans.

The relationships between these levels or stages in the critical decision-making process for school site selection and campus/facility design are shown in **Figure 4-2**.

4.1.1 Comprehensive Plans

Comprehensive Plans, also called General Plans, describe the guiding principles of development in a community. These plans include a community's objectives and goals, as well as a framework for zoning, land use, and transportation. The Comprehensive Plan typically does not include specific ordinances or by-laws, but rather establishes a document to ensure continuity in the direction the community wishes to develop. These are long-term plans with horizons of many years.

At this broad level, officials should look at development densities and land uses to help determine school boundaries (and in some cases, school district boundaries) and areas appropriate for school sites, such as zoned residential clusters, as well as mixed-use areas.

Using the Comprehensive Plan stage, school planners typically consider potential school sites based on:

- Development densities;
- Land uses compatible with a school site;
- Zoning requirements; and
- Proximity to transit and integrated transportation corridors.

4.1.2 District/Area Plans

District/Area Plans, also called Specific Area Plans, Village Plans, Neighborhood Plans, or Corridor Plans, are projects or area-specific land-use plans used to determine future zoning requests. Unlike the Comprehensive Plans, District/Area Plans are intended to provide unique land-use categories and establish thematic character elements within the plan areas. It should be noted jurisdictions, particularly smaller communities, do not always use this developmental stage. Thus, there is a fair amount of crossover between the decisions a school facilities planner must make during District/Area Plans and Subdivision Plans. Generally, the District/Area Plan is broader and less specific than the Subdivision Plan.

At the District/Area Plan level, school officials should begin to identify groups of developments that will be served by a school, shaping individual school attendance boundaries. Officials should not only consider student population densities to be served, but the proximity to compatible land uses. Additionally, school planners should consider and refine a potential site's location in relation to transportation infrastructure and services for all travel modes. If a school predates the neighborhood infrastructure, schools typically are responsible for building new roads, sidewalks, water and sewer lines, and other infrastructure to the site itself from the community it serves. A site nestled within an area with existing transportation infrastructure, including pedestrian and bike facilities, served by transit, and located centrally to the community it serves, will generally cost less to build and operate.

During the District/Area Plan stage, school planners typically consider potential school sites based on:

- Population densities;
- Proximity to compatible land uses;
- Requirements for new infrastructure;
- Proximity to and integration with pedestrian and bicycle infrastructure; and
- Location of transit routes and stops.

4.1.3 Subdivision Plans

The next critical stage is the **Subdivision Plan**, when one or more properties are subdivided into many smaller units, such as single family residential lots, commercial shopping centers, park sites, churches, retention basins, and schools. Typically, a Subdivision Plan will be shaped by transportation area studies to determine infrastructure needs for the area being developed based on the proposed land uses within. These studies are often multimodal, which means not only are vehicle travel and access considered, but so are pedestrian, bicycle, transit, and sometimes even equestrian and waterway facilities and access. At this time there should be an assurance there is appropriate access for all modes of transportation.

Before a final school site is accepted, school facilities planners are encouraged to develop a walking route for the school, to determine if the surrounding community has adequate access to the site and identify if and where additional access and infrastructure will be needed. At times, school sites within subdivision plans are offered at the outskirts of a subdivision where land values are lower and access is minimized, and is usually limited to arterial streets only. This results in a site that does not encourage students to walk or bike, has a higher number of driving parents, requires more students to be bused, requires more students to walk along busier streets, requires longer walking distances, results in more traffic and has more traffic congestion and safety concerns in general. A school site central to the community it serves will ensure a greater number of students will be able to walk and ride bikes to school.

During the Subdivision Plan stage, school planners typically consider potential school sites based on:

- Site location within community and proximity to residences;
- Location in relation to transportation infrastructure and services;
- Proximity to compatible land uses;
- Requirements for new infrastructure;
- Location and design of pedestrian and bicycle facilities; and
- Location of transit routes and stops.

4.1.4 School Site Plans and Transportation Plans

After a school site is selected, the final critical decision-making stages in school site selection are School Site Plans and School Transportation Plans. Both plans should be developed simultaneously because they have reciprocal effect.

The **School Site Plan**, which is the design and layout of the school campus and facilities, might also require improvements along the adjacent roadways. At this stage, approvals are necessary from local and/or regional jurisdictions to ensure the design meets all appropriate codes, ordinances, or by-laws pertaining to building safety, bicycle and pedestrian access, transportation, emergency access, or other concerns. At this time, zoning stipulations that place additional limitations on a school's access to facilities might be issued. Common examples of zoning stipulations to a school site might include denied or limited access of one or more modes of transportation to certain streets or conditional use of sports field lighting near neighborhoods. Additional requirements might be imposed through a Transportation Impact Study (TIS), which attempts to project school-related traffic impacts and needs. Requirements resulting from a TIS might include wider sidewalks abutting a school property, minimum bike parking requirements, additional pedestrian access points into the neighboring community, more on-site storage of vehicles to accommodate student drop-off and pick-up traffic volumes, decelerations lanes on streets adjacent to a school, or even construction of new traffic signals. Often, formal approval by local or regional authorities is required prior to construction of a school site.

The Site Plan is typically the last chance to address building layout, vehicle access, pedestrian/bicycle access, parking needs, parking lot design, bus loading areas, and parent vehicle queuing for student drop-off and pick-up. For this reason, school planners are urged to seek the advice and recommendations of local authorities and professional engineers, architects, and the key school staff members. Unfortunately, the people who will be responsible to operate and manage the facility typically are not involved in any stage of a school's site selection and campus design/layout; including them could avoid many design mistakes and inefficiencies.

The **School Transportation Plan**, also called an Operational or Traffic Plan, determines traffic flow and access for all vehicles (including staff, visitors, buses, parents for student drop-off and pick-up, and students in the case of high schools, as well as deliveries and emergency access), pedestrians, and bicycles to and from the school site as well as within the site itself. Primarily, this plan is shaped by traffic codes and by-laws, as well as approvals from local and/or regional jurisdictions, especially in the case of traffic control.

When developing both the School Site Plan and the School Transportation Plan, school planners typically consider:

- Location and design of pedestrian and bicycle facilities;
- School walk and bike maps;
- Traffic controls, such as traffic signals, STOP signs, and turn restrictions;
- Parking policies, parking lot layout, and designation of parking spaces for staff, visitors, and students;
- Site access for vehicles, pedestrians, and bicycles;
- Student pick-up and drop-off procedures;
- Busing areas and access;
- Interior and exterior facilities, such as bike storage, lockers, shower facilities, and daycare accommodations;
- Lighting both on-site and on-street; and
- Security, including access to the site and individual classrooms.

4.2 Guidelines for School Site Selection

Below is a summary list of the most important elements to consider when selecting a school site. Following these principles will contribute to creating a walkable, community-based

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

school, and will enable the maximum number of students to walk or ride their bikes to school, as well as reduce the needs for parent drop-off/pick-up and school buses.

- A smaller school (lower student attendance and smaller catchment area) is more walkable than a larger school.
- A school that serves more grades (such as K–8 rather than K–3) is often a more walkable school.
- A good school site is located in the center of the attendance boundary, especially the center of the walking attendance area.
- Locate a school to minimize the need for students to cross busy or high-speed arterial streets, especially primary or elementary school sites.
- Do not locate a school adjacent to or near an access barrier (such as a river, wash, freeway, or railroad tracks) unless pedestrian/bicycle access can be provided across the barrier.
- Provide pedestrian and bicycle access to all sides of the school campus (paths, sidewalks or gateways to enter the campus).
- It is best for a school site to be designed to have streets border at least two (and preferably more) sides of the school for vehicle access.
- It is best for elementary schools not to abut busy or high-speed arterial streets, but rather to abut at least one collector street inside the neighborhood, and preferably two.
- Avoid locating a school at the end of a cul-de-sac unless there are other ways vehicles and pedestrians can access the school site.
- Avoid multiple schools on the same campus or on adjacent campuses unless the schools are relatively small. Instead, the school campuses should be disbursed throughout the community that each school serves.
- It is best to avoid fronting a school onto a street with front-facing homes (single family homes with direct access to the street) because of the direct impact on residences, such as high traffic volumes during arrival and dismissal times and excessive on-street parking complaints.

4.3 Funding Issues and Availability

Throughout North America, there are a variety of funding models for the construction of new educational facilities; they range from full school-district-funded to partial or full state- or province-funded; many variations exist. While they focus on education, not all school districts have internal staff and the expertise to design efficient and effective sites with the appropriate access and transportation infrastructure. This report aims to identify transportation needs, so they may be identified early in the planning process and incorporated into all facets of funding and planning of a new school.

Typically, local jurisdictions treat new schools as any other development, requiring off-site work in the form of road improvements, sidewalks, and traffic signals. This additional and sometimes unforeseen financial burden can reduce available funding for the school campus.

School site selection often can be a trade-off between finances and operations.

School site selection often can be a trade-off between finances and operations. Depending on the jurisdiction, local planning legislation may provide specific parcels to be set aside for educational facilities, but assistance from the local jurisdiction is essential to ensure a location is chosen that is central to the community, to maximize walkability and the benefit to the community. In other cases, depending on local legislation and an individual school's circumstance, a school district may have to acquire new land for development of a site. This report is intended to assist school districts in evaluating sites from a transportation perspective.

4.4 Campus Size and Land Availability

As stated in Section 3, there is no widely accepted recommended formula for campus size, based on the number of students or the type of school, to determine the minimum or optimal acreage desirable for a school campus. While some state, provincial, and local agencies may continue to use the acreage requirements formerly recommended by the CEFPI, those have since been rescinded. In some circumstances, the school site property needs cannot be met from a size, shape, or access perspective for a variety of reasons, including, but not limited to, the following situations:

- **Existing Site**—A school located within a developed area of a community cannot support further capacity or operational requirements and the existing property cannot accommodate additional needs. This may result in adding buildings or recreational components to a constrained site;
- **Relocation**—An alternative to the above resolution is to relocate to a new site within or external to existing community, both of which present challenges of land availability and student transportation; and
- **Private/Special Program Schools**—The need or demand for private or special program schools might not have been apparent during the development of a particular area, when land of a sufficient size and position was available.

Currently, no preferred recommendations on campus size are known to exist. Each school site should be evaluated individually with input from local officials based on the student population, transportation needs for pedestrians, bicyclists, and motor vehicles, and other amenities at the school.

4.5 Location of School within Neighborhood and Road Network

Ideally, a school should be located centrally within a residential neighborhood, adjacent to and having access to a continuous collector road network. For a variety of reasons, some schools have been located on arterial and local roadways. The former situation may result in a higher conflict potential at the school accesses and poor pedestrian and bicycle access, which results in greater demands for busing and parent pick-up/drop-off facilities. The latter typically results in daily neighborhood impacts and operational issues associated with parent queuing and parking along the street.

For the majority of the students to be able to walk or ride their bikes, it is best for the school to be located in close proximity to the majority of the students it serves. Additionally, barriers, both natural and human-made, must be taken into account when determining a school's location and its attendance boundaries. Freeways or other wide, busy streets, waterways, and certain developments effectively cut off students from an otherwise nearby school. These barriers result in more students being bused or driven by parents.

Source: Dan Burden, WALC Institute, www.walklive.org

4.6 Circulation and Access to the School Campus

Proper connectivity to the residential areas within anticipated attendance boundaries is a key determinant of the transportation demands at a school. Poor connectivity results in a greater demand for busing and parent transportation.

Multiple street and sidewalk connections from the adjacent collector road network and to certain areas of an adjacent neighborhood might not be available due to major barriers, as described in **Section 4.5**. If street or sidewalk connections are precluded from one or more directions to a site, the likely result may be overloading of the available routes and increased walking as well as cycling distances.

Freeways or other wide, busy streets, waterways, and certain developments effectively cut off students from a nearby school.

For reasons of student security and containment of younger children, the number of access points (sidewalks, walkways, or gateways) between the school campus and adjacent residential neighborhood are usually minimized. Fewer access points create barriers to pedestrians and bicyclists and may result in longer walking distances and greater congestion and conflict at the school's main access. In other situations, school sites are readily accessible by foot through playing fields, parks, and other open spaces uses. In these cases, all-season access should be provided via maintained sidewalks and paths.

4.7 School Site Design

Low-cost location, design, and construction of a school with inadequate roadway, access, and parking infrastructure can result in a lifetime of higher costs for traffic control, enforcement, busing, and administration time to address ongoing safety and operational problems. Although the land available for the school campus might be limited, it is still necessary to accommodate traffic demands during the school's short peak

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Joel Cranford, North Carolina Department of Transportation

periods—student arrival and dismissal times. This can divert resources from other infrastructure and educational needs in order to make a less-than-desirable site function adequately.

In many cases, school sites appear to be designed from the inside-out, which inevitably results in parking, site circulation, and transportation access being secondary considerations. The educational and recreational needs of a school (such as classroom numbers, room sizes, and athletic field requirements) are designed and confirmed with school representatives early in the process. Transportation requirements and road user safety are often after-thoughts or secondary considerations.

Transportation requirements and road user safety are often after-thoughts or secondary considerations.

The educational, administration, and recreational needs of school are well understood by school officials, site planners, architects, and others typically involved in school planning and design. Unfortunately, transportation professionals are not always explicitly consulted during the early stages of the approval process, and often are engaged only if major issues with access or circulation are identified. The best solution is for school site planners to assemble a team that embraces all pertinent perspectives, including local and/or state or provincial transportation and planning officials at the start of the campus site selection process. Inadequate or improper campus locations should be rejected before the land is obtained. In addition, in the fall of 2011, USEPA published *School Siting Guidelines* as a tool for school officials and local authorities.[2]

The following is a summary list of the most important elements to consider when designing a school site. Following these principles will help create walkable, community-based schools that reduce the need for vehicular transportation of students.

- Provide sidewalks in the neighborhood adjacent to the school on both sides of the street and connect to the school entry points for students. Wider sidewalks near and along school property accommodate larger numbers of pedestrians at the school during school arrival and dismissal times.
- Provide bike lanes, paths, and other bicycle infrastructure connecting the school and the neighboring community.
- School walking maps (ideally developed during the planning stages of a school) encourage students to walk or bike to school, identify barriers to walking, and establish the optimal crossing locations and traffic control placement.
- Minimize the need for walking students to cross busy driveways along walking routes and when accessing the school building entrances.
- Evaluate and provide appropriate traffic control (including adult crossing guards, where needed) along the school frontage and at the primary street crossings.
- Physically separate bus loading areas from parent drop-off and pick-up areas.
- Design schools to accommodate parent vehicle traffic during arrival and dismissal times, so vehicle queues do not obstruct through lanes, crosswalks, bike lanes, driveways, or create other operational and safety concerns on the adjacent streets.

4.8 References

1. Cooner, S., et al., *Traffic Operations and Safety at Schools: Recommended Guidelines*. Texas A&M Transportation Institute for Texas Department of Transportation, Report Number 4286-2. October 2003. Available: tti.tamu.edu/documents/4286-2.pdf. (June 5, 2012).

2. U.S. Environmental Protection Agency, "School Siting Guidelines." October 2011. Available: www.epa.gov/schools/siting/. (June 5, 2012).

5. STREET LAYOUT AND NEIGHBORHOOD CONNECTIVITY

There are many good, as well as poor examples of walkable, community-based schools, in virtually every community. Some of the undesirable elementary school sites may have resulted from schools being built on arterial streets preceding the major development, when traffic volumes were much lower and streets were narrower. Other poor school sites have resulted from developers designating undesirable or largely inaccessible parcels of land for the school campuses within their developments. Poor sites designated for schools are many times the least marketable parcels in a development. In some cases, no adequate parcel was provided for a school campus.

Figure 5-1 illustrates an undesirable elementary school site built with primary access onto a high-speed, busy arterial street. When the master street plan was approved for the development, the school site was to be located in the neighborhood's interior, not on the arterial. However, the land originally designated for the school site was considered more valuable for building high-end homes; thus, the developer moved the school onto the arterial street. Unfortunately, this has resulted in considerable ongoing traffic and safety concerns from parents and school officials since the school opened in the early 1990s. Even the installation of a traffic signal with two adult crossing guards for student crossings did not alleviate parental concerns.

The school district took several actions to address those concerns, all without success. School officials attempted to make the arterial street the attendance boundary, but the parents living across the arterial street from the school protested and demanded their children attend their neighborhood school. The school offered busing to transport the children across the arterial street, but parents did not want their children to ride 20 minutes in a bus when they could walk across the street in five. Ultimately, a pedestrian bridge was built across the arterial street at a cost of $2.1 million, although an adult monitor remained at the crossing to ensure the children used the bridge.

Elementary schools should be located on collector streets inside neighborhoods, ideally with frontage onto at least two neighborhood streets.

There are some key design elements and campus placement guidelines for a school campus to function properly for all modes of transportation. First, the school should be somewhat centralized within the attendance boundary. Second, the attendance boundary needs to be a reasonable distance to encourage walking and bicycling. While this is not accomplished easily in rural areas with large attendance boundaries, it should be achievable in urban and suburban areas, especially for elementary schools. Elementary schools should not be located on busy or high-speed arterial streets and particularly should not have direct access off such a street. Instead, elementary schools should be located on collector streets inside neighborhoods, ideally with frontage onto at least two neighborhood streets. Similarly, middle schools are best located inside neighborhoods, but might also have access onto a minor arterial street as one of the adjacent streets.

Source: Michael J. Cynecki, Lee Engineering, LLC

High schools should have frontage onto at least two collector streets, although they may have access directly onto an arterial street. As with elementary schools, high schools should not have access (vehicle and pedestrian entry points) onto only one street. Typically, access points from two or three streets for vehicles and pedestrians/bicyclists are needed to provide adequate campus access.

All types of schools, including elementary, middle, and high schools, should provide pedestrian and bicycle access (walkways, paths, entrance gates) from all sides of the campus. Communities should have sidewalks or walkways along both sides of all streets to accommodate pedestrians. Separate walking and bicycle paths within a community can provide an even safer and more convenient way for students to travel to school and reduce the number of vehicles on campus during school arrival and dismissal times.

Figure 5-1. Elementary school on a busy arterial street
Source: Google Earth

KEY POINTS

***Avoid* sites for schools with the following characteristics:**

- **Located on arterials streets (especially for elementary and middle schools);**
- **Front onto only one street or located at the end of a cul-de-sac;**
- **Short or minimal frontage along the street;**
- **Many students required to cross busy or high-speed arterial streets;**
- **Little or no vehicle, pedestrian, or bike connection to the surrounding community;**
- **Located on the edge of the attendance or district boundary; and**
- **Located primarily on narrow local streets with front-facing homes.**

Local streets are ideal facilities for bicyclists of all ages, although some schools do not allow younger students, such as those in grades K–3, to ride bikes to school because of a lack of bicycling skills and maturity level. Older elementary and middle school students should be able to ride in on-street bike lanes along collector streets, and high school students should be able to ride in on-street bike lanes along many arterial streets, depending on speeds, volumes, and percentages of truck traffic.

Due to security concerns, some schools have limited access to only one or two accesses to the campus. A balance of access and security can be achieved through the use of gates that can be locked during the school day, adult monitors, and other measures such as lighting. This can allow a greater number of accesses without sacrificing security.

In addition to the need for pedestrian access from all points of a neighborhood, there is a need for good vehicle access. There is little benefit to having a school at the center of a neighborhood if the school is located at the end of a cul-de-sac with a single access point. That will result in considerable congestion during school arrival and dismissal times, which can create conditions that are less than desirable for pedestrians and bicyclists as well. A single access point will also result in diminished on-street parking opportunities, contribute toward inadequate drop-off and pick-up areas, and increase conflicts between vehicle and bus traffic.

Motorists in a neighborhood adjacent to a school should not be forced to drive onto an arterial street to access that school. The internal network of streets should allow direct access to a school from within a neighborhood. Many neighborhoods built with a high number of cul-de-sacs do not provide good vehicle access throughout the community and to the school. Other times natural features, such as canals, washes, or utility corridors, prevent good vehicle access within a neighborhood. When these occur, it is essential to provide adequate pedestrian and bicycle access across these barriers.

If the only site available for an elementary school is along an arterial street, the school should front onto a side street off the arterial street and not directly onto the arterial street. Furthermore, there should be direct vehicle, and pedestrian and bike,

Figure 5-2. Multi-school campus
Source: Google Earth

access from the community to the school without having to drive, walk, or bike onto or along the arterial street.

In **Figure 5-2**, a school district built one elementary school, two middle schools, and a high school on the same square half mile (1.3 square kilometer) parcel of land in an effort to minimize maintenance and land costs. Although some costs may be reduced, it is not desirable to group several schools onto one large campus for several reasons. Doing so will result in fewer children living close enough to the schools to walk or bike, and it will often result in schools with access from only one street. Because fewer children will be able to walk or bike to school, there will be more congestion from parents driving their children to school, creating more safety problems to the pedestrians and bicyclists.

KEY POINTS

Desirable elementary school sites have the following characteristics:

- **Located on one or more collector streets;**
- **Abutting additional local streets for neighborhood access;**
- **Ample pedestrian, bike, and vehicle connectivity/access;**
- **Located near the center of a “natural” walking area;**
- **Sufficient parent vehicle queuing for student drop-off and pick-up; and**
- **Sufficient parking—which could include shared parking with adjacent facilities.**

5.1 Location of School within a Community and Road Network

5.1.1 Elementary Schools

Figure 5-3 provides a good example of an elementary school with desirable site placement, campus layout, and connectivity to the neighborhood. This school is located almost in the center of a one square-mile (2.6 square kilometer) attendance boundary, at the intersection of two collector streets inside the neighborhood. This places the school at the center of a natural walking boundary.

Figure 5-3. Elementary school located at the center of attendance boundary
Source: Google Earth

This is a walking school, as the walking boundary and the attendance boundary are the same; the school provides no busing and all students live within the walking boundary, except for special education students. Additionally, the children do not have to cross a busy or wide arterial street to get to this school. Most of the streets in the neighborhood are on a grid pattern, providing good walking, biking, and vehicle connectivity to the school. Additionally, the school campus fronts onto two collector streets and has frontage along a local street to the north, as shown in **Figure 5-4**. There is pedestrian and bike access along the west side of the school and sidewalks exist along both sides of all streets, providing good walking and bicycle access to the school. There are separate loading areas for buses and parents, as well as sufficient on-site queuing areas to prevent backing onto the street. Crossing guards are provided at all collector street crossings, as well as at a few of the busier local street crossings.

Figure 5-5 provides another good example of a walkable school site and campus layout. The school fronts onto a collector street near the center of the attendance boundary. In addition to a good sidewalk network along the streets, there is a network of pedestrian and bicycle paths internal to the neighborhood that provides direct access to the school and an adjacent community center immediately west of the school. Although this school fronts directly onto only one street, the community center west of the school provides satellite parking and drop-off/pick-up activities, removing much of the traffic congestion from the school frontage. Additionally, many of the children can use the internal neighborhood paths to avoid street crossings.

5.1.2 High Schools

High schools typically have larger student populations than elementary or middle schools, as well as larger attendance boundar-

Figure 5-4. Elementary school with adjacent streets on all sides
Source: Google Earth

KEY POINTS:

Desirable high school sites have the following characteristics:

- **Main access off minor arterial or collector streets;**
- **Main access off major arterial street at signalized or located properly for future signalization;**
- **Abutting collector streets or wide local streets (ideally without front facing homes); and**
- **Sufficient, separated parking for students, faculty, and visitors.**

ies. While elementary schools might have a one- or two-square mile (2.6 to 5.2 square kilometer) attendance boundary, high schools will typically draw from larger areas. High schools require a larger campus to accommodate larger student populations, student motor vehicle and bicycle parking, athletic facilities, and other specialty facilities. High school students are more mature than elementary or middle school students, with approximately half the students being of legal driving age. Therefore, high school students typically should be able to cross arterial streets without the aid of adult crossing guards, and these schools are frequently located on or in close proximity to arterial streets. Additionally, high schools need to have separate parking areas for faculty, students, and visitors/guests. There are often concerns with overflow parking in the neighborhoods, higher traffic volumes, and excessive speeds on adjacent neighborhood streets. The parking lots, especially student parking lots, might generate fewer concerns if they do not direct high school vehicular traffic onto local neighborhood streets.

High schools require a larger campus to accommodate larger student populations, student parking, athletic facilities, and other specialty facilities.

Due to the regional areas they serve and the traffic volumes they generate, high schools are often located on arterial streets. A location on an arterial street also allows high schools to take advantage of existing public transit for students and faculty. The disadvantages of any school abutting an arterial street are higher traffic volumes and speeds, coupled with a large number of inexperienced student drivers. Thus, it is best if student driveways are accessed from collector streets or minor arterial streets. If primary student access is provided off an arterial or major arterial street, it is best to locate the primary student driveway at an existing or potential traffic signal location for improved access to and from the site. The need or desire for direct arterial street access needs to be determined in consultation with local authorities, based on local traffic patterns and roadway operations. However, some local codes deliberately limit site access onto arterial streets when it can be provided from collector streets instead.

Figure 5-6 provides an example of a high school located at the intersection of two collector streets within a 30-square mile (78-square kilometer) attendance boundary. This high school campus is bounded by streets on all four sides, and has good vehicle, pedestrian, and bicycle access to the campus. Both collector streets have on-street bike lanes and there is excellent connectivity to the neighborhood served by this high school.

Figure 5-7 shows an example of a high school with an arterial street on one side of the campus and collector streets on two other sides. This high school serves an attendance area of about six square miles (15.6 square kilometers) and a student population of 1,600 students. The traffic signals at the either end of the school campus are a quarter-mile (0.4 kilometer) apart and provide good pedestrian and motorist access onto and across the arterial street. The student and faculty parking lots access the collector streets adjacent to this school campus. There is a city park adjacent to one side of the school campus that has additional overflow parking and recreational facilities and also provides ideal pedestrian and bicycle access to the school.

5.1.3 Charter, Private, and Parochial Schools

Charter, private, and parochial schools come in all shapes, grade levels, and sizes. These types of schools present special challenges to students, parents, and school officials because of the lack of a defined attendance boundary and the need to transport students. Officials who establish and operate these schools might not have as much experience with school campus design, placement, and transportation facilities compared to public school

Figure 5-5. Elementary school with sidewalk system and internal path network
Source: Google Earth

district officials. Charter, private, and parochial schools typically do not have set attendance boundaries, so more parents are required to drive their children to school, generating more traffic congestion than a comparably sized public school.

A charter or private school likely will draw some students from the adjacent neighborhoods. In some cases, families relocate near a charter or private school to allow their children to walk or bike to school. Thus, in addition to providing good vehicle access, there needs to be adequate pedestrian and bicyclist access to these schools.

Charter, private, and parochial schools typically do not have set attendance boundaries, so more parents are required to drive their children to school, generating more traffic congestion than a comparably sized public school.

Some of these schools, especially charter schools, are established in strip malls along arterial streets, sometimes in former department store fronts. While these locations in theory provide "high visibility" for the school and good access for parents who drive their children, motorists may not recognize these sites as schools, and they may have poor pedestrian and bicycle access. In addition, the parking lots and student drop-off/pick-up areas that are poorly defined can contribute to confusion.

KEY POINTS

Multi-school campuses typically result in:

- **Fewer students walking and riding bikes to school;**
- **Increased busing and transportation costs;**
- **More driving parents;**
- **Greater parking concerns; and**
- **Increased traffic congestion during arrival and dismissal times.**

KEY POINTS:

Desirable charter, private, and parochial school sites are difficult to define because of their wide variability, but provide:

- **Appropriate pedestrian, bicycle, and vehicular access;**
- **Sufficient parent vehicle queuing for student drop-off and pick-up; and**
- **Adequate parking.**

Figure 5-8 illustrates a charter school established in a strip mall at the corner of two arterial streets. The K–8 school has about 700 students and provides two adult crossing guards at the traffic signal to assist with student crossings. There is not

Figure 5-6. High school located at intersection of two collector streets
Source: Google Earth

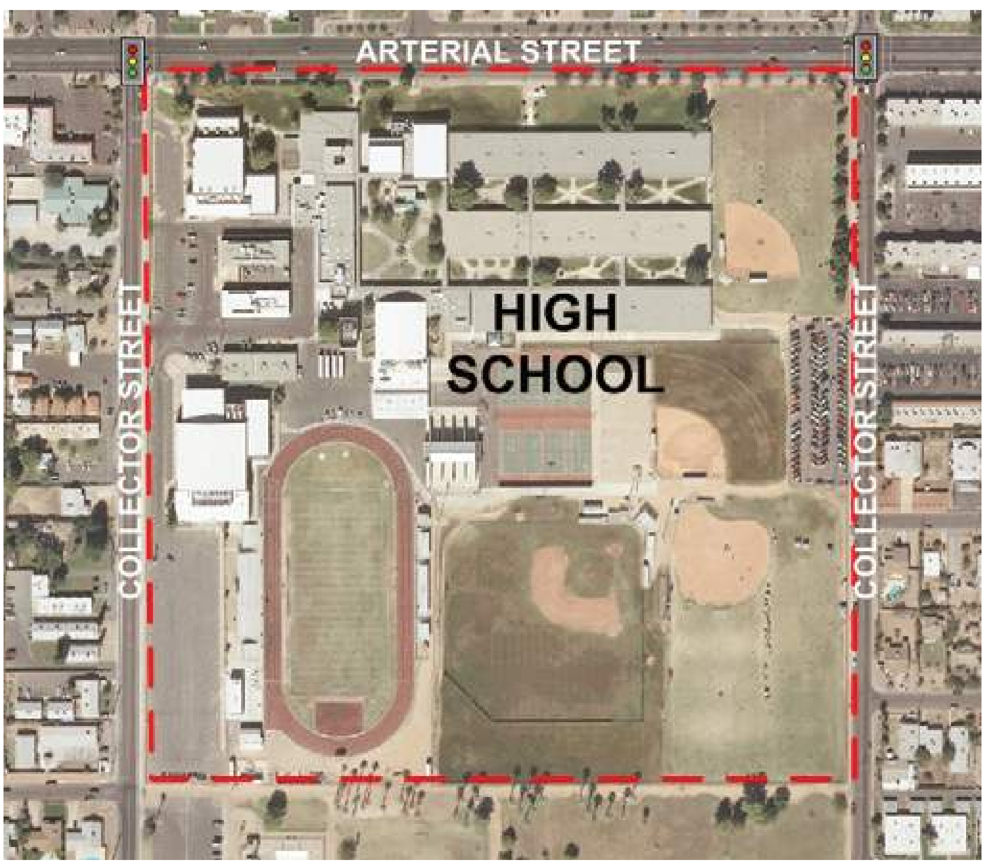


Figure 5-7. High school adjacent to an arterial street and two collector streets
Source: Google Earth

Figure 5-8. Elementary charter school located in strip mall along two arterial streets
Source: Google Earth

Figure 5-9. Charter school located on a collector street inside a neighborhood
Source: Google Earth

a well-defined walking path from the traffic signal to the school building outlined in **Figure 5-8**, and students have to cross a busy parking lot and driveways. In addition, there is not a good walkway to the traffic signal for young children living on the east side of the arterial street. Some students and parents have been observed crossing the arterial street a block south of the traffic signal. Other charter schools that front onto arterial streets experience problems with parent drop-off and pick-up traffic that back-up onto arterial streets. This condition is never desirable.

Not all charter schools are built on arterial streets. The charter school shown in **Figure 5-9** was built fronting onto a collector street inside a neighborhood. This charter school is for grades K–6 and has an enrollment of about 88 students. It still attracts a high proportion of students from longer distances whose parents drive them to school. The placement inside the neighborhood (along with small enrollment) allows it to function with a higher level of efficiency and safety for motorists and pedestrians.

The campus is adjacent to two streets, and students walking from the adjacent neighborhood do not have to cross a busy or wide arterial street. If parent pick-up or drop-off backs out into the street, it does so onto either a local or collector street. There is a good walking and bicycling network in this neighborhood. This charter school is located across the street from a traditional public school that is also situated in a good location for traffic safety and efficiency. The two schools off-set arrival and dismissal times to avoid congestion around the two campuses.

5.1.4 Shared-use Facilities

It might be advantageous for a school to partner with other entities and facilities to maximize benefits to both without incurring additional costs. Typical examples of facilities with which schools may share use or partner include parks, community centers, churches, and libraries. Shared use might be as simple as a spoken agreement or may require a formal inter-governmental agreement. Shared use of facilities works best when the school is abutting and has direct access to the other facility, although this is not required. These arrangements work best when the school can utilize the facilities of the nearby property, most often for overflow motor vehicle and bicycle parking during school arrival and dismissal times. In return, the other facility may be able to utilize one or more of the school's facilities, such as the school parking lot, playing fields, or multi-purpose rooms, at other times, such as weekends, during school breaks, or evenings. Shared-use facilities can be a great way for both facilities to expand the use of facilities without the additional costs or land.

Figure 5-10 demonstrates an example of a secondary school sharing use of a parking lot with an abutting sports facility. The school has two access driveways off a single arterial street, one of which is signalized and shared with the adjacent soccer dome. Because the soccer dome has different operating times than the school, the school uses the parking lot of the soccer dome during school hours and the soccer dome uses the school parking lot for overflow parking when needed during games.

Figure 5-11 demonstrates an example of an elementary school sharing parking and other facilities with an adjacent park. The school has a formal agreement with the park to provide snow removal during winter months in return for use of the parking lot and pedestrian access through the park. The school has other features that work in conjunction with the shared parking lot to improve operations, including pedestrian connections throughout the residential properties around the school, access to a signalized crossing of the nearby minor arterial street, wide sidewalks

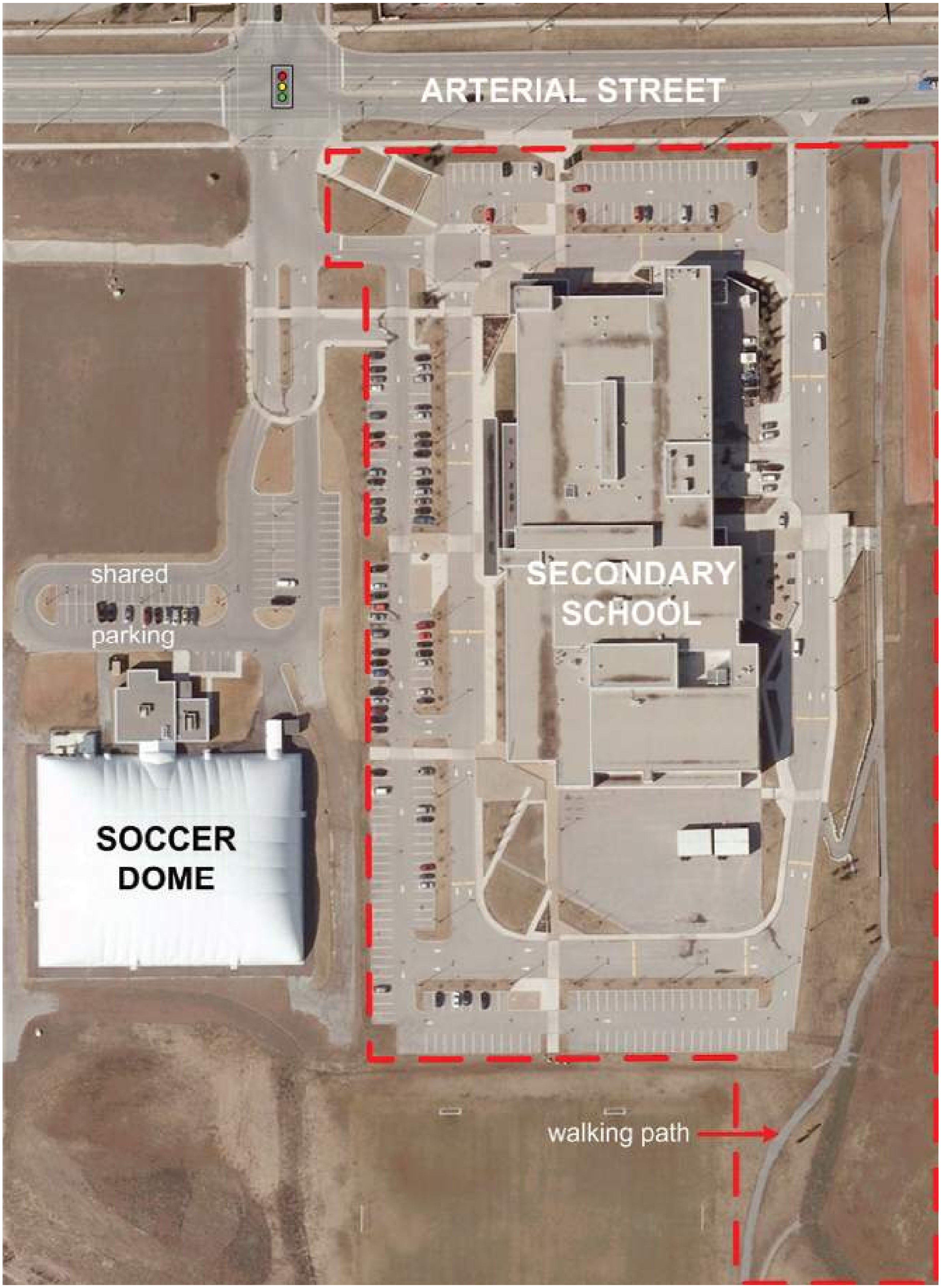


Figure 5-10. Secondary school with shared use of parking at soccer dome
Source: Google Earth

Figure 5-11. Elementary school with shared use of park and walking path connections to neighborhood and community center
Source: Google Earth

Figure 5-12. Challenging school site example 1
Source: Google Earth

separated from the street, one-way traffic flow to minimize vehicle conflicts, a "Kiss and Ride" program to coordinate student drop-off and pick-up, and an on-site daycare facility.

5.2 Improving Challenging School Sites

Not all school districts have the luxury of several sites to choose among for a new school campus, especially in developed communities. In many cases, there are few sites available for school development. Furthermore, the cost of constructing essential infrastructure (streets and utilities to serve the school) is another significant factor that limits the number of potential school sites. These limitations may contribute toward the selection of an unfavorable school location. A school site that is economically feasible to construct might not be the best choice. It is common for a parcel of land to be purchased prior to a full evaluation to determine whether the property can function in a safe and efficient manner as a school site. Advance planning and consultation with local transportation engineers and planners can avoid many years of frustrations, safety concerns, and higher operating costs.

Often, a less-expensive school site or design can create chronic traffic safety concerns, parent concerns, and higher operating costs.

KEY POINTS:

- **Provide site access on local or collector streets, not arterial streets;**
- **Design the school to prevent parent vehicle back-ups onto busy arterial streets; and**
- **Construct sidewalks beyond site, if needed, to ensure students can access the school by walking or by bike**

5.2.1 Case Study 1

A new elementary school was planned on a vacant lot in an otherwise built-out economically disadvantaged area. This long and narrow parcel was available for both a school and a future park site (**Figure 5-12**). The elementary school was originally to be built at the south end of the site, directly abutting a wide arterial street with a high truck volume. The original design had a short frontage along the school campus of about 300 feet (91.4 meters) and the only driveway access was onto the arterial street. There were to be no other streets along the school frontage and no walking or bicycle access to the school attendance area, which is all north of the original planned site. The areas immediately east, west, and north of the site are mobile home parks.

Figure 5-13. Final design for challenging school site example 1
Source: Google Earth

During the development review process, local officials convinced the school district officials to reorient the elementary school campus away from the arterial street. Local officials agreed to build the local street north from the arterial street for a distance of 0.25 mile (0.4 kilometer) to the north if the school campus were located further north, away from the arterial street. Sidewalks and streetlights were included in the revised design, and speed humps were placed along the local street adjacent to the school for traffic calming. An adult crossing guard would assist students across the street to the mobile home park to the east. The school district agreed to fund the extra utilities to extend to the campus site farther to the north.

The investment in the street and sidewalk infrastructure allowed most children to walk to their neighborhood school. Later, another street modernization project improved the rest of the adjacent local street north to the midblock collector street, which provided improved walking access to the rest of the school community. The final design with all street improvements can be seen in **Figure 5-13**. The school has operated well from the start and virtually all the children in this neighborhood walk or bike to school. While the school campus has only one street frontage, it is a long school frontage and, since it is a local street, there are fewer traffic problems if parking lot congestion creates a back-up onto the local street.

KEY POINTS:

- **Coordinate construction with input from jurisdictional authorities;**
- **Consider building new streets if the site does not have adequate access; and**
- **Plan for the long-term—if all the streets cannot be built at the time of construction, commit to establishing the future development of the new streets.**

5.2.2 Case Study 2

School district officials purchased the land for an elementary school on an arterial street (**Figure 5-14**) and prepared a school campus layout and design before discussing the school plans with local officials. The original plan for the elementary school was to front onto a short segment of a wide arterial street. The original design was to have one relatively narrow street frontage along the east side of school with no access to the north, west, or south when the rest of the community developed. Compounding this, the areas to the north, west, and south of the proposed school site were outside the jurisdiction in which the school was to be located.

Figure 5-14. Challenging school site example 2
Source: Google Earth

Figure 5-15. Final design for challenging school site example 2
Source: Google Earth

Figure 5-16. Elementary school retrofit on an arterial street
Source: Google Earth

Plans were underway for construction of the school building. Upon review of the plan, however, school officials were convinced to build a local street along the north side of the school property, and rotate the front of the school building to front onto that local street. Furthermore, a right-of-way dedication for a future local street was obtained along the north and west boundaries of the school site to provide a future vehicle and pedestrian connection to the rest of the community when it developed (**Figure 5-15**). Future developers will build the rest of the local streets along the north and west sides of the school, and access will be preserved to the rest of the community when it is built.

5.3 School Retrofit Example

Many existing schools are built in less than ideal locations, but might be improved with careful planning when the opportunity comes to renovate or rebuild. Consider the example of an elementary school built many years ago along a two-lane arterial street (**Figure 5-16**). When the school opened in 1970, it fronted directly onto the arterial street, which provided the only vehicle access onto the school campus. When the school opened, arterial traffic volumes were relatively low.

Over the years, the arterial street was widened to six lanes (68 feet or 20.7 meters) and traffic levels increased to nearly 40,000 ADT. Not only did children have to cross the wide, busy arterial street, all the school parent traffic was required to access the school from the same small school frontage off the arterial street, which conflicted with the school crossing. There was no direct vehicle access into the community east of the arterial street. School officials contacted city staff annually, attempting to resolve the ongoing traffic concerns.

KEY POINTS:

When retrofitting a school site, try to:

- **Identify existing conflicts to be neutralized;**
- **Not let the old campus design dictate the new campus; and**
- **Reorient buildings, parking lots, driveways, and playfields per the guidance provided in Section 5.1 as much as feasible.**

The campus was rebuilt on the same site, but the school building and access were focused to the interior of the neighborhood and fronted onto a local street within the neighborhood. Speed humps were installed along the local street that fronted the school and a larger parent drop-off/pick-up area was constructed to prevent back up onto the arterial street, eliminating school traffic conflicts with the school crosswalk on the arterial. A drop-off and pick-up plan was implemented along with a new student walking plan; and buses loaded from a local street on the south side of the school campus, separate from parent and other school traffic.

Since the school campus has been rebuilt, there have been virtually no traffic complaints from school officials or parents. This is despite the fact the school was rebuilt on the same site with access only to local streets.

6. SCHOOL CAMPUS DESIGN AND PHYSICAL SITE LAYOUT

6.1 Vehicle Access

Primary access to a school should be along a collector street, rather than a local street, particularly a local street having front-facing homes. This is to discourage some school-related vehicular traffic from infiltrating the surrounding neighborhood. Vehicle access from two or more streets helps spread the traffic load onto and off the campus. Separate entrance and exit driveways are typically recommended to improve traffic flow and minimize vehicle-vehicle and vehicle-pedestrian/bicyclist conflicts. Separate entrance and exit driveways should be designed to enable walking and bike riding students to enter school buildings without the need to cross busy driveways. School driveways should be located to avoid “interlocking left turn” movements at adjacent street intersections or at major driveways. “Interlocking left turns” occur when left-turn movements overlap from opposite directions on a street. It is best to separate parent traffic from faculty access and all car traffic should be separated from bus traffic.

Vehicle access to a high school campus is preferable from a minor arterial or collector street, especially for larger high school campuses. If the primary high school driveway is onto an arterial street, it should be established at a potential signal location. This will allow immediate or future signal control for vehicle access, or to accommodate pedestrian crossings, if needed. Schools located inside a neighborhood on collector streets rarely need signal control at driveways.

(Top) *Source: Michael J. Cynecki, Lee Engineering, LLC*

(Bottom) *Source: Michael J. Cynecki, Lee Engineering, LLC*

6.1.1 Access for Student Drop-off and Pick-up

Because of the large demand typically required for parent vehicle queuing, it is important to route this traffic carefully and to provide for as much on-site queuing as possible. Depending on anticipated needs, separate access, dedicated to parent vehicle student loading, may be beneficial. Because of the fluctuating demand for parent vehicle queues, it is recommended to design access to student drop-off and pick-up area, used by parent vehicles, to minimize any potential back-up onto the adjacent public street. Additionally, consideration should be given to the possibility of parent vehicle queues backing up onto adjacent streets, regardless of the amount of queuing available on-site. Parent vehicle queues might be better accommodated in a right-turn pocket or in an extra-wide curb lane to avoid obstructing through traffic. Regardless, the safety at driveway access points should be of utmost concern. Vehicles queued in the street can create a visibility obstruction to vehicles exiting a driveway. This is additional support for providing separate entrance and exit driveways at schools.

6.1.2 School Bus Access

School bus activity is a function of the planned short- and long-term attendance boundaries of a school and various other factors. Poor school placement may result in the need to provide

Source: Michael J. Cynecki, Lee Engineering, LLC

Figure 6-1. Reserved parking for people with disabilities should be conveniently located
Source: Michael J. Cynecki, Lee Engineering, LLC

"hazard busing" of students across wide, busy streets. Rural schools typically need to bus a large portion of students due to long travel distances to the school and the lack of sidewalk facilities. In the case of private or parochial schools, the school's attendance boundary may cross entire communities and regions; school buses should ideally access the campus via a collector street rather than a local residential street. Minimizing exposure of buses to residential properties can help reduce residents' complaints. Similarly, unnecessary routing of school buses through neighborhoods should be avoided. If school buses are required to compete with other vehicles, including queued and stationary parent vehicles, bus schedules might be affected. Therefore, a dedicated bus access or driveway is recommended.

Various measures can be employed to prevent parent access into the bus loading area, including signs restricting all other traffic, gates, and orange traffic cones that are removed when buses arrive. Parent education and some form of enforcement are also needed.

6.1.3 Visitor Parking Access

Typically, visitor access to on-site parking is via the main school access, although many variations exist. In some cases, general-use parking lots are separated from student drop-off and pick-up queuing areas, and if so, may require separate access as well. It is best to provide visitor access to an elementary or middle school parking lot from a collector street. Visitor parking spaces should be close to the entrance where the school administrative offices are located, for convenience of high turnover parking. High school visitor access may be from an arterial street and there may need to be more than one visitor parking area for larger high schools. These parking areas should be marked clearly for visitors and monitored by school staff. Special consideration should also be given to the location of visitor parking to ensure it is conveniently located and close to the school office. This is particularly true of parking spaces designated for people with disabilities, as seen in **Figure 6-1**.

The U.S. Department of Justice has requirements for new parking lots, as well as existing parking lots when restriped, which can be found at www.ada.gov/restripe.htm. These requirements are part of the *ADA Accessibility Guidelines*, which can found at www.access-board.gov/adaag/html/adaag.htm. In some jurisdictions, additional parking requirements for people with disabilities are identified in building codes or by-laws.

6.1.4 Bicycle Parking

Safe, convenient, and secure bike parking is needed to encourage students to ride bikes to school; it should be available for faculty and visitors as well. Bike parking areas should be placed on an all-weather surface, and the areas need to be located so the bicycles can be monitored to minimize theft and vandalism. This involves placing bicycle parking at a location where there is direct line of sight to the racks from the office or another room that is occupied throughout the day. Alternatively, the bike parking area can be monitored from the office by security cameras. Providing a "bike corral" that may be locked during the majority of the day can be another bicycle security solution.

It is beneficial to provide a secure bike parking area on each side of a school campus to minimize the need for a bicyclist to ride across campus and to minimize conflicts between bicyclists and walkers or other vehicles. Bike parking racks should be designed so the bicycle can be secured at two places on the frame, not only by the front wheel: This type of rack can cause damage to the front wheel. The optimum type is the U-type bike rack, as shown in **Figure 6-2**.

6.2 Sidewalk and Pathway Connections

Sidewalk, walkway, and bikeway access is beneficial on all sides of the campus to connect the residential areas to the school facility, while minimizing walking and bicycling distance. These access points should have all-weather walking surfaces that connect to the school building's primary entrances. Snow should be removed during winter months to keep these access ways functional.

Sidewalk connections from pathways and the neighborhood street system to the school entrances should minimize the number of driveways students are required to cross, especially busy driveways with parent or bus traffic. Sidewalk connections also should avoid mixing walking and bicycling students with students boarding or departing buses.

Sidewalk and pathway connections should be designed during the school planning process.

Sidewalk and pathway connections are best when designed during the school planning process. Schools that minimize student access to one or two access points for security purposes need to ensure there are accessible paths from all directions around the campus, and these access ways need to be lit during winter months and be visible from the adjacent streets for student security.

Officials at some schools may limit access to play/athletic fields for security purposes, student control during the school day, and to prevent animals from wandering onto the campus. Unfortunately, this may hinder direct access onto the campus for some neighborhood students. To achieve both security and access, these access points can be gated and unlocked during school arrival and dismissal times, and locked during the remainder of the day. These campus access ways should not be designed to hinder bicycle access, people with disabilities, or parents pushing strollers.

Sidewalks and walkways should be wider when on or adjacent to the school campus, to accommodate larger numbers of walking and bicycling students. Sidewalks should be 8 to 10 feet (2.4 to three meters) wide adjacent to the campus, depending on the number of students expected to walk and ride to school. These sidewalks should also be buffered from the adjacent streets and parking lot areas to better separate students from vehicular traffic. When wider sidewalks are provided, care should be taken to avoid placing sign posts and other street furniture within the walkway or main travel paths.

Consideration should be given to the desired boulevard treatment along the roadway adjacent to schools. Shade trees can provide comfort to pedestrians but a barrier between them and moving vehicles. Tree placement should not obscure the visibility of signs, crosswalks, or pedestrians.

Source: Michael J. Cynecki, Lee Engineering, LLC

6.3 Street Frontage Requirements

There is no standard street frontage requirement for schools, but designers must pay special attention that a number of transportation needs are met.

- Parent vehicle queuing/stacking;
- Driveway and emergency services access; and
- Overflow parking and evening/weekend parking.

Longer street frontages and multiple street frontages help disperse access points and provide more alternate parking or queuing areas for parents. While on-street parking and queuing areas along an arterial street are discouraged under most circumstances, a longer frontage might be able to accommodate multiple access points (visitor parking vs. student parking), or provide an access point at a location that is well-suited to a traffic signal in case one is needed.

Typically, it is not desirable for a school to front onto a single street or be placed at the end of a cul-de-sac. Even in rural areas, often it is preferable for a school to have access from more than one street or highway. However, if this condition occurs, a longer school frontage will be more functional. The desirable length of the school frontage will be proportional to the student population at the school and the ability to accommodate the private automobiles on site on the campus. A longer street frontage may also be desirable if more students are driven to school due to a larger attendance boundary.

Typically, it is not desirable for a school to front onto a single street or be placed at the end of a cul-de-sac.

TxDOT and other agencies recommend schools have at least two driveways, separated by no less than 600 feet (183 meters), although driveways may be located on two separate streets.[1] Adequate driveway separation helps minimize vehicle conflict and congestion on streets, and provides sufficient left-turn

(Top) Figure 6-2. U-type bike racks are recommended
Source: Michael J. Cynecki, Lee Engineering, LLC

(Bottom) *Source: Michael J. Cynecki, Lee Engineering, LLC*

(Top) *Source: Michael J. Cynecki, Lee Engineering, LLC*

(Bottom) *Source: Brandon Forrey, City of Peoria, Arizona*

storage. This provides guidance on desirable frontage for a school, suggesting longer street frontages are more beneficial.

Many schools have other community uses as well, such as community meetings and recreational uses for youth athletic leagues, as well as evening meetings associated with schools (such as parent/teacher meetings, school concerts, and open house meetings). The school frontage is an ideal place for overflow parking outside the normal school day, and a longer school frontage will accommodate more parking, even if parking is restricted in these areas during normal school hours.

It is best not to front a school onto a local street with front-facing homes, despite the fact that doing so places the school campus where there are more "eyes on the road" from these homes. While there is a benefit to having "eyes on the road" for improved student security and reducing school vandalism, residents in houses that front onto a street shared by a school typically do not enjoy the level of traffic the school generates during arrivals and dismissals, as well as during special events. This often results in repeated complaints about traffic and parking, noise, trash, and other concerns from the residents to the school officials and local jurisdiction that cannot be easily remedied.

6.4 Bus Loading Areas and Circulation

Many new school designs explicitly consider long-term school bus demands and have incorporated dedicated school bus accesses and loading areas. However, these needs may not be known during the site planning, or the design may not enable competing uses. In many instances, the school bus requirements at a particular site change with the

Source: Michael J. Cynecki, Lee Engineering, LLC

(Top) Source: Joel Cranford, North Carolina Department of Transportation

(Bottom) Source: Michael J. Cynecki, Lee Engineering, LLC

demographics of the surrounding residential areas or the consolidation of facilities. Individual states, provinces, and school districts specify different requirements and reimbursements for school bus transportation. This report does not discuss the need for or provision of school bus services, but summarizes the general planning needs for preferred bus loading and storage sites.

The bus staging area (including the student loading area and bus queuing) should be located proximate to the school, connected by a hard-surface walkway between the school exit and the bus loading area. Students should not be dropped off or picked up across the street from a school, unless students are using public transit for their school trip, in which case clearly marked crossings should be provided. Additionally, school bus operations should be limited near or around pedestrian crossings. Especially critical in weather-sensitive climates, a queuing area should be located to minimize bus exhaust from re-entering both buildings and outdoor areas in the student environment. The student loading area for buses should be wide enough for large groups of waiting students, walking students and teachers, and include a buffer area between pedestrian traffic and the curb; buffer areas are sometimes demarcated by a solid line to indicate a stand-back area.

School bus traffic should be routed in such a manner that will allow direct student access from the school bus to the sidewalk without having to come into conflict with traffic by crossing a driveway or parking lot. School buses may be routed behind a school building to load or unload from the back side of the school building. Consideration must be given to school bus turning radii and the need to allow other buses to pass a stopped bus in the loading area, as well as access points to the street system.

Bus/van loading may also occur for daycare and to transport students to after-school activities. Schools need to plan for and provide these loading areas, and it is best to separate them from the primary school bus loading areas, as well as from parent vehicle student drop-off and pick-up areas. If it is not possible to provide separate loading areas for daycare vehicles, they may be able to use the bus loading area, particularly after the buses have left the campus. Some jurisdictions, such as the state of Arizona, do not allow other vehicles or persons to use bus loading areas, so check all applicable ordinances and by-laws when exploring this option.

Source: Michael J. Cynecki, Lee Engineering, LLC

Figure 6-3. Color-coded student drop-off and pick-up area with shade structure
Source: Michael J. Cynecki, Lee Engineering, LLC

6.5 Student Loading Areas and Circulation for Personal Vehicles

Private vehicle student drop-off and pick-up should occur away from other transportation uses, such as parking areas, bus loading areas, and the main access to the school by bike or walking. Sufficient area should be provided for parent vehicles to line up (queue) while waiting to drop-off or pick-up students. This area does not need to be connected to the school building, but should allow for easy flow to a student loading area. Preferably, the queuing area should be located on the school property, but coordinated planning with a local jurisdiction may allow parent vehicle queuing to be established on public roadways that provide adequate parking areas or shoulders, or an adjacent park or community/church parking lot (with a written agreement from the managers of the adjacent facilities). An example of a shade-covered student drop-off and pick-up area located on a school site can be seen in **Figure 6-3**.

The following points should be considered when designing a student drop-off and pick-up area:

- Sufficient parent vehicle queuing must be provided or parent vehicles will wait where most convenient, including between parking aisles, along fire lanes, in the middle of traffic lanes, or along adjacent neighborhood streets;
- A wide paved waiting area for students, preferably with shade or shelter from adverse weather conditions, will promote use;
- A well-trained group of staff or volunteers can help ensure the drop-off and pick-up area operates as designed by assisting children in and out of vehicles, as well as ensuring drivers remain in their vehicles and pull all the way forward;
- A student waiting area at the far end of the vehicle queuing area will enable maximum on-site vehicle queuing and minimize the chance for back-ups onto an adjacent street; and
- A site designed with flexibility will enable a school to modify a student drop-off and pick-up process, as needs and parent vehicle volumes change over time.

Most parents prefer to use a loading process over other options if it is safe, efficient, organized, and moves quickly. By organizing a safe and efficient student pick-up/drop-off plan, traffic conditions can be made safer for students while improving overall traffic conditions around the school. This also helps minimize back-up and overflow onto the adjacent streets, which may cause other traffic problems for students walking/bicycling to school, as well as other motorists in the neighborhood. School officials are advised to contact the transportation officials in their jurisdiction for guidance or seek professional engineering assistance in developing a student drop-off and pick-up plan, if required. Some jurisdictions provide additional resources to schools, such as North Carolina Department of Transportation's (NCDOT) Municipal and School Transportation Assistance (MSTA), which provides guidelines for establishing organized student drop-off and pick-up plans, as shown in **Figure 6-4**.

6.5.1 Predicting Private Vehicle Queuing Needs

One of the most important and difficult tasks of designing a school site is predicting the number of private vehicles that need to be accommodated for the student drop-off and pick-up queue. At the time of publication, there were no standard methodologies to predict vehicle numbers, and it was beyond the scope of this informational report to develop recommended guidelines.

Source: Michael J. Cynecki, Lee Engineering, LLC

A few jurisdictions provide more extensive guidance for predicting private vehicle queuing needs. NCDOT offers a School Traffic Calculator for use in the state of North Carolina, shown in **Figure 6-5**, available at http://connect.ncdot.gov/municipalities/School/Pages/default.aspx. The School Traffic Calculator analyzes multiple factors, such as school type, student enrollment, and number of buses and faculty members to determine a school's anticipated queuing needs. Although this calculator is a valuable tool when used in its intended region, it might not be appropriate in other regions.

However, a paper published by ITE addressed both parent vehicle queues and air quality during dismissal pick-up traffic at elementary schools throughout the Houston, Texas area.[2] Rather than using trip generation, the study counted the maximum private vehicle queue and compared that to the total enrollment of the school to document the typical daily queuing need for student pick-up. Morning drop-offs were not counted as part of this study because drop-offs are spread over a wider time range and vehicles during those times circulate more evenly throughout the drop-off time.

The Houston study established the maximum vehicle queue as a percentage of the total student population at 55 public elementary schools from 2006 to 2009. These counts were used to determine a typical queuing need based on student enrollment alone. The end result was an expectation of a maximum parent vehicle queue representing one vehicle for 6 percent of the students with an allowance of 23 feet or seven meters per vehicle. So, a school of 500 students should expect a maximum queue of 30 vehicles, requiring 690 feet or 210 meters.

The methodology and results of the Houston study are similar to an unpublished study in the Phoenix, Arizona area for schools in Phoenix and Peoria. The Phoenix study documented maximum parent vehicle queues at 38 elementary schools in an urban/suburban environment, including a small number of private and charter schools, from 2004 to 2009. The Phoenix study consisted of a combination of schools with one dismissal for all students, as well as schools with two dismissal times, typically divided between grades K–2 and grades 3–8. The Phoenix area study identified a more conservative queuing need of one vehicle for 8 percent of the students for schools with one dismissal. For schools with two dismissal periods, the parent queuing need was found to be one vehicle for 16 percent of the students released during the dismissal of the younger students. In every school included in the Phoenix study, the queuing needs of the dismissal of older students could be accommodated by the queuing distance calculations based on the percentage needed to accommodate the younger students.

Regardless, the queuing needs at elementary schools can vary greatly from region to region, so a study of local comparable schools is the best approach to determine the needs of any new school in a given region. Based on the results from the Houston and Phoenix studies, the calculation of maximum vehicle queues for student pick-up based on student population might be a more helpful method than traditional trip generation models.

6.5.2 On-Site Versus Off-Site Student Loading

It is preferable for new schools to accommodate student drop-off and pick-up and bus loading on-site. Unfortunately, there are a number of existing schools that do not have the available campus space to accommodate all on-site drop-off and pick-up activities for parent vehicles and school buses. These activities can still function well, as long as an orderly plan is developed to process the drop-off and pick-up activities and adequate curb space exists to accommodate these activities along the school.

Best Practice
Student Loading Process for Elementary School

Making the student loading operations organized and more efficient will directly affect the pedestrian safety and ultimately affect the delays and queue length of the school related traffic.

- Make sure there is a clear demarcation of the loading area and of the vehicle bays in the loading area.
- A designated student loading zone should be established along the curb located near the school building entrance. The loading zone should have five (5) loading bays and be identified by installing 4-inch wide solid white pavement markings. Each bay should be a minimum of 8-feet wide, from the edge of curb, and the lengths of 20-feet for the end bays and 28 to 30-feet for the middle bays.
- Each bay should have its own teacher/supervisor/safety patrol assisting children to and from their appropriate vehicles.
- Enforce single lane loading, specifically in the student loading area, to help reduce pedestrian-vehicle conflicts.
- Short term parking spaces should be identified past the student loading zone and near the building entrance. This parking can be identified by installing "Visitor Parking" signs at the spaces to be assigned. These spaces are for parents requiring extended periods of time to load. If a parent stops in the loading zone, to wait to load their student, a loading assistant should direct that parent to the Visitor Parking.
- Enforce "No Parking," "No Left Turns," etc. to prevent circumvention of the carpool loading process.
- Pedestrian crosswalks, were necessary, should be located before and/or after the identified student loading zone. Crossing pedestrians will be more visible and can safely cross during the times vehicles are stopped being loading process.

Morning Loading Period

- Have a loading assistant (faculty member, parent volunteer, or identified student patrol) at each student loading bay.
  - It would be the loading assistant's responsibility to assist the student from their vehicle.

Afternoon Loading Period

- Identify each student loading bay using colors or numbers painted on sidewalk and/or traffic cones placed beside each bay.
- Weather permitting, have the children wait in an organized fashion in the loading area or adjacent to it by classes or grade.
- Use a vehicle-student identification system during the pickup process.
  - Parents should display a child identification card placed in the right front corner or sun visor of their vehicle's windshield. The card will indicate a corresponding number to their child in the windshield of their vehicle. This will expedite the flow of traffic, as a teacher/supervisor doesn't have to stop cars to ask whom the parent is picking up and it also assists in safety concerns.
- Use an "Advanced Identification" loading process to better organize and expedite the student loading.
  - This process will require the placement of a loading assistant (faculty member, parent volunteer, or identified student patrol) before the student loading zone. It would be the loading assistant's responsibility to read the child identification card placed in vehicle windshields and determine the name of the next student to be loaded. Once the information is obtained, it is forwarded (typically by walkie-talkie or megaphone) to another loading assistant who has access to the students. By the time the parent reaches the student loading zone, the student is waiting next to the curb ready to be loaded into the vehicle.

Figure 6-4. Example Best Practice Student Loading Process from NCDOT
Source: NCDOT

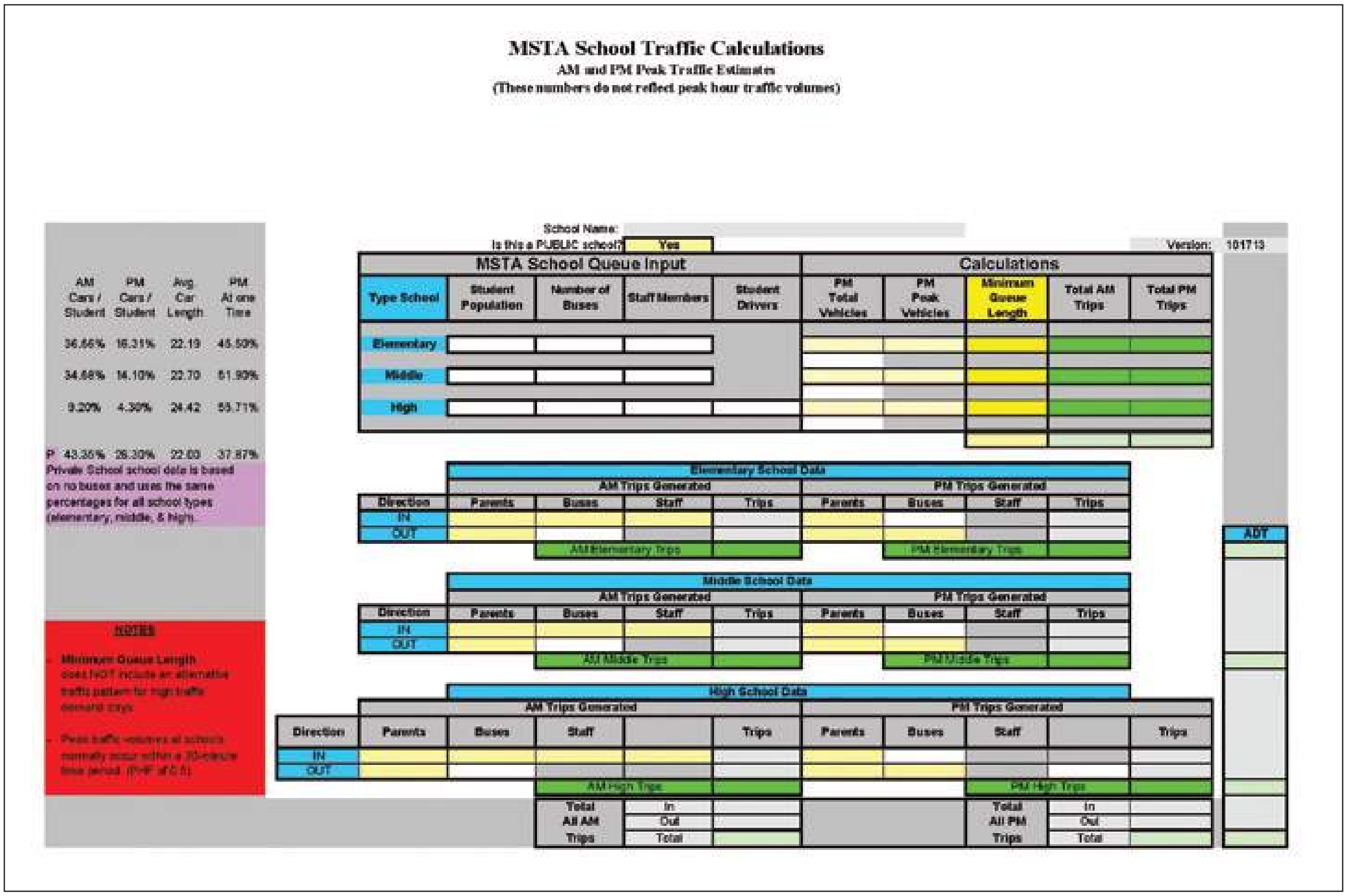


Figure 6-5. School Traffic Calculator from NCDOT
Source: NCDOT

Figure 6-6 shows a location where school officials place traffic cones in the street to prevent parent vehicles creating problems by stopping too close to a school crosswalk when dropping-off and picking-up students on a public street. However, school officials should consult the local transportation authority or police prior to placing cones or signs in the street.

As a general rule, a school designed as a “walking school” will require less student loading space than a school with a larger attendance boundary. Regardless, school officials need to continue to find ways to encourage more students to walk and bike to school. If these efforts are successful, the need to designate larger parts of the campus for on-site (or curb-side) loading space will diminish greatly.

Some campuses that serve very large student attendance areas, as well as magnet, charter, or private schools, may need to find innovative ways to further process the unloading and loading of parent vehicles in an orderly fashion. Some schools have established double- or triple-loading lines on campus, with school faculty or monitors safely escorting students to and from vehicles. In these examples, considerable planning, training, and educational efforts are needed to effectively execute and manage the plan. For example, the drop-off and pick-up activities should occur at the far end of the parent loading area to accommodate as many cars on the campus site as possible. Some schools have painted areas on the pavement or sidewalk where student loading is to occur and installed awnings at the designated student drop-off and pick-up area to shelter students from the elements. Furthermore, the individuals who escort children to and from the vehicles should wear bright safety vests (either Class I or Class II) to make themselves more visible to motorists and to command more respect from drivers and students.

If there is not enough space to accommodate all drop-off and pick-up activity on the school site or on a street abutting the school, a remote drop-off location, such as an adjacent or nearby park, community center, or church parking lot might be considered. If this is a possibility, a plan to educate students and parents on the proper use of remote sites should be developed. It would also be beneficial to deploy one or more school officials or parent volunteers at the remote drop-off/pick-up site to provide some level of monitoring. Although these instances of remote (off-campus) drop-off and pick-up sites may be rare, they can be very helpful in improving traffic conditions at schools.

Figure 6-6. Traffic cones might help direct parents or prevent parking in undesirable locations
Source: Michael J. Cynecki, Lee Engineering, LLC

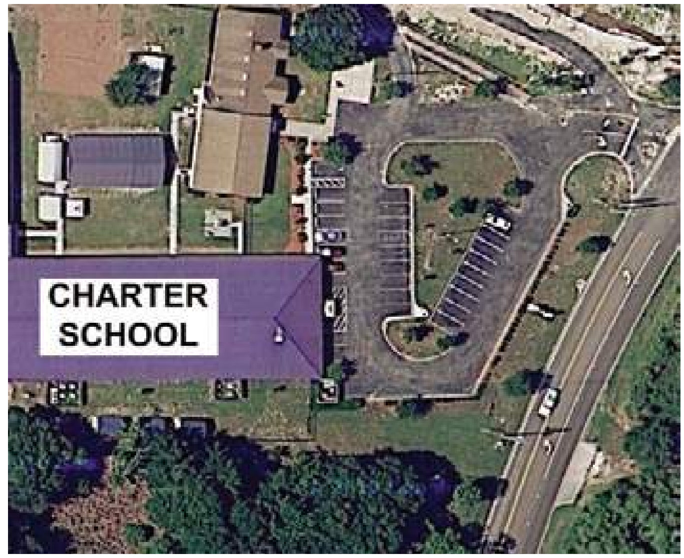


Figure 6-7: Student Drop-off/Pick-up Area One
Source: Google Earth

In some cases, schools may consider developing a student loading plan that incorporates more than one lane of active loading, particularly in the case of student pick-up. In multi-lane student loading processes, it is typical for several staff members or adult volunteers to escort students to the vehicles, assist in the loading of each student, and ensure students can access those vehicles safely by stopping all vehicular traffic when students are crossing. Although multi-lane student loading requires more oversight than single- lane curbside loading, it may be worth considering if a school has very little space for on-site parent vehicle queues.

Though multi-lane student loading requires more oversight than single lane curbside loading, it might be worth considering if a school has very little space for on-site parent vehicle queues.

Student loading should not occur across the street from the school unless there are special provisions made to safely and efficiently cross the students with an adult crossing guard. Some jurisdictions prohibit student loading on the side of the street opposite the school campus.

6.5.3 Student Drop-off/Pick-up Area Case Studies

The following case studies are intended to illustrate the connection between site design and behavioral policies. Every site will have specific locations that require strict behavioral management, but a small site or a plan using multi-lane student loading might require tighter control over every part of the operation.

Student Drop-off/Pick-up Area One

Figure 6-7 shows a charter school with limited pedestrian access and a small parking lot with no additional space for parent vehicle queuing. Despite staggered dismissal times, afternoon pick-up times consistently generated excessive traffic congestion and safety concerns. Because of the minimal loading and queuing area, school officials decided to implement a double-row student pick-up plan with up to four vehicles loading at one time. This change required modification of the standard student assisted pick-up procedures because students are typically not allowed to load anywhere other than at the curb. Volunteers among the older students assisted in loading students into vehicles adjacent to the curb, but only adult staff loaded students into vehicles in the outside row. Children in grades K–2 were loaded only in the curb lane to minimize hazards. Staff members stationed at the base of the driveway used a standard two-way radio to call the names of children to be picked up to the office. Staff in the office would then call the children's names over the intercom system, so the children could make their way to the front of the school. All students were required to be picked up from the queue (no parent could park and walk to pick up a student) to minimize vehicle/vehicle and vehicle/pedestrian conflicts. This also eliminated the impromptu parent/teacher conferences that would distract students and staff from hearing names called on the intercom. If the site was full and could not receive additional vehicles, cars were waved on to drive down the street a few blocks and return when the queue had reduced, although this happened rarely after the first week. Students not picked up after 30 minutes were sent to an after-care program and the parents could park and sign their children out of the program. The pick-up operation for the middle school students immediately followed the operation for the elementary school, although there were few issues with loading procedure and few conflicts were seen due to the middle school's lower enrollment. This unconventional procedure proved quite effective for

Figure 6-8. Student Drop-off/Pick-up Area Two
Source: Google Earth

this particular challenging school site. While this works, it illustrates the considerable daily effort required to address inadequate planning and design.

Student Drop-off/Pick-up Area Two

Figure 6-8 shows the second example student drop-off and pick-up area at a private elementary school that serves approximately 700 students, with little or no bus or pedestrian activity. The site is located on a busy three-lane road with a one-way driveway system with a lower parking lot that allows for recirculation of traffic, if necessary. The three-lane loading area for the school spans 570 feet (174 meters) with separate loading areas for each grade and an additional available storage queue length of 660 feet (201 meters), which was rarely used. Part of the success of this system was the outer travel lane, which allowed waiting vehicles to immediately access the appropriate loading area without being impeded by other loading vehicles. The two lanes closest to the curb were used for loading, while the outside lane was used for unimpeded ingress and egress. A monitor with a two-way radio stationed at the beginning of the loading area ensured there was available space in the appropriate zone before allowing a vehicle to enter the loading area. This practice helped prevent back-ups. Student crossings were strictly regulated at specific locations by adult crossing guards.

All other portions of this operation were fairly loosely regulated. Students were grouped in the loading area about 10 feet (three meters) from the curb, and a teacher was stationed with each class during the loading time. Parents frequently used this time to talk with teachers without creating delays to the loading operations. Additionally, parents were allowed to park in the lower lot and walk up the stairs to the loading area to pick up children, taking pressure off the student pick-up area. Supervision in the group waiting area was adequate, but not firm, and it often took several attempts to get the attention of children before they recognized their parent was waiting for them. However, safety was not compromised and the total time to load all students was less than 15 minutes. Because the loading time was of such short duration, the

Figure 6-9. Public transit stop near high school
Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

primary concern was traffic flow at the driveway, which frequently experienced queues greater than 10 vehicles. Fortunately, the queue length did not interfere with the loading operation and did not last long.

Comparing Student Drop-off and Pick-up Areas One and Two
At Area One, the operation was rigidly controlled and took more time because of limited loading and queuing distances. This heightened level of attention to the operation might make it marginally safer; however, the additional land available for Area Two allowed for more parent/teacher interaction, more flexibility and freedom, and a shorter loading time. The ability to allow unimpeded ingress and egress of vehicles despite multiple loading areas also improved operations in this case. This works to illustrate a transportation plan that works perfectly at one school might be a failure at another. It is vital to understand each school has different loading needs and a student drop-off and pick-up plan must be tailored to fit the needs of each school. Generally, strict regulation should be avoided, unless necessary to operate the loading process safely and efficiently. The need for tight regulation is typically triggered by high numbers of parent vehicles, short queuing distances, or both.

… a transportation plan that works perfectly at one school might be a failure at another.

6.6 Parking Layout and Access

New schools should provide enough parking to accommodate the entire staff, as well as visitors on campus. A school should not require staff to park in the surrounding neighborhood, but should enact policies to encourage faculty to walk, bike, carpool, or use public transit. Reserved parking for people with disabilities should be placed closest to the administration office door with a fully accessible route, and needs to be wider than traditional parking spaces to accommodate wheelchair loading. Additionally, these reserved spaces need to be signed and marked for qualifying users; painted aisles are needed to identify the access way to the school building. School staff should monitor the use of these designated parking spaces to ensure they are not misused. For more information on accessibility requirements and design, see the Technical Bulletin on parking from the United States Access Board at www.access-board.gov/adaag/about/bulletins/parking.htm.

The visitor parking area should be separated from faculty parking and be designated with signs. Ideally, the access to the visitor and staff parking should be separated from the parent drop-off and pick-up areas. Staff parking may be divided into two or three different parking areas, and it may be desirable to designate individual parking spaces for staff.

Student parking can present a significant problem at high schools, particularly in communities where more students have access to private vehicles. By the end of the school year, approximately half of the high school student population (grades 9–12) is old enough to qualify for a driver's license, yet it is not desirable or possible to allow all students who have access to a private vehicle to drive to school. As more high school students drive to school, on-site parking shortages and increased traffic congestion can increase motorist frustration, as well as create safety concerns for motorists, bicyclists, and pedestrians alike: Traffic safety concerns increase as greater numbers of inexperienced drivers traverse busy, congested streets and parking lots daily. Additionally, a greater number of driving students also equates to greater fuel consumption, intensifying air quality concerns. Public transit stops near a high school, as shown in **Figure 6-9**, can help provide relief to school-related congestion by providing students who live a long distance from the school with an alternative to driving. Furthermore, it is beneficial for school officials to seek partnerships with local public transit agencies, to provide free or discounted transit passes for students and coordinate transit schedules to coincide with school arrival and dismissal schedules, as strategies to encourage students to use modes of transportation other than private vehicles.

School officials should consider policies to limit high school students driving to school, but care needs to be taken when implementing these measures to prevent students from driving to the neighborhood surrounding the school, then parking in it. Some schools have implemented a fee to park on campus or have reserved the right to park on campus for those students with good grades or those who need a personal vehicle to drive to a job after school. Regardless, schools that allow students to park on campus need a system to validate drivers' licenses and insurance as minimum requirements for the privilege to park on campus.

Some communities have responded to overflow parking with parking restriction programs in the vicinity of a school campus, or resident-only permit parking programs (when authorized by local government ordinance/by-law).

6.7 Emergency Access

Requirements for emergency access, including fire lanes, vary from jurisdiction to jurisdiction, but special care must be given to the location of those facilities. The provision of fire lanes and other emergency access points must be reviewed and approved by the local fire marshal or other appropriate official. Occasionally, fire lanes may be used for parent drop-off and pick-up activities with approval from the local fire department, as long as minimal pavement width is maintained for fire vehicle access or if there is some guarantee parents will not leave vehicles unattended. This special use will have to be approved by the fire marshal or other designated fire department official reviewing and approving the overall school campus plans.

In some instances the fire lanes may be internal to the school campus, separating the school building from the athletic fields. In these instances, access to the fire lanes might be gated to secure the campus. It is the responsibility of a school to maintain the fire lane signs and red curb to ensure the fire lanes are properly posted. School officials need to monitor parent and other vehicular traffic to make sure fire lanes are not used for short-term parking or other uses that may prevent emergency access when needed. If parking in a fire lane becomes a concern, some jurisdictions offer enforcement through the police or fire departments, although the school should first make an effort to address the concern.

6.8 Lighting

Continuous street lighting should be provided for all streets along school grounds and adjacent to school facilities. Lighting is highly desirable for traffic safety, but it is also an important ingredient for improved personal security and for minimizing vandalism of the school facility. Not only do students arrive during hours of darkness in the winter months when days are shorter, there are a number of school-related activities during evening hours, such as "meet the teacher" events, parent and teacher organization meetings, parent and teacher conferences, school concerts and fairs, and other school activities that might involve the entire family. Many schools also serve as locations for youth sports leagues as well as other after-school student activities, and host numerous community meetings. Many of these additional events take place during hours of darkness.

Lighting should exist in the vicinity of all pedestrian or bicycle crossings serving a school. If lighting cannot be provided over a crossing, consideration should be given to moving the crosswalk to an existing streetlight location, particularly if the crosswalk will be serving students during hours of darkness. The least desirable condition is where a marked crossing is centered between two lights that are spaced 400 feet (120 meters) apart or more. This area midway between the lights will typically be the least illuminated portion of the street. Crosswalk locations and street lighting need to be coordinated to the greatest extent practical.

Lighting along both sides of the street is recommended for schools located along wide arterial streets…

Overhead streetlights should and normally can be included with the installation of traffic signals or pedestrian hybrid beacons where a ready power source and pole will exist to support a street light. One exception is when overhead utility lines might be located too close to the signal pole. Some utility companies require a 10-foot (three-meter) or greater separation between a streetlight facility or pole and overhead utility lines, but careful placement of a signal pole foundation may be able to overcome a potential conflict and allow an overhead light.

Most schools are located along local or collector streets where one-sided lighting is normally sufficient. When this is the case, there is greater benefit to placing the lights along the school side of the street where they will be closer to the school facilities and where there will be more pedestrians and bicyclists. Lighting along both sides of the street is recommended for schools located along wide arterial streets to provide more-even light distribution where street crossings will more likely occur. Any crosswalk across a wide, multi-lane street will benefit from having streetlights over both sides of the street.

New schools should provide continuous lighting as a part of the normal off-site improvements.

Some schools have been built without lighting to minimize initial construction costs or because a community did not require lighting. Additionally, some communities oppose street lighting to retain a "rural feel." This is an undesirable condition for pedestrians or bicyclists. New schools should provide continuous lighting as a part of the normal off-site improvements. During school upgrades, reconstruction, or evaluations, lighting should be a strong consideration for retrofitting if no or few streetlights exist along the school campus. Lights may be added to existing utility poles for continuous or intersection lighting to minimize installation costs, and light poles (or other pedestrian barriers) should not be placed inside sidewalks

Pedestrian level lighting may be a consideration, particularly if there is a wide buffer between the sidewalk and street or if tree branches block a sizable amount of the light to the pedestrian area. Pedestrian-level lighting is lower-level lighting placed over the sidewalk instead of the street. Because the lights are closer to the ground, a lower-intensity light level is needed. Many times, it is not financially feasible to provide pedestrian-level lighting, but there are instances where such lighting will be highly beneficial, especially in highly urbanized areas where crime or personal security is a concern. Pedestrian-level lighting may also be beneficial for pedestrian pathways and trails in urban areas, or along walkway connections to adjacent parks or community centers for improved personal security.

The type of light is important as well. Many agencies avoid low-pressure sodium lights, despite the reported energy efficiencies, because of the undesirable color provided by the yellow light. For this reason, high-pressure sodium lights are more desirable. The EPA Act of 2005 basically prohibited the manufacture or importation of mercury vapor streetlights for new construction, for environmental reasons. Some communities are exploring the use of induction lights or light emitting diode lights that are more energy efficient, last far longer than other lights, and provide an acceptable white light, despite their substantially higher initial cost.

Proper streetlight design must include the prevention of light pollution, especially into nearby residences where it is not wanted.

Proper streetlight design must include the prevention of light pollution, especially into nearby residences. Shielding may be helpful to minimize residents' complaints, but placing the light along the school side of the street is a better way to minimize homeowners' complaints. Agencies that maintain streetlights should also have a program to periodically monitor the lights to ensure they are working. A phone number or website for reporting streetlight outages will also be beneficial.

Schools should provide some form of lighting on their buildings to improve security and minimize the potential for vandalism, as well as place lights throughout campus walkways where students, parents, or faculty may be walking during hours of darkness. This is especially important for parking, and drop-off and pick-up, areas. Lighting should also be a consideration for the location of school bus stops in the community.

6.9 Location of Athletic Fields and Recreational Areas

All school facilities at a site typically should be located on the same side of a street. Arterial or high-speed streets should not bisect a campus unless some provisions for grade-separated crossings or other crossing protection is provided, such as traffic signals with crossing guards. Similarly, students should not have to cross streets, driveways, or parking lots to access recreation or athletic fields. Furthermore, athletic fields should not be located a long distance from the access point to the school building, and it is highly desirable to retain a line of sight between the play area or athletic field and school access point for personal security purposes. **Figure 6-10** shows one innovative treatment for a school built at the intersection of two busy collector streets that separated the school campus from the adjacent athletic field in a city park. During the design of the school and off-site improvements, the school district and local government officials worked together to provide a grade-separated crossing under the street by raising the street. Thus, students have a direct, secure, and safe access to the nearby park and mountain preserve. The pedestrian underpass was designed with a high degree of comfort for personal security by narrowing the street to the extent practical and making the undercrossing more open and visible from the school facility.

Arterial or high-speed streets should not bisect a campus unless some provisions for grade-separated crossings or other crossing protection is provided, such as traffic signals with crossing guards.

Because school athletic fields frequently are used by community youth sports leagues, consideration must be given for placing the parking lots conveniently near the access points to the athletic fields to discourage parents from parking in the neighborhood instead of the school parking lot. Overflow of parking from youth athletics leagues can become a source of animosity among nearby residents, involving complaints about trash, noise, and blocking driveways. The athletic fields should be an asset to the entire community and not a detriment to adjacent residents.

School campus sites along arterial streets pose a special concern, particularly for elementary and middle schools. School athletic fields need to be fenced off for security purposes and to prevent children from darting into traffic after balls or during play time. Because the school fencing provides the needed security and student safety barrier, it may be preferable for an elementary school campus located on one or more arterial streets to have the school building front into the interior of the neighborhood, and place the athletic fields closer to the arterial streets. This can change a potentially poor school site into a workable campus by focusing the pedestrian activity and parent vehicles inside the neighborhood rather than requiring direct access from an arterial street.

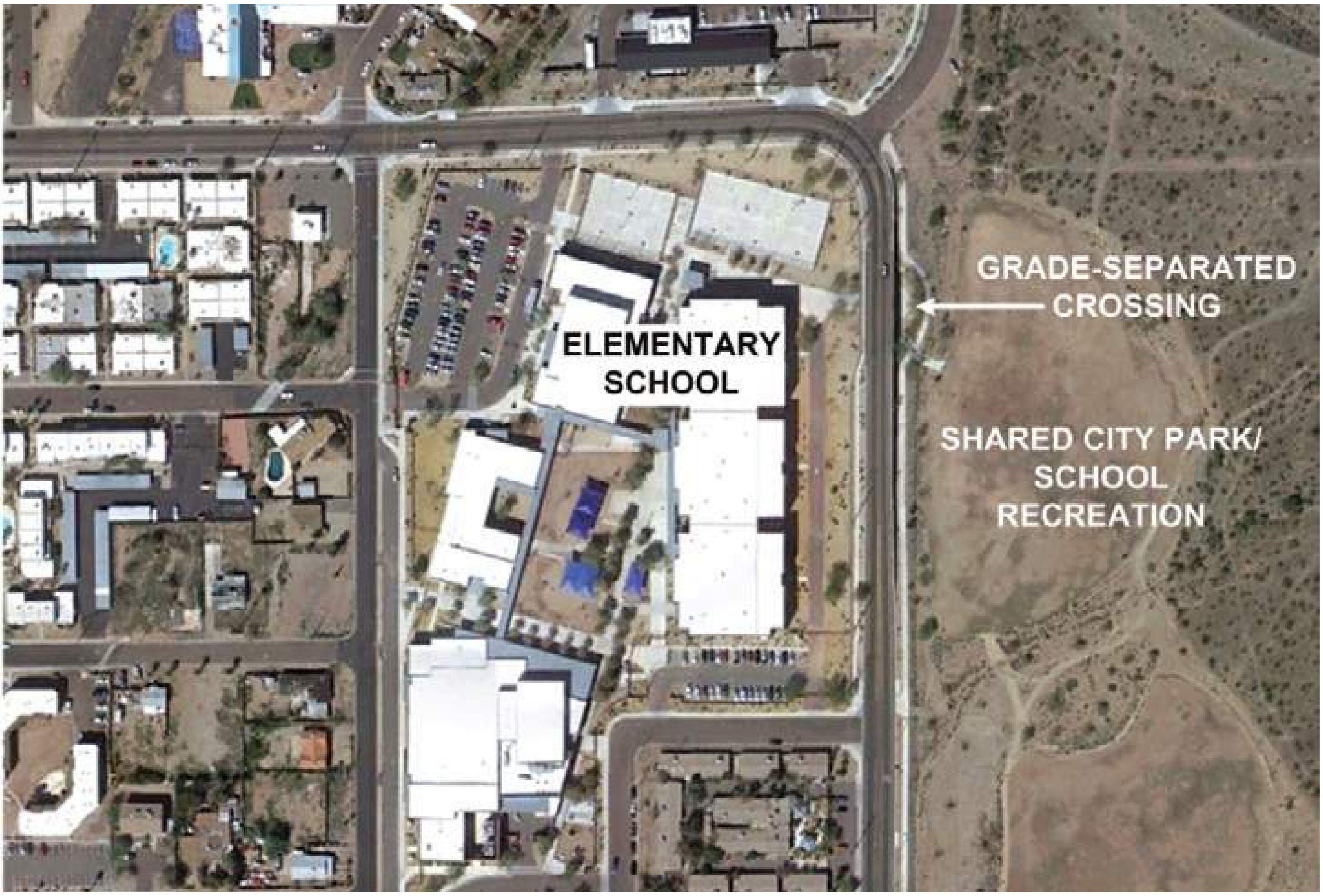


Figure 6-10. Grade-separated pedestrian crossing between a school campus and recreation area
Source: Google Earth

6.10 Campus Security

Security has become a primary concern for many schools and has the potential to affect a school's transportation facilities and systems. Extreme security plans can impede the walkability of the campus and directly interfere with a school's connection to the community. Careful consideration of the real threats and opportunities within the environment can result in a safe, coordinated system that allows for multiple uses of the facility.

Careful consideration of the real threats and opportunities within the environment can result in a safe, coordinated system that allows for multiple uses of the facility.

Security issues can change dramatically with the age of the student population. Although custody issues have brought new concerns about outside threats in elementary and middle schools, the primary concern is keeping students contained within the campus. Because of U.S. Individuals with Disabilities Education Act regulations, most schools now include students with varying needs. Some younger students or those with emotional or mental disabilities may require constant supervision and barriers to keep them safely on campus. Additionally, the risk of danger to a child with disabilities leaving campus is significantly greater if that campus is adjacent to high-speed, high-volume streets.

Many children would walk to school if given the opportunity and access. A perimeter fence with gated openings at locations convenient to walking students can allow access before and after school, but can be locked to limit access during the school day and at other times, when needed.

Most elementary schools limit access to the campus to one location during the day; therefore, the primary concern is limiting pedestrian access. Accordingly, parking areas are typically left outside the perimeter fencing and become barriers to access. Security issues in a middle school or high school setting are somewhat different. Although there is still concern about students leaving campus, the risk is less immediate. Securing access to and throughout the campus is far more important. In particular, high schools frequently attempt to limit access to both vehicles and pedestrians. Perimeter fencing is frequently used for the building area, but many middle and high schools also include a security gate for vehicular access as part of that perimeter. This is partly a result of parking limitations, but is also an attempt to limit outsider access to the student body. In this case, it is very important to provide adequate queuing distance between the gate and the street to accommodate at least two vehicles, and a pass-through area to provide a temporary vehicle storage area if, for example, a vehicle requires closer inspection without impeding access to the campus. Using removable bollards can assist in this operation. Security at the pedestrian level is controlled by clear visual sight lines for all open areas around the front of the school and ubiquitous fencing in areas that are not as easy to monitor.

The unfortunate side effect of excessive campus security can be an unwelcoming facility. Security may be enhanced through a system of cameras throughout the campus and school exterior that can be viewed in the central school office. Barriers might be used around the exterior of buildings or might allow for access to individual buildings without allowing access to the entire campus. This approach is particularly effective for rental of school buildings outside normal school hours, which

…potential public use should be considered as the school parking location and site access are designed.

can provide an additional income for the school and may be a good use of public facilities. Therefore, potential public use should be considered as the school parking location and site access are designed. If the school intends to allow extensive use of its gymnasium, auditorium, or cafeteria, pedestrian access, bicycle parking, and private vehicle parking should be allotted close to those locations to make their use more attractive.

6.11 References

1. Cooner, S., et al., *Traffic Operations and Safety at Schools: Recommended Guidelines*. Texas Transportation Institute for Texas Department of Transportation, Report Number 4286-2. October 2003. Available: http://tti.tamu.edu/documents/4286-2.pdf. (June 5, 2012).

2. Qualls, D. "Strategies for the Greening of Student Pick-Ups at School." November, 2010, accessed May 10, 2012 at www.ite.org/annualmeeting/compendium10/pdf/AB10H2704.pdf.

7. SCHOOL AREA TRAFFIC CONTROL

7.1 School Walk and Bike Route Maps

The first step in establishing a traffic control plan for a school area should be the creation of a Walk and Bike Route Map for the students. This process is critical to determine the best student crossing locations, as well as identify the locations where it is likely students might be tempted to cross, whether those locations are desirable or not. Ideally, the Walk and Bike Route Map is based on input from parents, school officials, and staff from the local jurisdiction. Students are also encouraged to get involved in the process to identify the most desirable routes. The recommended walking plan is used to identify the best walking routes and most desirable crossing locations for students, as well as any deficiencies along the routes. The mapping process is also helpful to evaluate the need for school traffic control and the placement of adult crossing guards and sidewalk/driveway monitors. After the walking routes and desirable crossing locations are determined, the rest of the traffic control around the school can be determined, including crossing guards and school monitors locations. Walking and bicycling route maps are most appropriate for elementary schools and may be used for middle schools, but these maps typically are not used or appropriate for high schools.

Examples of deficiencies along the walking route include missing sidewalks, missing or non-compliant wheelchair ramps, and overgrown vegetation obstructing walkways.

The local transportation authority, school officials, and parents ideally should be involved in the process to create a Walk and Bike Route Map, but police input is also desirable. The walking attendance boundary for the school should be obtained from the school district to ensure all students who are expected or encouraged to walk are taken into consideration in the map. This is a good time to review the walking attendance boundary to determine if adjustments should be made. After the walking attendance boundary is identified, a walkabout should be performed by teams of individuals provided with area maps to identify existing traffic control, as well as walking and crossing deficiencies along the route. Those involved in the "walkabout" or site assessment should include representatives from the schools, districts, cities/municipalities, parents, and students.

(Top) *Source: Michael J. Cynecki, Lee Engineering, LLC*

(Bottom) Figure 7-1. Sidewalk obstructions limit usable walking space for pedestrians
Source: Michael J. Cynecki, Lee Engineering, LLC

A quantitative assessment tool, such as the Walkability Checklist available at www.walkinginfo.org, could be used for these assessments.

Examples of deficiencies along the walking route include missing sidewalks, missing or non-compliant wheelchair ramps, and overgrown vegetation obstructing walkways. Overgrown vegetation is easily corrected, yet can create a significant concern by forcing pedestrians to walk in the street, as seen in **Figure 7-1**. The teams should also look for less obvious concerns, such

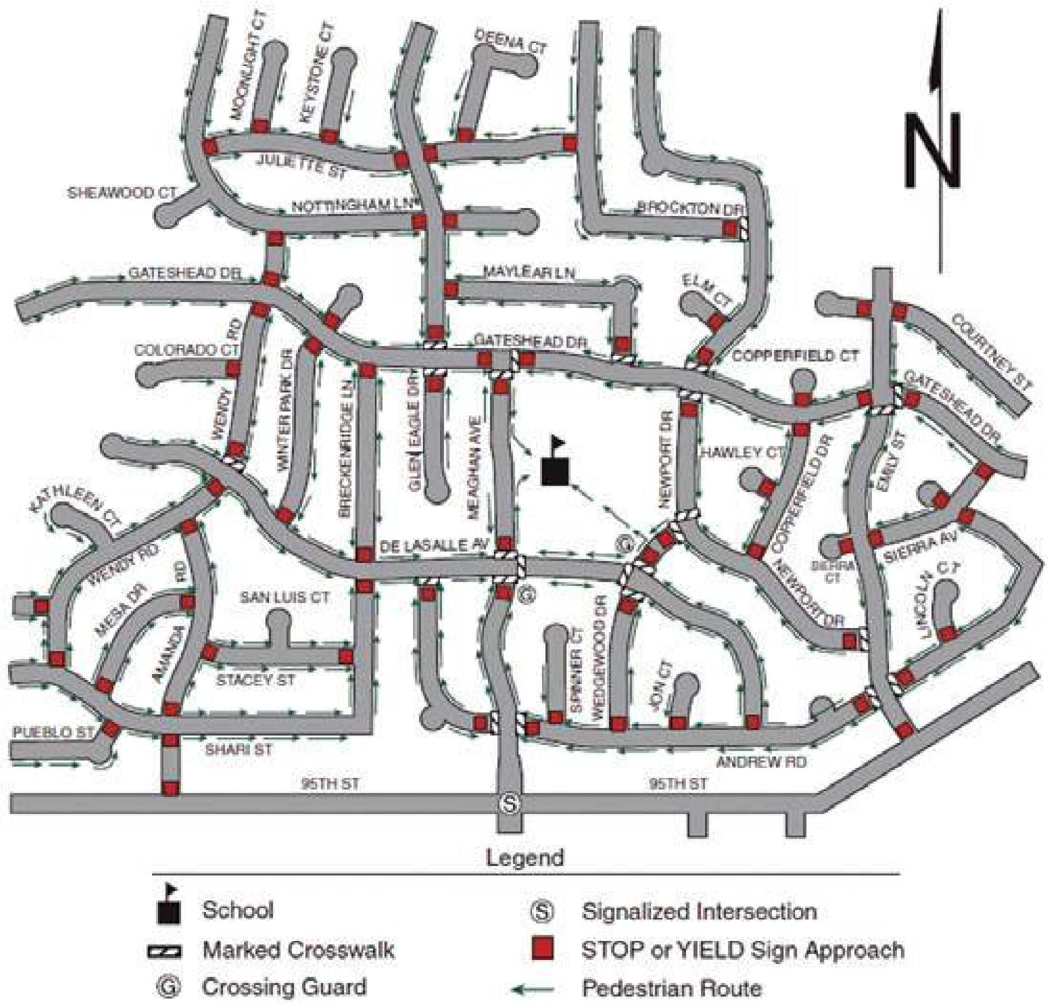


Figure 7-2. Example school route plan map from MUTCD
Source: MUTCD

as poor street lighting, vacant properties, and stray animals, to name a few. This process should also identify challenging street and driveway crossings for students, and the review of the walking/bicycle routes should include the pedestrian entrance(s) to the school buildings and the location/placement of bicycle racks. Where possible, some of the deficiencies should be documented through photographs. Each item identified may be identified on a map for follow-up action.

Following the evaluation of the entire walking boundary, the walking routes can be drawn on maps directing students toward the school from every residential property within the walking boundary. Each map should show every intersection where a student is directed to cross a street. The walking/bicycling routes should minimize the number of crossings, especially busy street and driveway crossings, and minimize walking along busy or high-speed arterial streets. The recommended walking/bicycling routes should utilize existing traffic control such as traffic signals, STOP signs, and crosswalks for crossing locations, where practical. Alternatively, traffic control may be adjusted to best accommodate the recommended school crossing locations.

This process should identify the locations where special school-related traffic control, such as school crosswalks and other associated signing and striping, are the most appropriate. The final decision on the placement and extent of traffic control is made by the local transportation authority, but it is helpful to solicit the opinions of the school district and parents for buy-in and support. Additionally, this process may help school authorities identify the most appropriate placement of bike parking facilities.

Examples of school walk and bike maps are shown in **Figures 7-2** through **7-4**.

Walk and Bike Route Maps should be reviewed periodically to take into account changing walking boundaries, new development, and maintenance. It is desirable for the school walk and bike maps to be maintained by the local agency or the school district. In this way, when a principal or assistant principal leaves

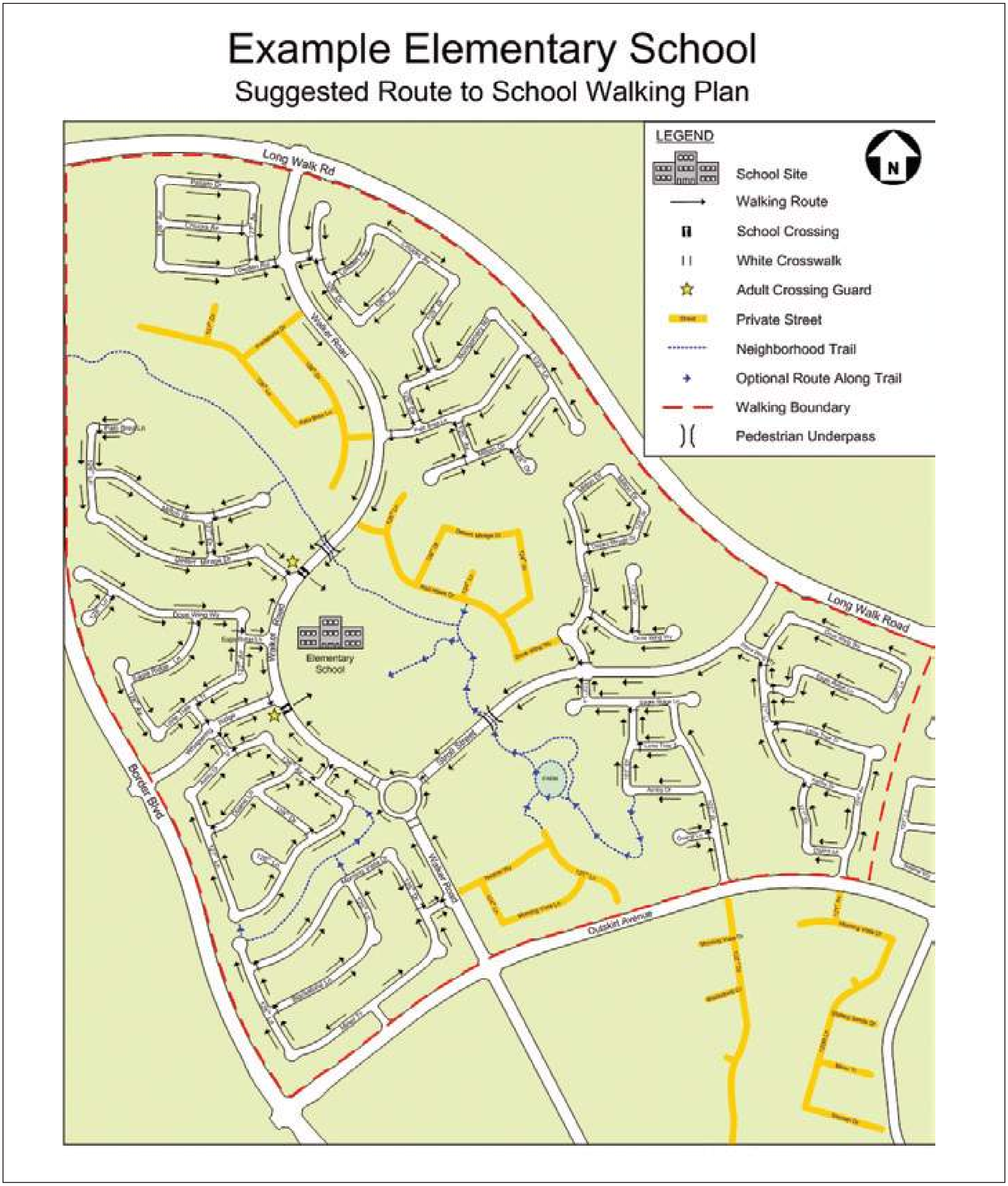


Figure 7-3. Example "Suggested Route to School Walking Map"
Source: Brandon Forrey, City of Peoria, Arizona

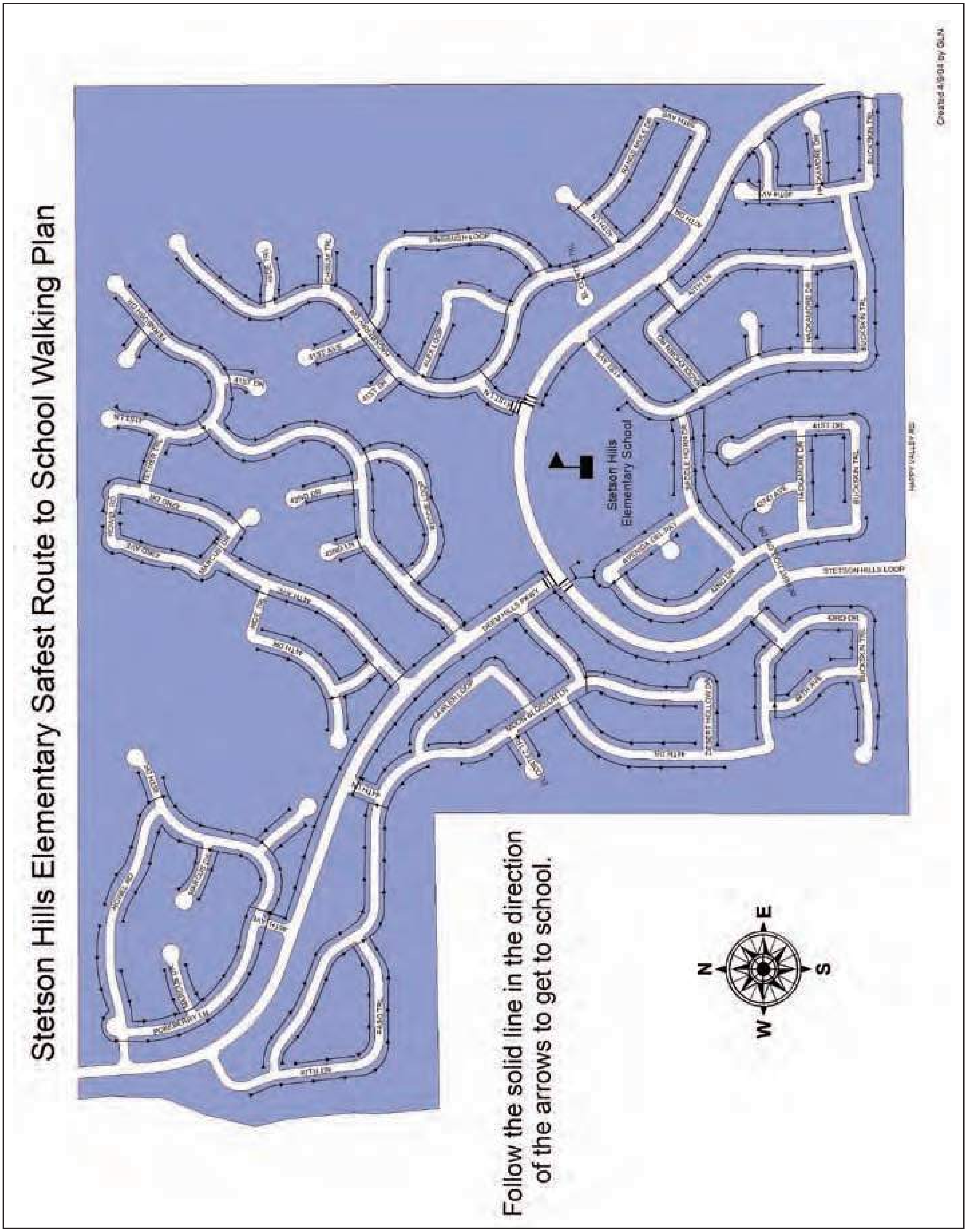


Figure 7-4. Example "Safest Route to School Walking Plan"
Source: City of Phoenix, Arizona

a school, the walking/bicycling route map will be retained and can be better maintained. Copies of the map should be made available to parents and students through the Internet or as hard copies at the start of each school year to reinforce the recommended walking and crossing locations. When new students enroll at the school, their parents should be provided copies of the recommended school walking/bicycling map as well. Additional information may be added to the map, such as estimated walk times and marked Walking School Bus routes, where they exist (for more information on Walking School Buses, see Section 8: Methods to Minimize Peak School Traffic Congestion).

Figure 7-5: Advance school warning sign
Source: Brandon Forrey, City of Peoria, Arizona

7.2 Traffic Control Devices

7.2.1 Traffic Signs

The *Manual on Uniform Traffic Control Devices* (MUTCD) in the United States and the *Manual on Uniform Traffic Control Devices for Canada* (MUTCDC) provide guidance on the use of school-related signs. For the purpose of this document, all references are to the MUTCD used throughout the United States. In addition to the federal guidance, state and local authorities may establish more extensive guidelines.[31] Some jurisdictions provide for special traffic control revisions in their state-adopted manuals, such as the use of 15 mph speed zone crosswalks in Arizona in the U.S. The most basic sign for any K–12 school is the advance school warning pentagon sign (S1-1), which the MUTCD states shall be a fluorescent yellow-green color (**Figure 7-5**). These signs may be supplemented with other school traffic signs. Some agencies are also using reflective post covers to supplement the school pentagon signs, especially for wide or high-speed arterial streets where there is considerable competition for driver attention.

There is a direct relationship between traffic speed and the likelihood of a serious injury or death of a pedestrian in the event of a collision. It is desirable to minimize speeds at school crossings to increase the likelihood a driver will slow and yield to a pedestrian, and to minimize the severity of injury if a collision occurs. The MUTCD allows for reduced speed limits at schools, especially when children are crossing to and from school or when school is in session. There are a variety of ways this can be accomplished; examples are shown in **Figure 7-6**. These include:

- Reduced speed limits in effect during listed time and days (such as 20 MPH—7 AM TO 4 PM—SCHOOL DAYS or 25 MPH 7–9 AM, 3–4 PM / SCHOOL DAYS);
- Reduced speed limits when flashers are activated (such as 25 MPH WHEN FLASHING signs);
- Reduced speed limits when children are present; and
- Reduced speed limits in effect when signs are placed in the street.

Figure 7-6. Four different reduced speed limit concepts for schools
Source: Michael J. Cynecki, Lee Engineering, LLC

There are advantages and disadvantages to each method. The reduced speed limit using static signs listing a time of day when the lower speed limit is in effect and SCHOOL DAYS requires drivers to know the exact time of day, and if school is in session on that day. The signs must be able to command the attention and respect of approaching motorists and should be kept in good condition and clear of obstruction from trees, bushes, and other obstructions. If the school crossing times change, the times listed on the signs need to be changed as well. Reduced speeds accompanied by flashing beacons need to be programmed to accurately reflect the days and times when school is in session or when crossings occur.

If a half-day is scheduled, the flashing beacon must be changed to reflect the shorter school day. If the beacon is not flashing, the old speed limit remains in effect. Additionally, power outages, may pose an unexpected problem. Similarly, electronic speed limit signs may be preset to display a reduced school speed limit during crossing times or during the school day. Once again, the reduced speed limit times must reflect the school schedule and may have to be reprogrammed each calendar year if the school schedule changes. This might be beyond the capability of some agencies that have many schools to track. Additionally, electronic signs/flashers in remote areas may be very expensive to install and maintain. Solar-powered devices may not work well in all parts of North America and may require back-up batteries that need to be checked and replaced occasionally.

More sophisticated flasher systems may be controlled from a central location or by using cellular phone technology, which may make adjustments to flasher start and end times easier. Even when remote operation is utilized, field verification should still be used to verify the devices are functioning properly. Reduced speed signs placed daily by local or school officials, such as the crossing guard, are more labor-intensive and require the signs be reset and removed daily. Portable signs can be a very effective and flexible method to reduce speeds, reflecting changes in the school schedule from day to day, although staff members will be exposed to traffic when placing and removing the signs from the street.

Electronic signs must have a high level of maintenance. If the electronic sign is not operating, it should be repaired or replaced promptly. Extra electronic signs or components should be retained as spares or should be readily available through a vendor to provide a high level of uninterrupted operation.

Advance signs may be used to alert motorists when they are approaching a reduced school speed limit. Additionally, the reduced school speed limit should typically not be more than a 10 mph (16 kph) reduction from the normal speed limit or compliance will be low. School reduced speed limits must be reasonable to motorists to command respect and have a high level of voluntary compliance. Speeds that are unrealistically low, are in effect for an excessive portion of the day, or include an over-extended length of roadway are usually ignored by drivers and will be difficult for police to enforce. An excessive number of reduced speed school zones or closely spaced reduced school speed limits will also require excessive police enforcement and should be avoided. Some jurisdictions have laws to govern the use of reduced speed zones at schools that supplement the MUTCD. Consistent application of reduced school zones will result in a higher degree of driver compliance.

Turn restrictions or other traffic restrictions such as DO NOT ENTER signs at school driveways should be used judiciously.

Other signs that are not specifically school-related are often essential components of school area traffic control, such as parking restrictions or School Bus/Student Loading Zone signs. NO PARKING signs alone might not be enough to prevent parents from dropping-off or picking-up students. In some cases, NO STOPPING, STANDING, or PARKING signs may be required to exclude vehicles from stopping along the curb for any duration—eliminating any possibility of dropping off or picking up students. Conversely, the example in **Figure 7-7** shows a NO PARKING—STUDENT LOADING ONLY sign with an additional message DRIVER MUST REMAIN IN VEHICLE, with the intent of allowing vehicles to queue on-street for the student drop-off/pick-up area while prohibiting vehicles from parking along the curb and disrupting the loading queue. In this case, the additional message is needed because the state traffic code definition of parking includes standing and stopping.

Parking restrictions should be considered at locations where parent parking or student loading would create undesirable conditions, such as the side of the street opposite the school, close to crosswalks or driveways, and at locations on the approach to STOP signs, fire hydrants, or intersections. However, special care must be taken not to eliminate all available on-street parking, especially if the school parking lot cannot accommodate all parent, teacher, and visitor vehicles.

Similarly, turn restrictions or other traffic restrictions such as DO NOT ENTER signs at school driveways should be used judiciously. This is particularly true when a turning movement either creates a conflict or some other undesirable condition when other movement options are available for parents and school guests. If any regulation is overly restrictive and alternative options are not readily available, motorists, especially parents, will ignore the restrictions. If a majority of parents ignore the traffic restrictions, it may not be possible for police to adequately enforce the restrictions.

School authorities should consult with local transportation officials or a professional transportation engineering consultant before manufacturing traffic signs for use on the school campus, to ensure the sign size, design, and placement is appropriate. This could prevent unnecessary expenditures resulting from replacement of inappropriate, unclear, or unusual private signs.

Figure 7-7. Custom parking restriction sign
Source: Michael J. Cynecki, Lee Engineering, LLC

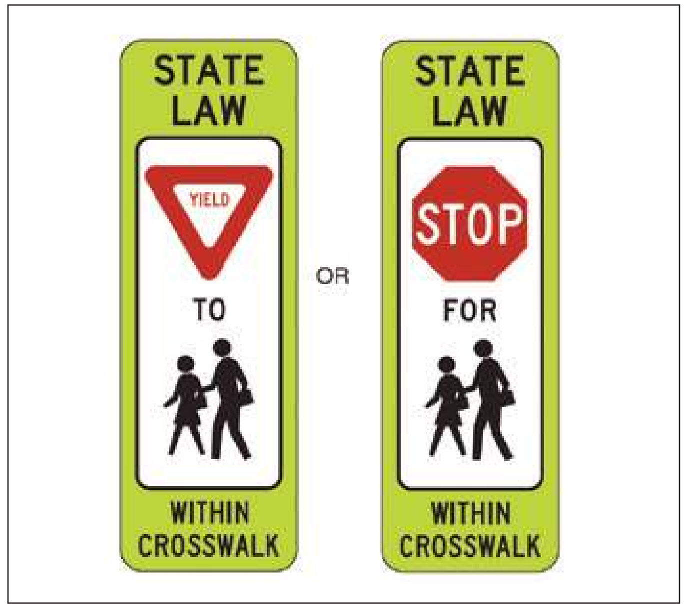


Figure 7-8. In-street school crosswalk signs
Source: MUTCD

Some parking restrictions that are relevant during school crossing times should not be in effect during evening hours or other times when on-street parking is in high demand, such as parent-teacher conferences, school open houses, and other special events such as concerts and fairs. Furthermore, many youth sports leagues use school athletic fields during weekends and after school hours, requiring a commensurate amount of on-street parking.

Parking and other traffic restrictions around schools should not be overly complex or difficult to understand. A sign with multiple restrictions or messages might be confusing to motorists and is more likely to be ignored or misunderstood.

In most cases, ground mounted signs on the right side of the road are sufficient. In some cases, supplemental signs mounted on the left side of the road, such as in a median, or overhead mounted signs, might be desirable to draw motorists' attention. Overhead mounted signs can be particularly helpful when advance warning is needed on a high-speed or multi-lane arterial street, having three or more approaches in one direction, where visibility on the approach to the school or school crossing is limited.

The MUTCD allows in-street signs that have application for use at school crosswalks, shown in **Figure 7-8**. In some cases, these signs can be placed by crossing guards at the start of student crossing and removed after crossings have been completed. Sometimes, orange traffic cones also may be used in the same manner by crossing guards to bring driver attention to a crosswalk. Some agencies have used permanent in-street crossing signs at select crosswalks that are designed to flex under vehicles, if hit, and rebound back into position (for a limited number of strikes). Additionally, permanent in-street signs may not be practical in many areas of North America due to the need for snow removal.

7.2.2 Crosswalks

Many state and provincial laws typically define legal crosswalks as existing at all sidewalk extensions across the street at an intersection of two public streets, whether marked or not. However, marked crosswalks often are helpful at schools to designate precisely where students should cross. Crosswalk markings are covered in the MUTCD Section 3B.18 and 7C.02.[1] A school walking plan can and should be used to identify where marked crosswalks are placed along the school walking routes. In some cases, creating a school walking plan may result in the removal of crosswalk markings at locations where it is not desirable for school children to cross. There is no need to mark all crosswalks on the school walking plan; only the important crosswalks need

Ladder/high-visibility crosswalk
Source: Michael J. Cynecki, Lee Engineering, LLC

be marked. To some extent, the number of marked crosswalks in a school walking plan is related to the local agency's ability to mark the crosswalk and maintain the markings. Furthermore, there should be uniform application of marked crosswalks for all schools within the agency.

There is little controversy about the marking of crosswalks controlled by STOP signs and at traffic signals; therefore, typically it is desirable to mark all crosswalks at traffic signals and stop-controlled intersections where students cross, near schools, or at crossings monitored by a crossing guard. The markings will typically encourage the students to cross at the STOP signs or traffic signals instead of crossing immediately downstream from the traffic control device. The controversy about marking crosswalks relates to uncontrolled crosswalks.

…typically it is desirable to mark all crosswalks at traffic signals and STOP controlled intersections where students cross, near schools, or at crossings monitored by a crossing guard.

A study conducted by Charles Zegeer for FHWA[2] concluded there is little safety advantage or disadvantage to mark crosswalks on most two-lane roads. However, where speeds are 40 mph (64 kph) or greater or for multilane streets with higher traffic volumes (12,000 ADT or more), the crosswalk markings alone will not result in safer conditions for pedestrians. The study concluded that *more* than just the painted crosswalk is needed to allow the crossing with an acceptable level of safety on these streets. These additional measures might include raised pedestrian crossing islands, STOP signs, crossing guards, a narrower street crossing, flashing beacons, or traffic signals.

Most local streets inside neighborhoods should be acceptable for marked crosswalks, if considered desirable by the local agency. If a crosswalk is marked, it should have appropriately designed, ADA-compliant, accessible wheelchair ramps on both ends, and they must be contained within the crosswalk lines. Raised medians will also require wheelchair ramps or a cut-through crossing to accommodate persons in wheelchairs, which will also accommodate pedestrians with strollers, persons walking bicycles across the crosswalk, or any other users.

Crosswalk markings may be the standard parallel white lines or a high-visibility marking (zebra pattern, ladder markings, or the continental design) as shown in **Figure 7-9**. Some jurisdictions mark all crosswalks with a high-visibility pattern. When ladder style or continental markings are used, the markings can be strategically positioned to avoid aligning the white lines with the vehicle tire paths; that will allow the markings longer life.

Other agencies prefer to reserve use of high-visibility markings to provide extra emphasis at busy crossings, midblock crossings, or at school crossings. Regardless, the agency needs to have a program for consistent application of markings. Ideally, crosswalk markings should be checked annually to determine if they need

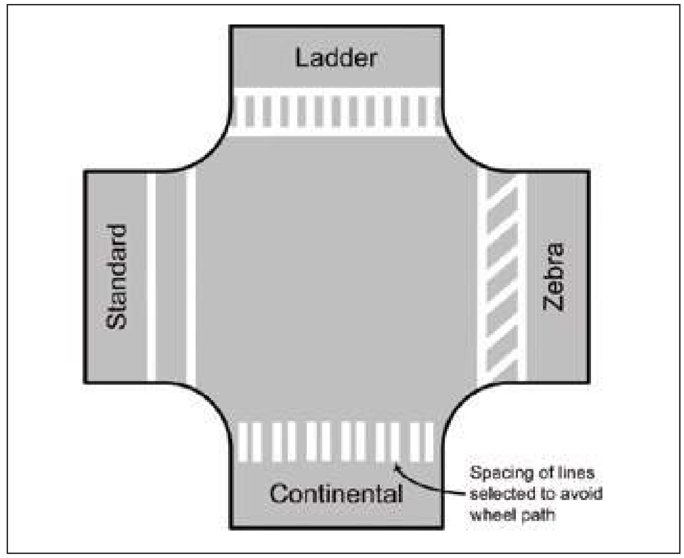


Figure 7-9. Various crosswalk marking patterns allowed by MUTCD
Source: Brandon Forrey, City of Peoria, Arizona, based on an MUTCD figure

to be remarked. Longer-lasting marking materials such as thermo plastic, cold plastic, or epoxy paint are preferable for painted crosswalks to provide the markings longer life. In most cases, special crosswalk materials such as thermoplastic or cold plastic have little-to-no dry time, which means less disruption to traffic during crosswalk installation or maintenance.

Other types of crossings for arterial streets at uncontrolled locations include staggered or off-set crossings, which direct pedestrians to a central island (**Figure 7-10**). Typically, a fence is placed in the central island to require pedestrians to turn to the right to face oncoming traffic before crossing the second half of the street. This design results in pedestrians crossing only one half of the street at a time to a central area of refuge, and is more like crossing two one-way streets. The crossing islands must be carefully located to avoid creating left-turn conflicts with side-streets and driveways.

7.2.3 Other Pavement Marking

Advance stop lines or yield lines (MUTCD Section 3B.16[33]) may be used to address multiple-threat pedestrian crashes at uncontrolled crosswalks on multilane streets. When used for this purpose, yield or stop lines are normally placed 20 to 50 feet (6.1 to 15.24 meters) in advance of the nearest crosswalk line at an uncontrolled crosswalk to cause motorists to stop or yield further from the crosswalk. This will allow better visibility between the pedestrian and the vehicle in the adjacent traffic lane. The advance lines should be accompanied by a YIELD (or STOP) HERE FOR PEDESTRIANS sign (R1-5 or R1-5a) for improved driver compliance. The specific sign text (YIELD or STOP) must compliment the wording of the individual state law. The shark-teeth advance yield line is shown in **Figure 7-11**. Pedestrians should be taught to cross one lane at a time and to make sure traffic stops before entering each lane.

Figure 7-10. Two-stage crosswalk and pedestrian safety island
Source: Michael J. Cynecki, Lee Engineering, LLC

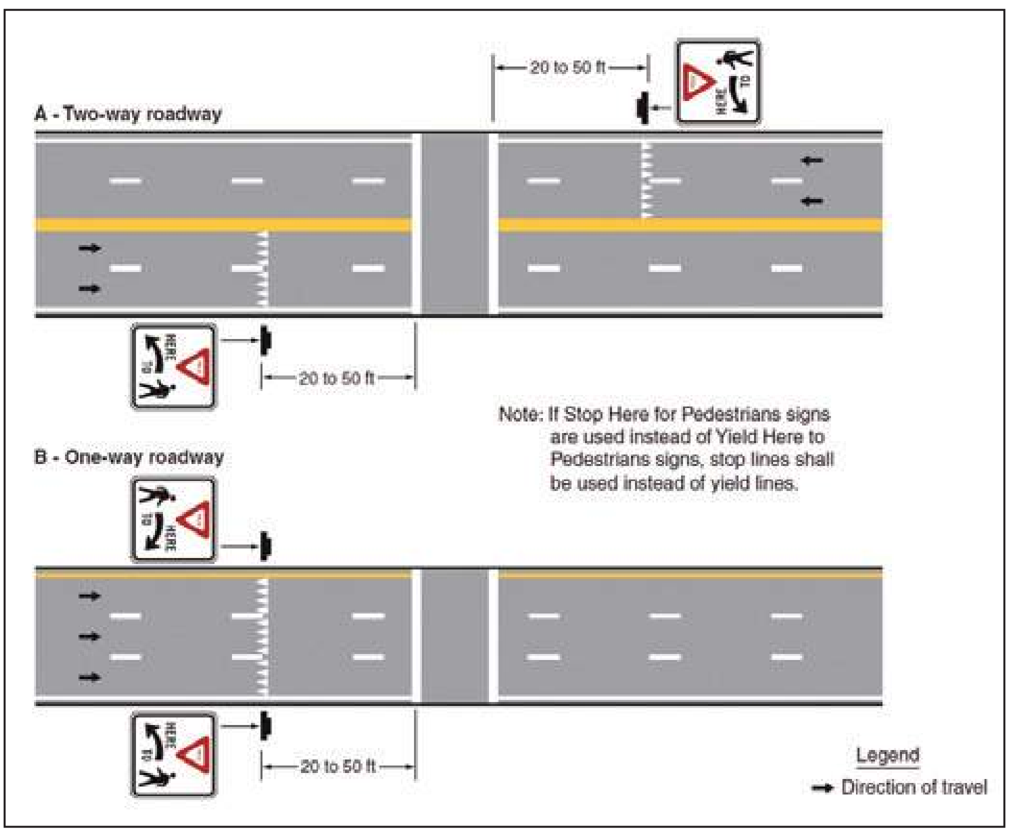


Figure 7-11. Shark-Teeth Yield Line and YIELD HERE TO PEDESTRIANS signs from MUTCD
Source: MUTCD

(Top) Figure 7-12. SCHOOL pavement stencil
Source: Michael J. Cynecki, Lee Engineering, LLC

(Bottom) Figure 7-13. A student and parent waiting behind a "stand-back" line at a crosswalk
Source: Michael J. Cynecki, Lee Engineering, LLC

SCHOOL pavement stencils are an optional tool that can be effective to communicate to drivers on an arterial street approaching a school or school crossing. Pavement word and symbol markings are covered in Section 7C.03 of the MUTCD[3] The SCHOOL pavement stencil, when used, is placed in each approach lane to the school or school crossing, but also can be used in larger letters across two lanes at a time. Typically, pavement stencil letters will be eight feet (2.4 meters) tall, but if the SCHOOL stencil is across two lanes, the letters must be 10 feet (three meters) tall. Word and symbol pavement markings are to be white unless there is an exception in an adopted state manual. A typical application of a SCHOOL pavement stencil is shown in **Figure 7-12**.

While pavement stencils are very effective because they are placed directly in the drivers' path, they can be covered by snow during the winter months for most of North America and, thus, are rendered ineffective. Furthermore, placement and maintenance of pavement stencils puts the agency maintenance staff at risk. Pavement stencils should be reviewed annually for maintenance needs and typically are not needed on local streets or collector streets inside neighborhoods.

Ideal placement of the SCHOOL pavement stencil is in conjunction with the S1-1 advance school warning sign or at the sign designating the start of a reduced speed school zone. Other optional pavement stencils may include a speed limit designation or STOP regulatory message or PED XING or STOP AHEAD warning stencil.

7.2.4 "Stand-Back" Lines

"Stand-back" lines are not traffic control devices and are not in the MUTCD, but are simply lines painted on the sidewalk on the approach to a crosswalk where there is a need to keep students back from the traffic. They are a good tool for crossing guards to use when directing students where to stand. "Stand-back" lines also may be used at busy driveway crossings or at crossings where guards are not used, as long as the students are directed to wait for crossing opportunities behind the line (**Figure 7-13**). "Stand-back" lines might be painted four to 10 feet (1.2 to three meters) back of the curb, depending on available sidewalk space, to provide a separation between students and moving traffic.

Additionally, "stand-back" lines may be used along student vehicle loading or bus loading areas to maintain a separation between the vehicles and students. The lines alone will not change student behavior, so the students must be taught to stay behind the painted line before boarding vehicles, but the lines are an aid for parent and teacher volunteers/monitors.

"Stand-back" lines are most appropriate at elementary school crossings at busy collector and arterial street crossings, but may also be helpful for middle school students.

7.2.5 Curb Markings

Curb markings are used to designate no parking zones and may be used to designate student loading areas. Signs shall be used with curb markings in those areas where the curb markings are frequently obliterated by snow and ice accumulation unless the no parking zone is controlled by statute or local ordinance.[33] Typical red curb areas are at fire hydrants, and on a specified distance to the approach to STOP sign, driveway, or crosswalk. Curb markings also may be used to help delineate raised median curbs at islands. Under these circumstances, the curb marking paint should be retroreflective and may be supplemented by raised reflective pavement markings.

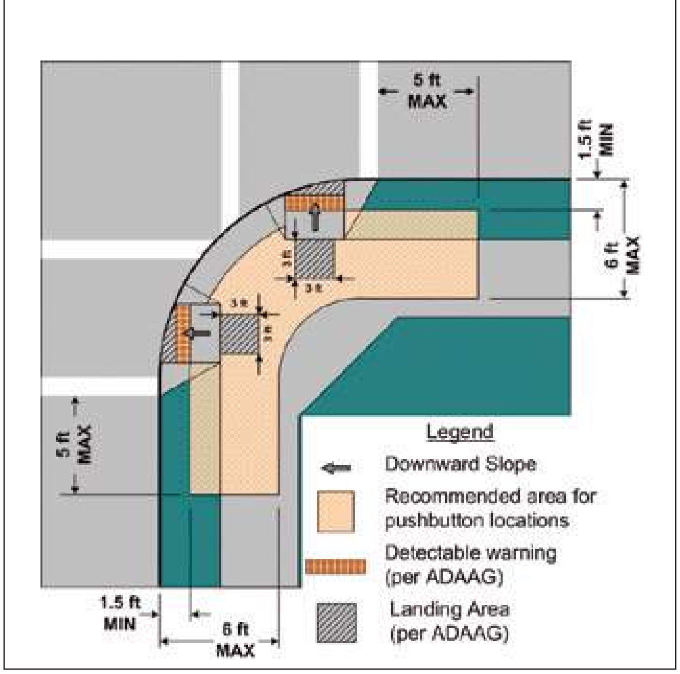


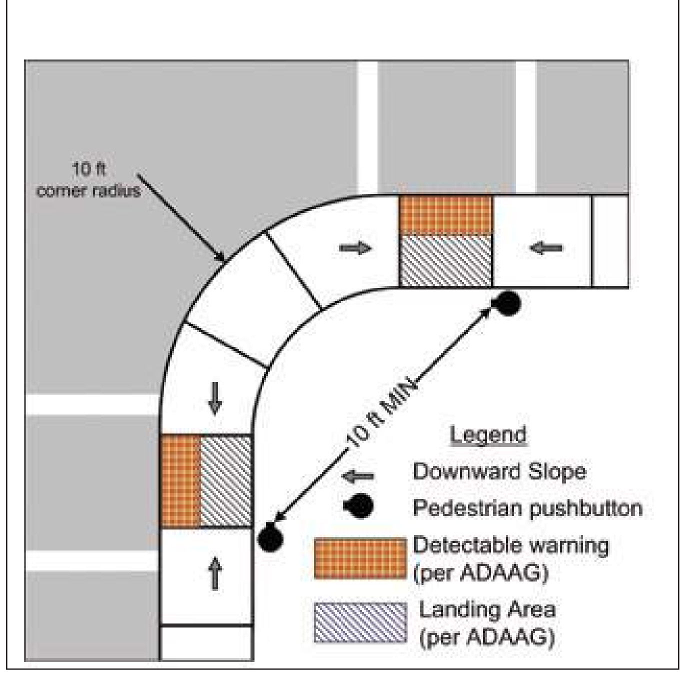
Figure 7-14. Recommended push button areas based on MUTCD Figure 4E-3
Source: Brandon Forrey, City of Peoria, Arizona, based on MUTCD

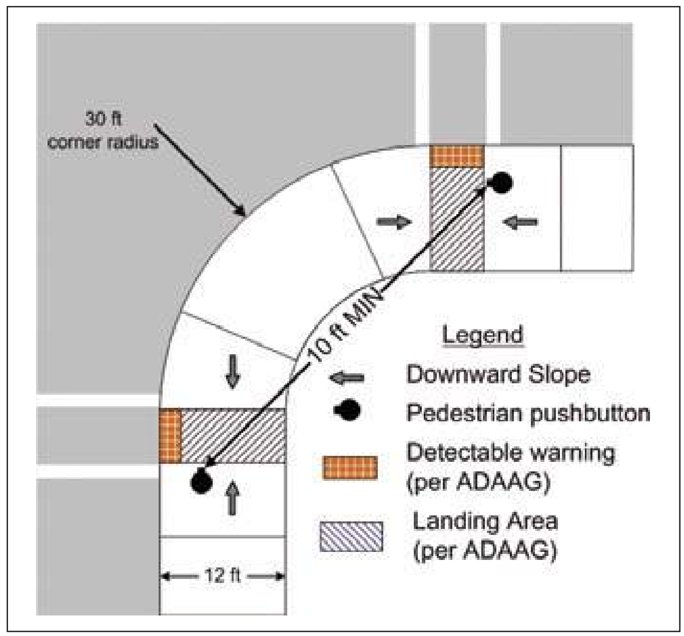
7.2.6 Traffic Signals

Traffic signals may be needed at schools or school crossings located on certain arterial or busy collector streets, for both drivers and pedestrian crossings where warranted. There are eight warrants contained in the MUTCD that may be used to justify installation of a traffic signal. Warrant 5 (Section 4C.06) can be used for evaluating traffic signals at school crossings.[3] Just because a signal meets a warrant does not mean a traffic signal should be installed. Instead, a traffic signal *should not* be considered for installation unless one or more of the warrants has been met.

The MUTCD specifies the engineering study of roadway, traffic, and other conditions to be used for evaluating locations for traffic signals. Since vehicular delay and the frequency of some types of crashes sometimes are greater under traffic signal control than under STOP sign control, consideration should be given to providing alternatives to traffic control signals even if one or more of the signal warrants are met as stated in Section 4B.04.[3]

Traffic signals should be equipped with pedestrian signals with countdown signal indicators. Vehicle signal indications do not give adequate notice of the clearance (amount of time left to cross) for pedestrians before the crossing interval ends. New traffic signals or signal upgrades should use the walking person/raised hand symbols for pedestrians. Push buttons may be used to call the crossing interval at traffic actuated or semi-actuated signals, although continuous service is provided to pedestrians with fixed-time signal operation where a crossing interval is provided every signal cycle. Some pedestrians are not aware they need to use a push button to call the WALK signal, and sometimes the buttons are poorly placed, which hinders their use. If used, pedestrian push buttons should be located consistently close to the crossing location, no more than six feet (three meters) behind the curb and within five





(Top) Figure 7-15. Recommended push button placement based on MUTCD Figure 4E-4C
Source: Brandon Forrey, City of Peoria, Arizona, based on MUTCD

(Bottom) Figure 7-16. Recommended push button placement based on MUTCD Figure 4E-4B
Source: Brandon Forrey, City of Peoria, Arizona, based on MUTCD

feet (1.5 meters) of the crosswalk extension into the sidewalk as shown in **Figure 7-14**. If there are physical constraints that make it impractical to place the pedestrian push button within six feet of the edge of the curb, it should not be farther than 10 feet. If pedestrian push buttons are used to call the crossing interval for both streets at an intersection, they should be located at least 10 feet (three meters) apart at the corner, as shown in **Figures 7-15** and **7-16**, based on the MUTCD. Also refer to National Cooperative Highway Research Program Project 3-62, *Guidelines for Accessible Pedestrian Signals*, which is being carried out by the Transpor-

Figure 7-17. Countdown pedestrian signal
Source: Michael J. Cynecki, Lee Engineering, LLC

tation Research Board (www.apsguide.org) and the proposed PROWAG (Public Right of Way Accessibility Guidelines) for accessible pedestrian traffic signals (www.access-board.gov/prowac) for additional details on pedestrian signal and push button design.

When traffic signals are used, the preferred traffic signal features should include:

- Marked crosswalks for all crossings at the signal, even if the School Walk and Bike Route Map uses only one to three of the crossings at a four-leg intersection.
- Stop lines or wider crosswalks on all four legs at the signal. Crosswalks at busy crossings may be 15 to 20 feet (4.6 to 6.1 meters) in width to accommodate large numbers of students at the crossing.
- Two wheelchair ramps at each corner to provide better alignment for pedestrians and to keep the students further from the center of the curb return.
- Large landings on all four crossings. The landings should be large enough to accommodate larger numbers of students waiting at the signal so the students are not crowded up against the curb.
- Tighter curb returns at the corners, which result in shorter crossings and slower vehicle turning speeds. The corner curb returns should be large enough to accommodate the predominate types of vehicles, but need not be so large as to accommodate the largest vehicle expected at the intersection.

The MUTCD recommends traffic signals should have a minimum of seven seconds of WALK (Walking Person) time to start pedestrian crossings but for school crossings, longer intervals are desirable. Clearance intervals (flashing UPRAISED HAND indication) are currently based on a 3.5 feet per second (1.07 meters per second) walking speed, but slower intervals may be needed if walking speeds are slower. For wide street crossings, it is beneficial for two or more adult crossing guards to monitor the intersection, one on each side of the street, so the guards have sufficient time to be the first people in, and the last out, of the street at a traffic signal. Regardless, the crossing guard should not extend the crossing time against the signal indications. Instead, the guard should require students to wait for the next WALKING PERSON signal if the flashing UPRAISED HAND indicator is activated and students have not entered the street.

Other features that may be employed at traffic signals to improve conditions for students include:

- If there is a heavy turning movement, a leading pedestrian interval may be used to allow pedestrian crossings to start before the concurrent through and turning movements, allowing pedestrians to create a presence in the crosswalk. The leading pedestrian interval should provide three or more seconds of a head start for pedestrians before potentially conflicting vehicles are allowed to proceed. If an early pedestrian release is used, an accessible pedestrian signal should be considered along with prohibiting right turns on red.
- Restricting right-turn-on-red (RTOR) during school crossing times. While this restriction might help conditions at one crosswalk, it also might create more right-turn-on-green (RTOG) conflicts at the adjacent crosswalk. A study of vehicle pedestrian crashes found RTOG was associated with more pedestrian crashes than RTOR conditions.[4] This is not to infer RTOR is safer than RTOG, but if RTOR vehicle maneuvers are prohibited, the result may be more RTOG pedestrian-vehicle conflicts. Thus, each crossing should be evaluated individually to determine if the advantages outweigh the disadvantages.
- Countdown pedestrian signals (**Figure 7-17**) display the amount of time left during the pedestrian clearance interval and offer considerably more information to pedestrians, especially at wide street crossings. The countdown feature can only be used at the beginning of the pedestrian change interval, when the orange hand begins flashing. After the countdown displays zero, the display shall remain dark until the beginning of the next countdown.[5] The 2009 MUTCD requires all new pedestrian signal equipment to have the countdown feature if the pedestrian clearance interval is more than seven seconds.
- Accessible pedestrian signals that provide both an audible message and a vibro-tactile message to vision-impaired pedestrians when it is time to cross. Pedestrian push buttons can also be equipped with locator tones to alert vision-impaired pedestrians of the location of a signal push button.

Special signs may be used to educate pedestrians as to what the pedestrian signal indications mean and how to safely cross at the traffic signal, as shown in **Figure 7-18**. If a new traffic

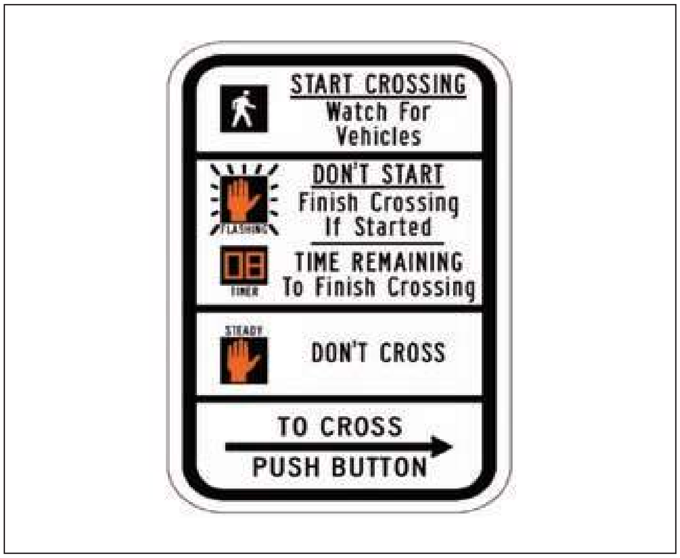


Figure 7-18. Countdown pedestrian signal instructional sign
Source: City of Phoenix

Figure 7-19. Reduced speed limit beacon
Source: Michael J. Cynecki, Lee Engineering, LLC

signal is installed at a school or school crosswalk, a representative from the local agency should meet with school officials to explain how the signal will operate and how students and parents should safely use the signal.

7.2.7 Other Traffic Control

Flashing Beacons

Flashing beacons are another option to supplement standard school or pedestrian warning signs to alert unfamiliar drivers of a school crossing, or to be used in conjunction with a reduced speed school speed limit (MUTCD Chapter 4L[5]). When used as a warning device, the beacons may be placed in advance or at the crosswalk and may also be used along the side of the road or over the road mounted on a mast arm. Yellow flashing beacons are most effective at school crossings where a large proportion of drivers are unfamiliar with the crossing, or if the crossing is not obvious to approaching motorists. If a warning beacon is placed over the roadway, the clearance above the pavement shall be at least 15 feet (4.6 meters), but not more than 19 feet (5.8 meters).[5] If the warning beacon has more than one signal section, they may flash either alternatively or simultaneously.

If used, an agency should have a uniform application of flashing beacons across the jurisdiction to treat similar crossing conditions in a similar manner. Agencies should develop warrants for beacon application. Flashing beacons should be in operation only during the school day or school crossing times. Flashing beacons that are active around the clock, seven days a week, can blend into the highway background and command little respect from motorists. Preferred methods of operation include push-button activation by pedestrians or crossing guards, automatic detection of pedestrians, or on a time-of-day clock that is coordinated with the school calendar to limit the flashing to school crossing times or the school day. Flashing beacons are rarely appropriate inside neighborhoods.

If used, flashing beacons should be well maintained and checked annually, along with the activation devices and/or the timer schedule and calendar to ensure they are operating properly. If an agency cannot afford to maintain flashing beacons, they should not be used.

Reduced Speed Limit Beacons

Reduced speed limit sign beacons (**Figure 7-19**) are described in Section 4L.04 of the MUTCD, and consist of one or more circular yellow signal indications, not less than eight inches (20.3 centimeters) in nominal diameter. If two lenses are used, they shall flash alternately.

If used, a local agency should develop a uniform application of these devices. Reduced speed limit beacons must be well maintained and activation should be limited to reflect the school crossing times and days. If a flashing beacon is used to indicate that a reduced school speed limit is in effect, and it is not operational, the normal speed limit is in effect. Reduced speed limit beacons must be checked regularly to ensure proper operation.

Applications of in-roadway light, sometimes referred to as flashing crosswalks, are provided in Chapter 4N[5] of the MUTCD. These are optional devices that may be used only at uncontrolled crosswalks, including school crosswalks, where traffic signals cannot be justified. They cannot be used at crosswalks controlled by traffic signals, STOP signs, or YIELD signs. If used, the in-roadway warning lights at crosswalks shall be used along both sides of the crosswalk and shall span its entire width. The lights can be no higher than 0.75 inches (1.9 centimeters) above the pavement surface and they are to be located

Figure 7-20. Electronic speed feedback sign
Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

in the area between the outside edge of the crosswalk line and 10 feet (three meters) from the outside edge of the crosswalk.

In-pavement lighted crosswalks are relatively expensive to install and maintain. If used, they should be checked regularly to ensure proper operation. They are typically pedestrian-activated through push buttons or automated detection, and it is desirable to give the crossing pedestrian an indication when the in-pavement lights are activated. If operated by pedestrian actuation, they should be timed to allow the pedestrian to cross the street (or to a refuge island) at a normal walking speed of 3.5 feet (1.07 meters) per second, but in areas where more crossing time is needed, a slower walking speed may be used.

Electronic Speed Feedback Signs

An electronic speed feedback speed sign (**Figure 7-20**) is another option an agency may consider to help control driver speeds near a school or school crossing. Typically, the electronic sign has a built-in radar speed detector and can be permanently installed or can be used as a portable speed device to circulate to several crosswalks. If an agency chooses to use these devices, a uniform practice of application or deployment is advisable. They should be used in conjunction with a speed limit sign and have the legend, YOUR SPEED XX MPH. Devices that provide a flash or other driver warning at a preset speed over the speed limit may provide better results. The feedback device should not show very high speeds beyond the posted speed limit to discourage improper driver behavior. This device is also more effective if the operation is limited to school crossing times or the school day and should be used in conjunction with a police enforcement program. If used, the agency should commit the resources to maintain the electronic speed feedback devices, and they should be checked regularly to ensure proper operation.

Rectangular Rapid Flash Beacons

Another new type of beacon to alert and warn drivers of pedestrian at crossings is the Rectangular Rapid Flash Beacon (RRFB), sometimes called the "stutter flash" (shown in **Figure 7-19**). This device did not make it into the 2009 MUTCD, but it was given interim approval for use by the FHWA in July 2008. The RRFB has undergone substantial field testing in Florida and has a driver yield rate of 81 percent when activated, compared to a driver yield rate of 18 percent when not in use at a crosswalk. Driver yield rates were as high as 88 percent when the RRFB was installed on both sides of the street.[6] The flash pattern of the alternating yellow strobe lights is similar to that of an emergency flasher and is far more eye-catching than a standard flasher. For optimal use, the flashers are positioned on both sides of the street and in the median (if possible) at the crosswalk. An agency must request permission from the FHWA to use the new device. Agencies should check with the appropriate department of transportation to see if a general approval to use the RRFB has been obtained already.

Pedestrian Hybrid Beacons

The 2009 MUTCD, Chapter 4F allows agencies to use Pedestrian Hybrid Beacons (PHB), a new traffic control device developed and field tested in Tucson, Arizona as the High-intensity Activated crossWalK, or HAWK (**Figure 7-22**). The PHB is a special beacon that has one yellow light centered below two red lights for drivers, and has countdown pedestrian signals controlling the crosswalk. The vehicle indications are dark when not in use. When activated by a pedestrian, a flashing, then solid yellow light will be given to drivers, followed by solid red lights for motorists. When motorists receive the solid red light, pedestrians receive a WALK signal. After a given interval of solid red, the motorist indications change to alternating flashing red indica-

(Top) Figure 7-21. Students crossing with a Rectangular Rapid Flash Beacon (RRFB)
Source: Michael J. Cynecki, Lee Engineering, LLC

(Bottom) Figure 7-22. Pedestrian Hybrid Beacon
Source: Michael J. Cynecki, Lee Engineering, LLC

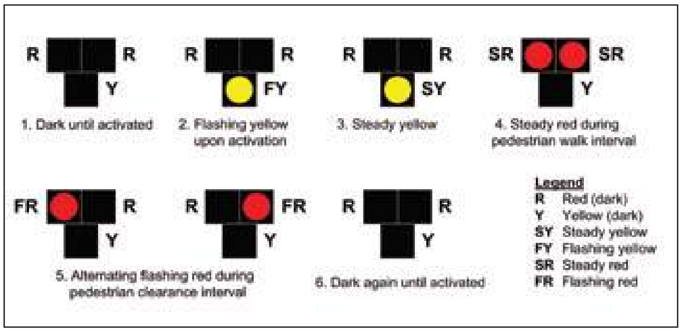


Figure 7-23. Pedestrian Hybrid Beacon sequence based on *MUTCD*
Source: Brandon Forrey, City of Peoria, Arizona

tions, whereby drivers are allowed to proceed (after stopping) if pedestrians have crossed their half of the street. The sequence of the PHB is shown in **Figure 7-23**. Analysis of the field tests in Tucson have revealed these devices are associated with lower pedestrian and vehicle crashes. The 2009 MUTCD has warrants for the use of these devices and provides guidance on application and signing. The advantage of a PHB over a traditional traffic signal is that it is about half the cost of a traffic signal, and typically results in less delay to pedestrians and drivers compared to a traffic signal.

7.3 Traffic Calming

Traffic signs and speed limits alone cannot always control speeds to a reasonable level. Local agencies should give consideration to providing "traffic calming" inside neighborhoods. Some measures are appropriate for local streets and others are available for collector streets. These devices include:

- Speed humps;
- Speed tables or raised crosswalks;
- Speed cushions;
- Mini traffic circles/roundabouts;
- Chokers, bulb-outs, or neck-downs;
- Chicanes; and
- Other traffic calming islands.

Speeds humps or raised crosswalks often pose challenges to emergency responders, including ambulances and fire trucks. One solution may be a modified speed hump called a speed cushion, where there are "gaps" for the wheels of an emergency vehicle to drive through relatively unimpeded. Unfortunately, if emergency vehicles can drive through the device unimpeded other vehicles can as well, which may limit the function of the speed cushion. Many traffic-calming devices in the roadway can complicate snow removal, street sweeping, and other forms of street maintenance. Additionally, any traffic-calming device must be designed to accommodate drainage and storm water runoff.

Figure 7-24. Example of a traffic calmed street with speed hump and painted choker
Source: Michael J. Cynecki, Lee Engineering, LLC

When selecting an appropriate traffic-calming device, designers first must determine the desired effect. Mini-circles and roundabouts may be used at intersections to help break-up long streets, thereby discouraging higher speeds and cut through traffic. Devices that narrow streets help discourage higher speeds as well, but limit available on-street parking and must still accommodate bicycle traffic and street drainage. Narrowing treatments at crosswalks help reduce crossing distances, as well as limit the exposure of pedestrians to vehicular traffic, but may also make an intersection more difficult for larger vehicles (including emergency responders) to maneuver.

Some school agencies, in cooperation with local traffic officials, have requested installation of traffic restrictions or changes, such as turn prohibitions, one-way traffic patterns, road closures, etc., to control vehicle access and minimize pedestrian and bicycle/motor vehicle conflicts when students are crossing the streets. These restrictions can be permanent or in effect only during school arrival and dismissal times. Those restrictions that will affect other local property owners should have their support as well.

Because many traffic-calming devices, particularly movement prohibitions and narrowing treatments, restrict motorists' actions and limit on-street parking, they should be used with care near schools to avoid undue disruption of traffic flow into, out of, and around the school. It is best to design traffic-calming devices as part of an overall traffic plan so its individual elements work in concert. Traffic-calming measures should be designed and implemented in consultation with local elected officials, residents and other street users, emergency responders, utility providers, and any other stakeholders. Often, a public process, such as petitioning or community meetings, is required to implement traffic-calming devices, particularly if use of a public roadway is restricted. Residents not directly affected by the proposed traffic calming should also be included in the

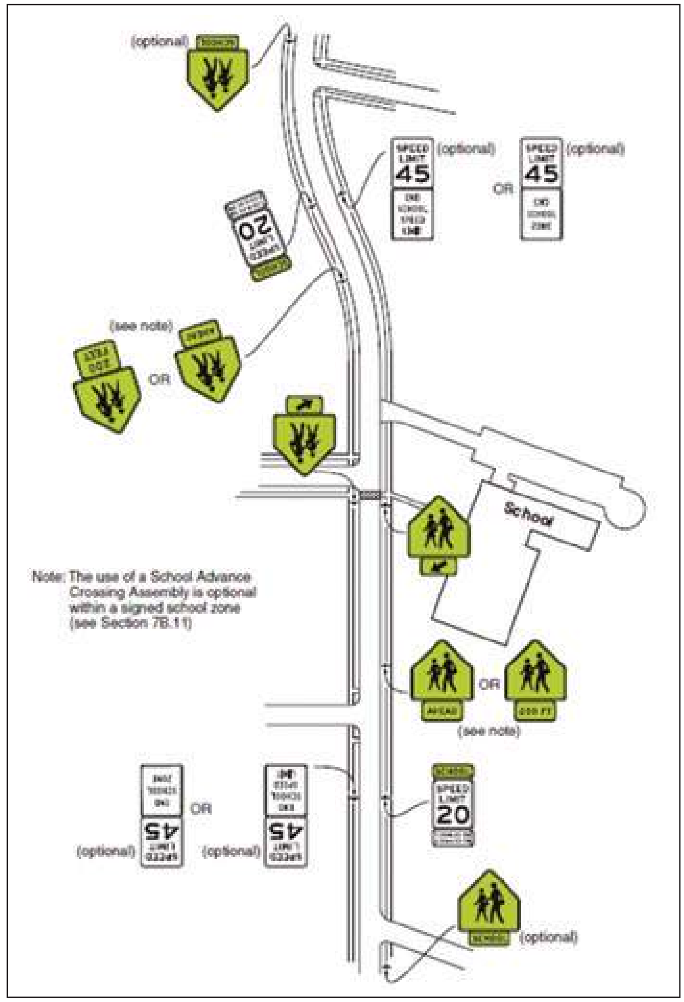
(Top) Figure 7-25. Mini-circles help discourage speeding and cut-through traffic
Source: Michael J. Cynecki, Lee Engineering, LLC

(Bottom) Figure 7-26. Example of local street access restriction during school arrival and dismissal times
Source: Michael J. Cynecki, Lee Engineering, LLC

public process if there is a chance some traffic may be diverted off a "traffic-calmed" street onto their streets. This process takes longer and may pose a greater obstacle in implementing traffic-calming devices or a traffic-calming plan, but will minimize the likelihood of post-installation controversy and, worse, the need to remove traffic-calming devices after installation.

7.4 Creating School Traffic Control Plans/Maps

It is desirable for transportation agencies to create and maintain a map of school-related traffic control devices for each school within their jurisdiction. These traffic control plans may be created electronically or prepared manually on maps. The traffic control plans should include the locations of all school-related traffic signs, signals, and pavement markings, especially crosswalks, in the public right of way for the school (as shown in **Figure 7-28**).



(Top) Figure 7-27. Example of ONE WAY traffic circulation in effect only during school arrival and dismissal times
Source: Michael J. Cynecki, Lee Engineering, LLC

(Bottom) Figure 7-28. School traffic control plan example from MUTCD
Source: MUTCD

These traffic control plans can be used to ensure a level of uniformity among schools within a jurisdiction and can be used for an annual check of all traffic control devices for the school. It is desirable to conduct a check of the traffic control plan toward the end of the school year or during summer break to allow for any required maintenance before the start of the next school year.

In addition, agencies should make it a practice to contact the school principal or the school district administrator to determine if there have been transportation challenges at the school during the past school year that need to be addressed. Furthermore, school officials should be contacted annually to identify any planned changes for the upcoming school year, such as a change in attendance boundary, changes in the school schedule, or information on new schools that will open during the upcoming school year. Information on changes in the school start and end times might require changes in parking or other traffic restrictions for the school, including the start and end times for flashing beacons and other electronic warning devices School start and end time information is also needed to coordinate police enforcement activities at school crossings.

7.5 Adult Crossing Guards

The functions of the adult crossing guard are to choose adequate gaps in traffic, concentrate attention on controlling the school children, and guide the proper use of the crossing by the school children. Unless sworn members of the police force, crossing guards are not to direct traffic. Adult crossing guards must wear an ANSI Class II retroreflective safety vest (**Figure 7-29**), as prescribed in Section 7D.04 of the MUTCD, over their clothing while in the street and shall use hand-held STOP signs, as prescribed in Section 7D.05.[37] In addition to these items, crossing guards also benefit when equipped with either a two-way radio or a cell phone in case of emergencies or other concerns, especially when located away from the school site. Adult crossing guards should be dressed neatly, avoiding any clothing with logos from alcohol or tobacco products or anything potentially offensive, and wear comfortable footwear appropriate for the job. Crossing guards should not wear sandals or open-toe shoes.

Before working in the street, crossing guards should be trained properly to protect themselves and the children. If they are not properly trained, the school district and local authority may be subject to litigation if a collision should occur. Training is typically the responsibility of the school district, state, province, or local authority that hires and employs the adult crossing guards, although outside agencies may provide assistance and support. For example, if a school district is responsible for hiring and training adult crossing guards, local police, transportation, and fire personnel can provide training at the start of the school year. Annual refresher training is also recommended, and those who serve as back-up guards or who supervise the crossing guards should also be trained in their proper duties and procedures. In addition to monitoring student and driver behavior and training students how to cross the street safely, adult guards can be watchful for stray dogs, gang activity, or suspicious activities.

In the event of an emergency, a crossing guard should generally remain at the assigned location, unless unable to do so, to provide first aid, to continue to assist students in crossing, or to prevent students from crossing when unsafe conditions exist. Crossing guards should have a means to summon help in the event of an emergency either via two-way radio, cell phone, or by sending students/other adults to contact authorities. If a crossing guard is equipped with a cell phone, the cell phone should not be used when on duty except in the event of an emergency. It is impossible to anticipate every possible emergency, but an adult crossing guard should always consider the safety of the students the top priority.

Figure 7-29. Adult school crossing guard with Class II vest
Source: Brandon Forrey, City of Peoria, Arizona

7.6 Student Patrols and Adult Monitors

In addition to adult crossing guards, schools may also utilize other assistance and supervision from student patrols and adult monitors, which for the purpose of this document will be referred to collectively as volunteers. Volunteers can be a great help by providing additional eyes and ears away from the school campus and on surrounding streets. However, caution must be taken any time a volunteer, especially a youth, is responsible for the safety of students. There are a couple of key points to remember when utilizing volunteers. Because volunteers are not paid for their services, they are less likely to follow through with their commitments, so avoid placing a volunteer in a crucial role. Due to liability concerns, it is recommended volunteers:

- DO NOT work directly in public streets; and
- DO NOT dictate when students cross public streets.

The use of student safety patrols is mentioned briefly in Section 7D.01 of the MUTCD.[7] Additional information regarding the organization, administration, and operation of a school safety patrol program is contained in the *AAA School Safety Patrol Operations Manual*.[8]

The best uses for student patrols do not place them in direct conflict with motor vehicles. A few examples of such uses include:

Source: Michael J. Cynecki, Lee Engineering, LLC

- Assisting students as they load into or out of vehicles in an organized student loading procedure;
- Assisting adult crossing guards by keeping students away from the curb at a street crossing;
- Assisting with walking and bike riding encouragement programs by distributing awards/incentives to students displaying good behavior, wearing bike helmets, and walking to school; and
- Monitoring student activities while on school grounds.

The use of adult monitors is not thoroughly discussed in the MUTCD, but parents and adult volunteers can provide invaluable support for schools in a number of ways by:

- Assisting student loading in an organized pick-up and drop-off procedure, directing parent vehicles in the parking lot, and getting students ready to load into vehicles;
- Assisting student loading in the bus loading area;
- Providing adult supervision along walking routes, both on and off campus;
- Assisting with walking and bike riding encouragement programs by distributing awards/incentives to students displaying good behavior, wearing bike helmets, and walking to school;
- Organizing and participating in walking school buses; and
- Being good adult role models with friendly faces.

It is recommended adult monitors wear bright safety vests to help them stand out, especially when working in school parking lots, and to give parents and other motorists a visual cue they are official school representatives. Schools should carefully select adult monitors with appropriate personalities for the tasks to which they will be assigned. For example, an aggressive personality might be required in a parking lot, but not one that might be likely to escalate a conflict.

Student Safety Patrol assisting drop-off
(Top) *Source: Michael J. Cynecki, Lee Engineering, LLC;*
(Bottom) *Source: Joel Cranford, North Carolina Department of Transportation*

7.7 References

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8. METHODS TO MINIMIZE PEAK SCHOOL TRAFFIC CONGESTION

The main problem with traffic operations during school arrivals and dismissals is the streets adjacent to and around a school are filled with vehicles (including parents, buses, and daycare vans) at the same time large numbers of students are walking and riding bicycles. To make the situation worse, the greatest concentration of walking students and vehicles occurs during the final minutes before classes start in the morning and the moment the dismissal bell rings in the afternoon, when both students and adults are in a hurry to get to class on time or to make an after-school appointment. The concepts discussed in this section can be applied to existing school sites or for planning purposes when designing new school sites.

Typically, traffic congestion and concerns around schools exist for less than an hour in the morning and less than half an hour in the afternoon. Fifteen minutes after arrival or dismissal, the surrounding streets that were filled with vehicles may be virtually empty. This indicates that nearly all traffic is local and school-related. School-related traffic is inevitable and must be taken into account when planning a new school site.

The student drop-off and pick-up processes, including private vehicles and buses, not only play big parts in traffic safety on-campus, but also along the adjacent road system and at nearby intersections. Additionally, the school must enforce procedures through policies even if those policies are unpopular with some parents. At the same time, parents must realize that by following the established student loading procedures, even when they do not seem as convenient as other options, they are helping school officials operate and maintain safe and efficient student loading . This begins with understanding the main goal of both the school and parents is the same—ensuring their children are safe. Only through a combination of efficient design, supportive policies, and encouragement of congestion- mitigating behaviors can many schools effectively address school-related traffic congestion during peak school times.

8.1 Reducing Congestion through Design

The design of the street network can play a major role in traffic flow and school-related congestion. Trends to create neighborhoods dominated by cul-de-sacs surrounded by solid block walls can have very harmful effects. First, the street network may not be built with pedestrians in mind. Many times, the streets in such a neighborhood switch back and forth and are very inconvenient and indirect for pedestrians to use. Furthermore, tall block walls segregate communities in an effort to preserve privacy, but it is done at the cost of a walkable community. If the walking route to a neighborhood school is too indirect, an increase in the number of driving parents is to be expected. Below are some guidelines to use in laying out a new community for improved school walkability:

- **Street Layout**—Communities should be designed with easy street and pedestrian access to schools, parks, local shopping, and other amenities in mind. The mentality of cities and developers that only motor vehicles use streets, must change for there to be any impact on this trend.
- **Pedestrian Easements**—In communities that have already been established and the roadways network creates overly inconvenient walking routes, there may still be opportunities to improve pedestrian and bicycle access. Openings can be created in walls, or pedestrian easements may be dedicated or created. City planners should always look for opportunities, such as vacant lots, to create such pedestrian connections. Some residents may fight pedestrian access, arguing increased crime will result, so it may be a difficult process to create or even maintain a dedicated pedestrian easement through a neighborhood.
- **School Site Design**—The school site should be designed in such a way that students who walk and ride bikes are separated from the bus loading area and student loading area for driving parents. There are a few relatively simple design elements that may be employed to reduce traffic congestion.
    - Adequate queuing should be available on-site, if possible, to avoid back-ups onto the adjacent public streets.
    - Adequate deceleration lanes and turn pockets should be provided.
    - School crosswalks should, ideally, not cross the line of parent vehicles in the student loading queue.
    - Some turns may be restricted at school driveways or in the parking lot to reduce potential conflicts and make the traffic flow easy to determine.

For more information on school site design, see **Section 6—School Campus Design and Physical Site Layout**.

Source: Michael J. Cynecki, Lee Engineering, LLC

8.2 Reducing Congestion through Policy

School or district policies can unintentionally affect traffic congestion at and around a school. When making decisions regarding such policies, all the advantages and disadvantages should be weighed. Unfortunately, traffic congestion that might last only a few minutes may not be viewed as significant enough to invest substantial resources into making changes.

- **Wider Arrival Windows**—Due to a shortage of school personnel and liability concerns, students are typically not allowed on campus before a certain time. While it is important to not have students on campus without adult supervision, sufficient time must be allowed for the arrival of the student population. For example, if a school with 1,200 students allows arrivals only 15 minutes before classes begin, the school will invariably experience traffic congestion in the mornings. This can be easily remedied by assigning a few staff members to start a little earlier to provide a longer student arrival time frame.
- **Organized Student Loading Procedures**—One of the best ways to reduce the negative impact of school-related traffic is to develop organized student pick-up and drop-off procedures. Establishing an official pick-up and drop-off area can reduce congestion created by parent on-street parking in surrounding neighborhoods, and reduce the number of and variety of maneuvers performed following pick-up or drop-off, such as U-turns and parallel parking. Suggestions for developing student loading procedures are discussed in **Section 6—School Campus Design and Physical Site Layout**.
- **Refine Existing Student Drop-off/Pick-up Procedures**—School officials periodically need to re-evaluate traffic patterns and student loading operations, address on-campus deficiencies, and determine changes that will help minimize vehicular influence on and off campus. Examples of solutions that can be implemented are to reduce and control drivers' options, provide adequate driveway queue length for student loading vehicles, identify the student loading zone and related short-term parking, develop better traffic route patterns, and inform school staff, students, and parents . One example of a student drop-off procedure is called a "Kiss and Drop" program. This is where staff or volunteers are available along the curb to open and close car doors, help students out of car seats, and pick up backpacks and musical instruments, to speed up the student drop-off process.
- **Staggered Class Dismissals**—Another factor affecting school-related congestion is common dismissals. Especially for larger schools, by dividing dismissals the traffic congestion can be cut nearly in half. In many cases, grades K–2 or 3 may be dismissed first, followed by dismissal of the remaining students a half hour to an hour later. When this is not possible, minor staggering of dismissals may still prove to be advantageous. Minor staggering of individual grade levels or groups of grade levels, even by as little as five minutes, may prove beneficial. The only problem that may occur is when parents need to pick up more than one child when each is released at a different time. However, this can be overcome by having a monitored student waiting area, so students released earlier can wait for siblings who are released later.
- **Early Release for Walkers and Bicyclists**—One way to encourage more walking and bicycling, and discourage parent drop-off and pick-up, is to provide incentives for walking or riding a bike to school. One such incentive is to allow students who walk or ride to school to leave a few minutes before those who are driven by their parents. This may be a strong disincentive to being driven and may minimize the number of vehicles on campus during school dismissal times. Early release for walkers and bicyclists helps these students clear the campus and cross the streets closest to the campus during a time when a majority of parent drivers are in the queuing area.
- **Early Arrival Policies**—Additional traffic congestion is created when driving parents arrive early to pick up students. Congestion breeds a mindset in parents: Arriving early will let them "get a good spot" to avoid struggling with the rest of the traffic. This can result in parents arriving half an hour or more before dismissal, with vehicles idling along the curb of the pick-up area and on surrounding streets. Schools can create early arrival policies to combat this. One example early arrival policy does not allow parents to sign students out within 30 minutes of the dismissal and does not allow parents to queue in the pick-up line until five minutes before the dismissal.
- **Exception (or "Hazard") Busing**—Many schools do not provide busing within a set distance or radius from the school. There may be students who live too close to the school to benefit from buses, but must walk along or cross

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

particularly difficult obstacles, such as freeways, areas lacking sidewalks, washes, and other difficult terrain. In such cases, the school or district should consider providing busing for these students despite their proximity to the school. By doing so, fewer parents will have to drive their children to provide a safe way to and from school.

- **Coordinated School Schedules**—The start and dismissal times of a school can greatly affect traffic congestion. Morning and evening rush hours are not optimal times for students to be walking and riding to school, nor for large numbers of parents and buses to be on the roads. All these vehicles will be competing for limited roadway when the majority of the population is trying to get to work or return home. Typically, evening rush hour occurs after schools have dismissed, but the morning is often a concern. By starting classes after the rush hour, a great deal of additional congestion can be avoided. Additionally, if other elementary schools, high schools, larger charter schools, or other traffic generators are in the area, care should be taken to coordinate the school schedule to avoid setting arrival and dismissal times that compete with other traffic generators.
- **School Size and Boundaries**—Larger schools have been an increasing trend . Unfortunately, a school with greater enrollment also means a larger attendance area and a larger percentage of students who live too far away to walk or ride bikes to school. This will result in more buses and driving parents, adding to congestion.

8.3 Reducing Congestion through Education and Encouragement

One of the great challenges to improved traffic safety at a school results from not designing the school properly or providing sufficient police enforcement. These elements are essential to a safe environment. But providing them requires changed behavior: If the bad habits and poor behaviors of the students and parents are not changed, engineering and enforcement cannot sufficiently compensate. Education and encouragement are two other tools required to supplement engineering and enforcement.

Education is the process of equipping parents and students with the knowledge to do what is right and safe, whether it means obeying the commands of a crossing guard, looking left, right, and left before crossing a street, or not dropping off students on the side of the street opposite the school. It is essential the reasons be explained as well, so those being educated understand why they are supposed to do what they are told.

At the core, everything we are educated to do is for our good, as well as the good of others, which is perhaps even more important. When looked at from one's own perspective, there is no problem dropping a student off directly in front of the school building rather than pulling all the way to the end of a drop-off area. However, when the entire operation is taken into account, the one driving parent, who is not doing anything to directly harm himself or his child, may be causing other parents' vehicles to back up unnecessarily onto a public street, creating additional congestion around the school. This can lead to frustration and inappropriate or unsafe actions on the part of those parents.

Encouragement is the ongoing reinforcement following the education effort.

Encouragement, on the other hand, is providing incentives to people who already *know* what is right to actually *do* what is right. Encouragement is the ongoing reinforcement following the education effort. If a parent is illegally parking too near

Source: Michael J. Cynecki, Lee Engineering, LLC

Figure 8-1: Bike helmet fitting
Source: Michael J. Cynecki, Lee Engineering, LLC

a crosswalk but is unaware of the restriction or did not see a posted NO PARKING sign, a police officer may provide education in the form of a warning or citation. On the other hand, if the parent is parking in the same location the next day after being educated, the citation would be the encouragement for the parent to find somewhere else to park. Examples of encouragement efforts to reduce school-related traffic congestion include

- **Bus Riding Encouragement**—Many parents choose to drive their students rather than have them ride the school bus provided because of safety or behavioral concerns, such as bullying and offensive language. These concerns could be allayed if greater adult supervision were provided on buses, especially at the back. A bus driver should focus on driving and getting students to school or home safely, not monitoring student behavior. A separate bus for younger students is appealing to most parents, but is rarely practical or possible. Segregation of grade levels on the bus may be another option worth exploring. Another, more practical option is to install cameras on buses to monitor student behavior and to discipline students if they misbehave. It is better to remove bus privileges from one student causing problems than to have several parents choose to drive instead and lose trust in school-provided transportation. As long as parents do not feel the busing provided by the school is safe, large numbers will continue to choose to drive their students.
- **Carpool and Vanpool Promotion**—Reserved parking or preferential loading areas for carpool and vanpool vehicles may be a good incentive, in addition to the other benefits of pooling.
- **Walk and Bike to School Programs**—Due to concerns about child abductions, safety, and, ironically, traffic conditions, many parents living within the walking attendance boundary choose to drive their students to school. Programs to address parent concerns and encourage more students within the walking attendance boundaries to walk or ride bikes to school can reduce the number of vehicles at arrival and dismissal times. These programs are discussed in **Section 8.3.1**.

8.3.1 Encouraging Students to Walk and Bike to School

When many students begin attending elementary school, they have not been properly trained by their parents how to cross streets, to wear bicycle helmets, or to never assume the driver of a vehicle will see them. It is important all students be taught what is expected of them, consistently and according to school and district policy, as well as local and state law, which may be vastly different than what they have been taught by their parents.

When teaching students proper walking and bike riding procedures and rules, it is critical to make the material interesting. Safety education can and should be fun and exciting for students. Perhaps the most effective safety education programs place the students in situations where they get to put into practice what they have been taught. A good example of such a program is a bike rodeo, where students ride their bicycles along a course with simulated STOP signs, traffic signals, and other traffic control; potential conflicts with motor vehicular traffic and pedestrians; and obstacles to avoid. Without this practical portion of the training, safety education may not be as beneficial.

Students are often more responsive to encouragement than adults. This encouragement can either be positive, as detailed by examples later this section, or corrective. Corrective encouragement is typically disciplinary action, such as detention, when a student is observed demonstrating behaviors that place them or others in potential harm, or violate school policy,

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

such as crossing a busy street at a location other than a marked crosswalk, for example. It's important such behavior is addressed appropriately whether it occurs on campus or off.

While corrective actions may be needed, the school is strongly encouraged to explore ways to offer positive encouragement for student to walk and bike to school. There are numerous examples of successful encouragement programs from across the country that can provide helpful ideas. Some ideas are:

- Walking school buses;
- Bike trains;
- Safety assemblies;
- International Walk to School Day;
- Walking Wednesdays and other ongoing programs;
- Mileage clubs and contests; and
- In-class curriculum.

Walking School Buses

A walking school bus is a program operated by parent volunteers in conjunction with school staff, whereby small groups of students, particularly younger students in elementary school grades, are accompanied to school on foot by a parent or responsible adult. The program is most effective at elementary schools where a large number of students reside within reasonable walking distance to the school.

A walking school bus can be as informal as two parents taking turns walking their children to school or as formal as a map with marked routes, meeting locations, pick-up times, and a regular rotating schedule for participating volunteers. The flexibility of the walking school bus makes it appealing to schools of all sizes with varying needs. The program's benefits include providing a safe walking environment to school as the children are both part of a group and accompanied by an adult. It also promotes a sense of community among the neighborhood children and parents; and promotes a healthy lifestyle through the exercise. It can greatly reduce the traffic congestion at the school by reducing the number of parents dropping off or picking up their children. The difficulty in implementing the program is that its heavy reliance on volunteer participation. Sustained commitments from both parents and school staff are required to make the program a success.

Bike Trains

A bike train is simply a variation on the walking school bus, in which one or more adults supervise children riding their bikes to school. Adults should also ensure students are obeying the rules of the road, such as riding on the right side of the road, stopping at STOP signs, and yielding to pedestrians.

Safety Assemblies/Bike Rodeos

Safety assemblies and bike rodeos can be organized during class time, as well as before school, after school, or during a lunch hour. Safety assemblies may include the principal, staff, or guest speakers, typically personnel from a police or fire department, health care professionals, individuals with testimonials about the importance of safety, friends and families of victims, or survivors. The tone of safety assemblies should reflect the age group of the students. Younger children typically respond to a fun message that stresses what is safe and the right thing to do whereas older students, especially teenagers, may respond more to graphic details and seeing the results of not following safety rules. A bike rodeo, as noted above, is a bicycle skills course designed to test children's knowledge of laws and safety skills they have learned, as well as their ability to maneuver their bicycles around obstacles.

Source: Michael J. Cynecki, Lee Engineering, LLC

Source: Michael J. Cynecki, Lee Engineering, LLC

International Walk to School Day
International Walk to School Day began in 2000, following successful walk to school campaigns in a number of countries in the late 1990s including the United Kingdom, Canada, and the United States.

Communities are encouraged to pick a day, a week, once a week or the entire month to celebrate the event and bring increased attention to these issues. International Walk to School Day events may be as informal as students being encouraged to walk that day or as structured as meeting at a gathering point, such as a park, and walking together as a group at a fixed time, followed by safety assemblies, safety poster contests, or any number of fun safety-related events. The official International Walk to School Day is the first Wednesday in October.

October 2006 marked the first time International Walk to School activities had been officially expanded to cover the entire month. The expansion to a month-long event allows communities flexibility in organizing their Walk to School events. Actively promoting Walk to School throughout the month could also transition smoothly into the launch of a year-round walking program.

For more information on International Walk to School Day events, please visit www.walktoschool.org and www.iwalktoschool.org.

Walking Wednesdays and Other Ongoing Programs
Walking Wednesdays is a program that establishes one day a week as a designated walking day, when students are encouraged to walk or ride their bikes to school. Walking Wednesdays are intended to be ongoing events throughout the school year that may occur one Wednesday each month, every Wednesday, or even more frequently. It is important these events are fun and provide incentives for student to participate.

Mileage Clubs and Contests
Mileage clubs and contests encourage children either to begin walking and bicycling to school or to increase their current amount of physical activity, by making it fun and rewarding. Typically, children track the number of miles they walk or bicycle and get a small award or a chance to win a prize after a certain mileage goal is reached.

Mileage clubs and contests usually involve incentives like prizes—such as medals, certificates, or trophies—or small gifts. In order to be most effective, incentives need to be provided in concert with other strategies over a period of time, not just given once.

Mileage clubs and contests are usually designed in one of three ways:

- On an individual basis where every child logs miles walked or bicycled and has a chance to win;
- As a classroom competition where a classroom's collective miles are compared against other, classes; or
- As a competition between or among schools.

These activities can be very flexible. Depending on the school, the competition aspect may be emphasized, and the rewards can be simple or elaborate. In rural areas or other places where the route to school is undesirable or difficult to walk or bicycle, the activity can be modified by providing credit for distance walked and bicycled at home, to and from a bus stop, or during the school day on campus.

In-class Curriculum
Safety and school policy topics incorporated into core curriculum can be another effective method to reinforce positive

Source: Michael J. Cynecki, Lee Engineering, LLC

behaviors. Geography projects can incorporate mapping the walking route to school, math word problems can include a calculation of the distance it takes for a vehicle to stop for a student in a crosswalk, and physical education classes can reinforce the need for low-impact physical activity, such as walking and riding a bike to school, to list a few examples.

Any or all of the ideas previously listed may be used in conjunction with one or more others to establish a comprehensive walk and bike to school program.

8.3.2 Modifying Parent Behavior

Convincing adults to change their behavior is much different than doing the same for a student. Unfortunately, the desire to do what is right is often overshadowed by doing what is convenient in an adult's view. Doing something simply because it is the right thing sometimes can be little motivation to an adult. There are several techniques that should be employed to help modify parent behavior, including:

- Addressing parent fears and concerns;
- Emphasizing the child's well-being;
- Reinforcing parents as role models;
- Thanking parents for patience; and
- Parent outreach.

Addressing Parent Fears and Concerns

Parents frequently cite safety issues as one of the primary reasons they are reluctant to allow their children to walk or ride their bikes to school. Providing adult supervision may help reduce those worries for families who live within walking or bicycling distance to school.

Emphasizing the Child's Well-being

Parents must be reminded school policies and procedures, although they may be inconvenient, are intended to protect their children from harm. Often, if parents are informed why a procedure is in place, they may be more willing to cooperate than if they are just told the procedure.

Reinforcing Parents as Role Models

It should be reinforced to parents that they are setting examples for their children, good or bad, by their every action. When a parent chooses to not cross the street at a crosswalk or knowingly parks in a no parking area, he or she is sending a message to the child: It's okay to disregard rules if they are inconvenient. Parents should understand their actions are shaping their children's decision-making processes.

Thanking Parents for Patience

Acknowledging parents may be inconvenienced by following school procedures and policies can diffuse a great deal of tension. The impact of a simple "thank you" should not be underestimated.

Parent Outreach

If the goal is to modify parent behavior, it is imperative parents be informed of changes to policy or procedures before the changes are implemented, and educated regarding existing laws. Examples of effective ways to reach parents include:

- Parent-faculty conferences;
- Flyers, preferably provided directly to parents;
- Police educational contacts/presentations;
- Community safety fairs;
- School newsletters;
- Information on school websites; and
- Personal contact.

8.4 Reduce Congestion through Enforcement

Police enforcement is usually seen as the first solution to address traffic safety concerns at schools and to modify undesirable behaviors, whether they are speeding vehicles, illegal parking, or student crossings at undesirable locations. Not only must enforcement be combined with engineering, education, and encouragement, but the enforcement applied must be implemented strategically for maximum effect of this finite resource.

8.4.1 Limitations of Enforcement

Random, infrequent police enforcement may not be as effective as desired. This is especially true if the enforcement is to address an ongoing concern, such as illegal parking during school dismissal. If there is a bigger concern, random police enforcement may not be able to correct the problem. If there is not enough available

Source: Michael J. Cynecki, Lee Engineering, LLC

parking on-site for driving parents, for example, enforcing parking restrictions around the school will likely have little impact, and a parent who receives a ticket one day will likely be illegally parked in the same location the next if no viable alternative is available. In any case, the majority of the enforcement will come from school officials who are present daily.

8.4.2 Reasonable Restrictions and Traffic Control

It is important that any restrictions should be reasonable in order for police enforcement to be effective. If all parking is restricted around a school and there are no alternatives for driving parents, a police officer may be unwilling to issue a citation and parents may be more likely to violate the restriction. Balancing restriction with availability and offering programs to encourage the desirable behavior is important to achieving it.

8.4.3 Coordination with Police, Engineering, and Schools

The most effective police enforcement at schools is the result of a cooperative effort among police, transportation engineers, and school officials. If traffic engineers are judicious and reasonable in their application of traffic control devices, and school staff supports and reinforces existing rules and restrictions on a daily basis, police officers may do their jobs more effectively.

8.4.4 Start Enforcement with Warnings

The goal of police enforcement is to convince the public to obey the law willingly, so it is not always necessary to issue a citation and levy a fine in order to accomplish this. Because the same parents and students go to the same school every day, they are easier to educate than the motorists on a busy interstate freeway. Parents and students (and even staff) may respond well to educational contacts. Educational contacts give the police the opportunity to clarify traffic or other laws to the public during a minor violation without issuing a citation, at the officer's discretion. However, after a short period of educational contacts, police should begin issuing citations for violations in earnest. This type of program requires good interaction with the police to coordinate a program of progressive ticketing.

9. SUMMARY

Traffic safety in and around school areas is a highly sensitive subject with the public, school officials, and local officials. Many of the traffic problems created for or at schools are related to insufficient guidelines on selecting optimal school sites, improper campus design, larger school sizes (student populations), and poor connectivity to the neighborhood the school serves. When a school is built, it will typically remain in operation for a very long time. Thus, it is important for the community, local officials and school officials to do their best to make sure the school will operate safely and efficiently in serving the needs of the community, and not generate undo traffic congestion or safety problems for students, parents and other community members.

Traffic engineers, planners, and school officials have learned a lot of important lessons on where to place a school to best serve the community with minimal adverse traffic and safety impacts, how the campus should be designed, and how to best provide access to the community. To achieve the best service and provide the greatest access, the school needs to be walkable, bikable, and community-based. However, as one generation of traffic engineers, planners, and school officials moves on, the lessons learned are not always passed on.

There is more than one right way to build a school campus to provide safe and convenient access to the students and community. While this document provides many suggestions and examples based on successful experiences in communities across North America, it was not intended to provide a formula to create a perfect school. Every community has different needs and each potential school should be considered on an individual basis within its context. We are hopeful this report provides its readers with new insights and considerations to make when selecting and designing a new school site, when retrofitting an older campus, when working to improve circulation at an existing school site, or to provide improved access to a school site for pedestrians, bicyclists, and motor vehicles. The most important point of this document is its emphasis on creating communication and coordination between school officials and local authorities at every stage of school planning, selection, and design. Many communities are building closer ties between local or regional government and school districts; those relationships are paying dividends that benefit everyone. Furthermore, there is a need for on-going training, and learning from past experiences what decisions will result in a better and more walkable school site location and design, particularly as experienced staff members retire or leave. This will help prevent the loss of vital skills and knowledge within an agency.

Source: Michael J. Cynecki, Lee Engineering, LLC

Below is a summary list of the most important elements to consider when selecting a school site and designing the campus layout and connections to the community. Following these principles will contribute toward creating a walkable, community-based school that will enable a maximum number of students to walk or ride their bikes to school and reduce the need for parent drop-off/pick-up and school buses.

- A smaller school (lower student attendance and smaller catchment area) is more walkable than a larger school.
- A school that serves more grades (such as K–8 rather than K–3) is often a more walkable school.
- A good school site is located in the center of the attendance boundary, especially the center of the walking attendance area.
- Locate a school to minimize the need for students to cross busy or high-speed arterial streets, especially for primary or elementary school sites.

- Do not locate a school adjacent to or near an access barrier (such as a river, wash, freeway, or railroad tracks) unless pedestrian/bicycle access can be provided across the barrier.
- Provide pedestrian and bicycle access to all sides of the school campus.
- It is best for a school site to be designed to have streets border at least two (and preferably more) sides of the school for vehicle access.
- It is best for elementary schools not to abut busy or high-speed arterial streets, but rather to abut at least one collector street inside the neighborhood, and preferably two.
- Avoid locating a school at the end of a cul-de-sac unless there are other ways vehicles and pedestrians can access the school site.
- Avoid multiple schools on the same campus or on adjacent campuses unless the schools are relatively small. Instead, the school campuses should be disbursed throughout the communities that each school serves.
- It is best to avoid fronting a school onto a street with front-facing homes (single-family homes with direct access to the street).
- Provide sidewalks in the neighborhood adjacent to the school on both sides of the street and connect them to the students' school entry points. Wider sidewalks near and along school property accommodate larger numbers of walkers at the school during school arrival and dismissal times.
- School walking maps (ideally developed during the planning stages of a school) encourage students to walk or bike to school, identify barriers to walking, and establish the optimal crossing locations and traffic control placement.
- Minimize the need for walking students to cross busy driveways along walking routes and when accessing the school building entrances.
- Evaluate and provide appropriate traffic control (including adult crossing guards, where needed) along the school frontage and at the primary street crossings.
- Physically separate bus loading areas from parent drop-off and pick-up areas.
- Design schools to accommodate parent vehicle traffic during arrival and dismissal times, so vehicle queues do not obstruct through lanes, crosswalks, bike lanes, driveways, or create other operational and safety concerns on the adjacent streets.

Readers of this informational report are encouraged to seek additional resources and guidance such as those references throughout this document or included in Appendix B. Only through a concerted and cooperative effort can school and local officials identify and implement the many design concepts and features that will result in walkable, community-based schools. In turn, these schools will better serve the children and community by enabling freedom of transportation choice, reducing school-related traffic congestion, and improving safety for all students, whether they walk, ride bikes, take a bus, or are driven by their parents to and from school.

APPENDIX A: RESULTS FROM SURVEY OF SCHOOL SITE SELECTION, DESIGN, AND TRANSPORTATION ISSUES

The purpose of this survey was to gain a better understanding of current practices of school site selection, acquisition, design and layout, and transportation planning in the United States and Canada. Additionally, the survey sought to help determine what guidance was available at the time and what additional information and guidance was still needed. Three surveys were distributed between May and December, 2009. The first survey was distributed via e-mail to all Institute of Transportation Engineers (ITE) members in May, 2009. A total of 285 ITE members responded to this first survey. Since the target group of the first survey was engineering professionals, no school officials were represented in the responses. To solicit input from school officials, a second survey with six additional questions was distributed in June 2009 to organizations more likely to represent officials involved in school facility design and construction. A total of thirty-eight additional responses were gathered. Unfortunately, school officials were not well represented in the second survey and the number of responses was less than desired.

A third survey was distributed in December 2009 amongst members of three major school organizations; the Association of School Business Officials International (ASBOI), Council of Educational Facility Planners International (CEFPI), and the American Institute of Architects (AIA) Committee on Architecture in Education. A total of 141 additional responses were gathered from the previously under-represented groups of school officials and architects. Overall, responses were obtained from a total of 464 professionals, mostly in the traffic engineering profession from the U.S. and Canada. The survey responses should not be considered to be a statistically representative sample of North America, but it was hoped to be a "snap-shot" of results from professionals working in the area of school facility site selection and design, either as a school official, government official, or a member of the design and consulting profession.

In most cases, the survey instrument provided specific categories of responses for the participants to choose from. Opportunities were made to allow additional responses. Three of the survey questions allowed open-ended responses with no multiple-response categories provided to the survey participants. Substantial time was invested in reviewing the responses and attempting to group the responses into specific categories. The results of the surveys are provided in **Tables A-1 through A**.

A.1 Employment Category of Respondents

Participants were asked to identify their employment category (**Table A-1**). The largest number of responses (284) was gathered from the first survey distributed among ITE members, of which a majority was vendors and consultants. This was followed by representatives from local governments and school facilities planners, representing another 30 percent of the responses combined. This was followed by responses from county government/metropolitan planning organization (MPO) and state representatives at 16 percent combined. Finally, architects, professors, school administrators, federal government employees, developers, and other unclassified professionals were only minimally represented.

As expected, 40 percent of the respondents to the third survey (sent to school-facility organizations) were school facilities planners and another 5 percent of the responses were school administrators. Nearly 27 percent of those who responded to the third survey to school facilities organizations stated that they were consultants or vendors.

A.2 Primary Reasons for School Construction

Participants were asked to identify the primary reasons schools are being built in their communities. More than one response was allowed for each individual. New development and growth were the primary reasons for new school construction (71 percent of respondents), followed by 60 percent of participants indicating reconstruction or expansion of existing facilities was the second most common reason. A small number of respondents, 15 percent, indicated school consolidation, which typically works counter to the principals of walkable, community-based schools, was the primary reason for the building or reconstruction of schools in their jurisdiction. Only 10 percent of participants indicated no new schools had been built in the recent years in their area. Because more than one response was allowed from an individual, the combined results exceed 100 percent. Unfortunately, it was not possible to break down these responses by region of the country because of the survey structure and distribution.

New development and growth were the primary reasons for new school construction.

Table A-1. Employment Category of Respondents.

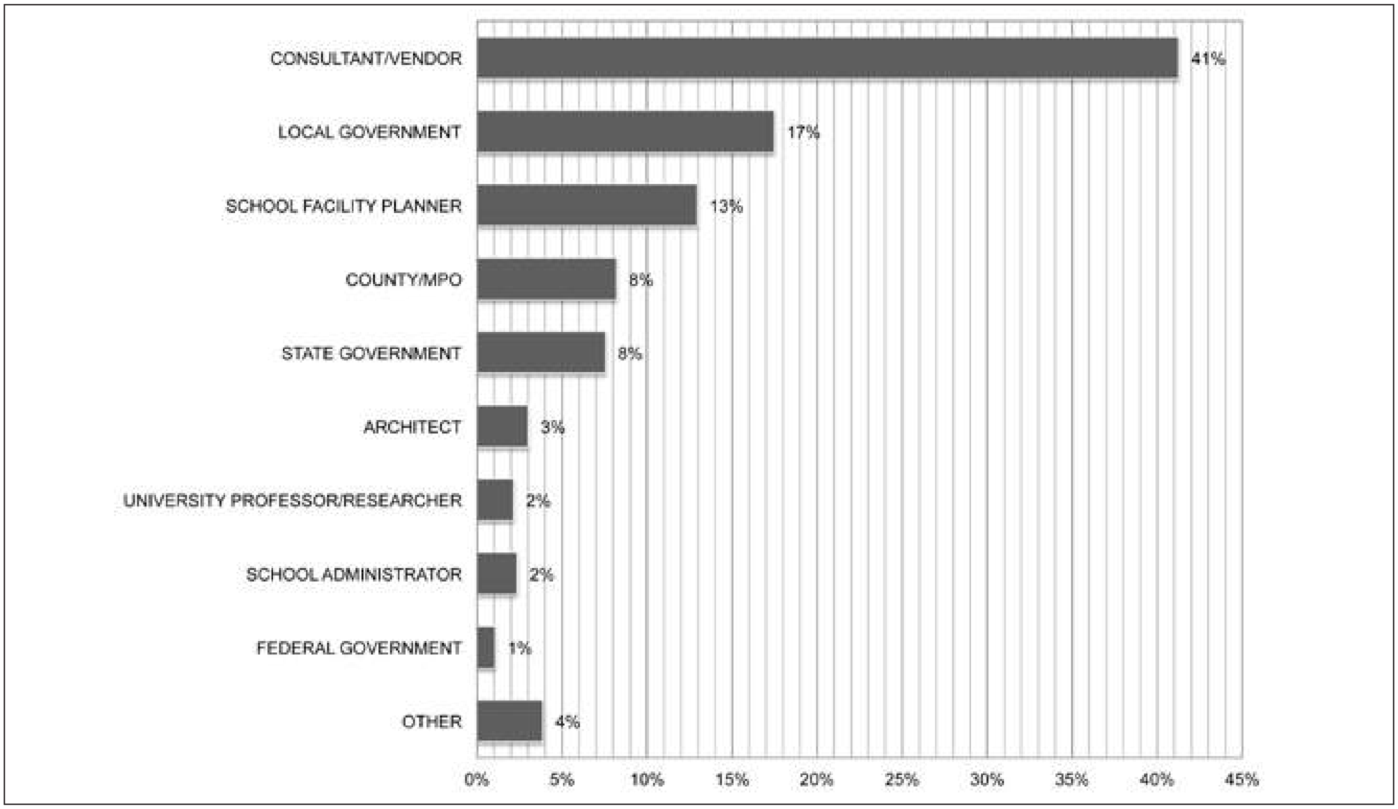


Table A-2. Primary Reasons for School Construction.

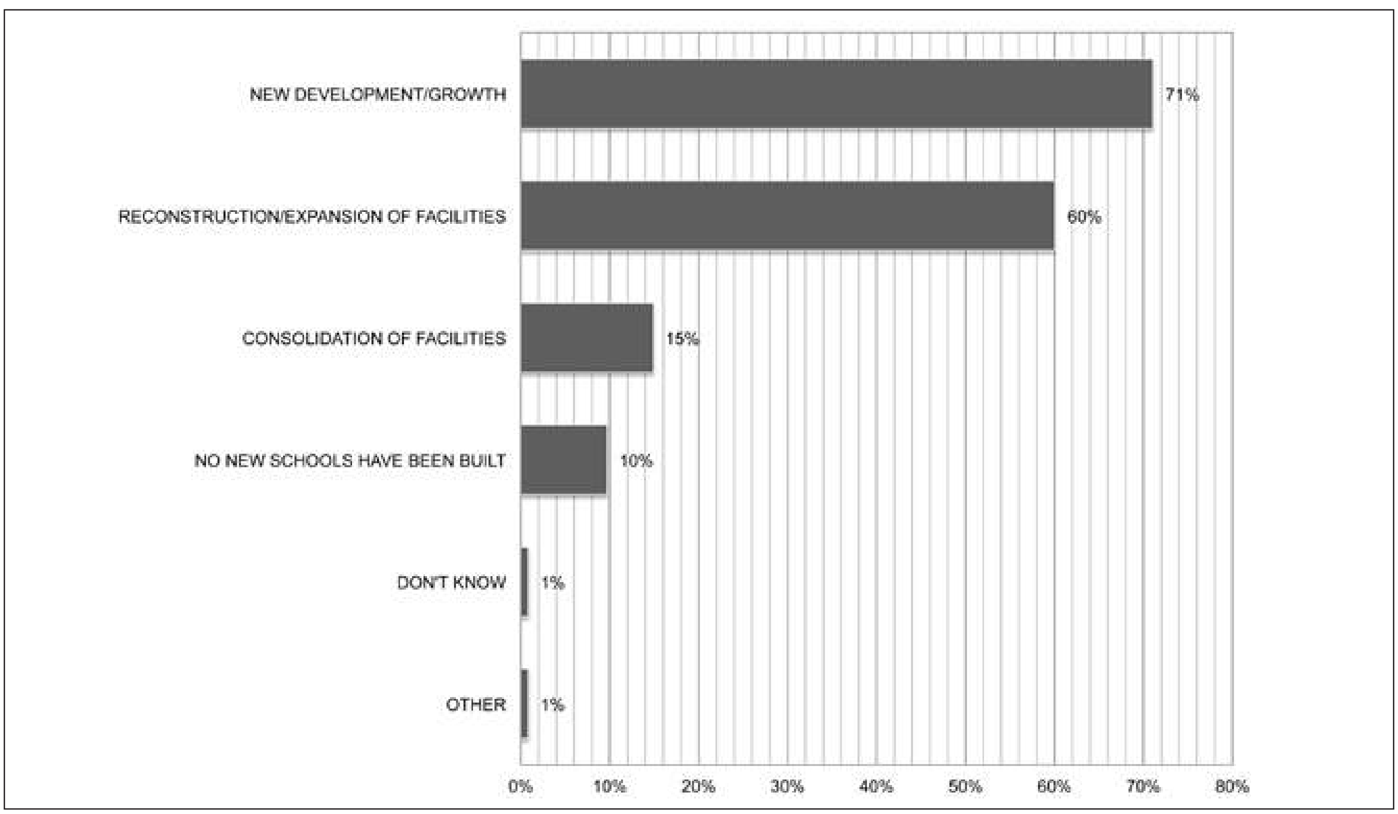
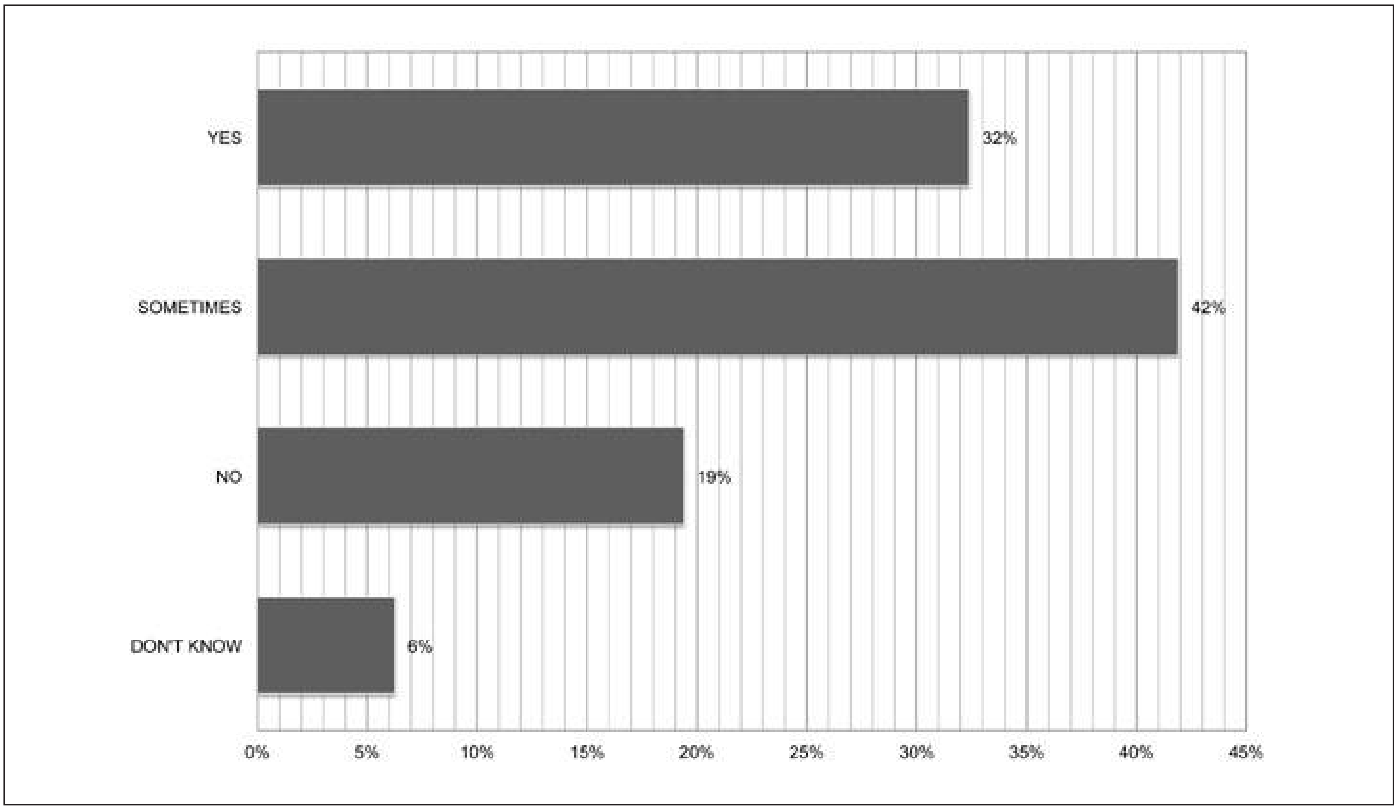


Table A-3. Are Elements of Walkable, Community-Based School Used in Design?



A.3 Elements of Walkable, Community-Based Schools Used in Design

Survey participants were asked if planners, transportation officials, and school officials in their communities are actively working to incorporate elements of walkable, community-based schools in the construction of new schools or the renovation and reconstruction of existing schools. The vast majority (74 percent) reported design elements for creating more walkable schools are used at least some of the time in school construction and renovations, with 32 percent responding "yes" and 42 percent responding "sometimes." Only 19 percent of the survey respondents stated these elements are not typically incorporated or considered in school design. Six percent reported that they did not know. The responses were consistent across all three surveys.

A.4 Methods Used to Create Walkable, Community-Based Schools

The 344 participants who answered they *are* incorporating design elements to make new and renovated schools more walkable and community-based were asked to identify the primary methods planners, transportation officials, and school officials employed to accomplish this goal. The responses were reviewed and evaluated to identify general categories of responses. Some individuals provided more than one response to this question. The following methods were reported as shown in **Table A-2** with the most common responses listed first. The two top categories of response included improved neighborhood connectivity to the school facility and developing better ways to select school sites to enable students to walk or bike to school.

A.5 Why Walkable, Community-Based Schools are Not a Goal

Individuals who stated creating walkable, community-based schools *is not* a goal in their community were asked to provide the reasons from their perspective. Opened-ended responses were allowed for this question and general categories of responses were developed. The following reasons were reported as shown in **Table A-3** with the most common responses listed first. A total of 189 responses were received with several individuals providing more than one response. The first response is rather disappointing and represents either a lack of concern for walking and bicycling or a lack of understanding of the health and fitness benefits of non-motorized trips to and from school. Creating walkable schools in rural areas is a challenge that often cannot be accomplished because of the large areas served and long distances involved. Regardless, smaller school populations will provide a greater oppor-

Table A-4. Methods Used to Create Walkable, Community-Based Schools.

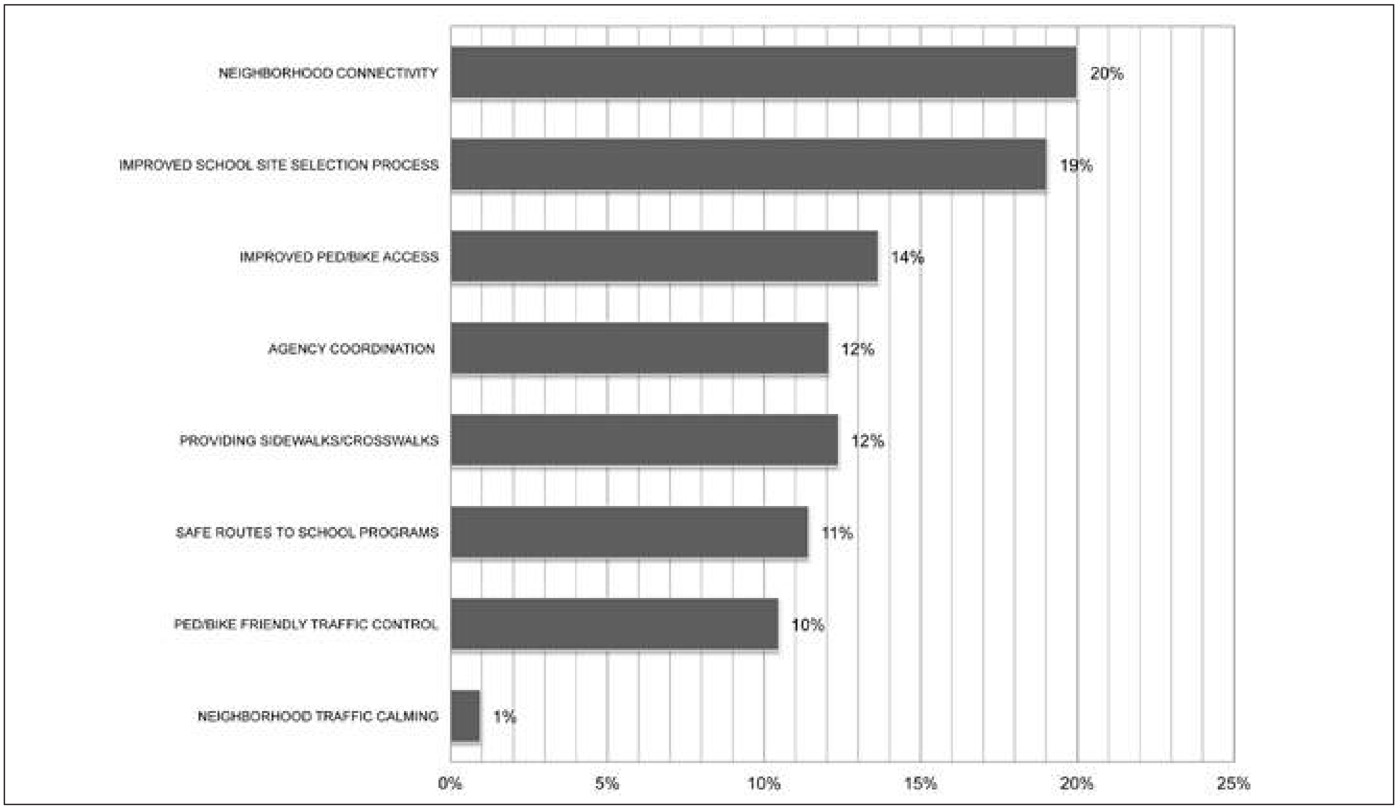


Table A-5. Why Walkable, Community-Based Schools is Not a Goal in Some Communities.

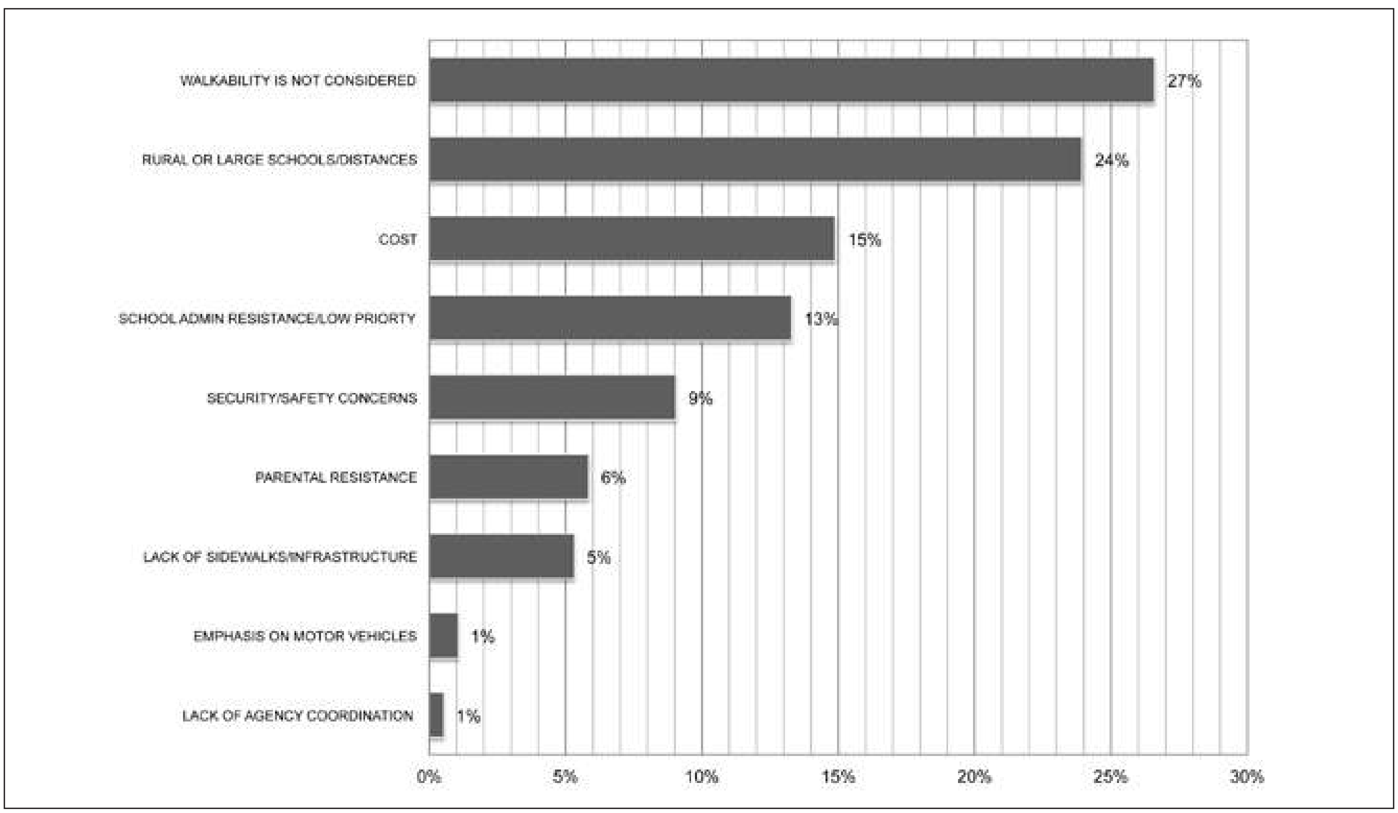
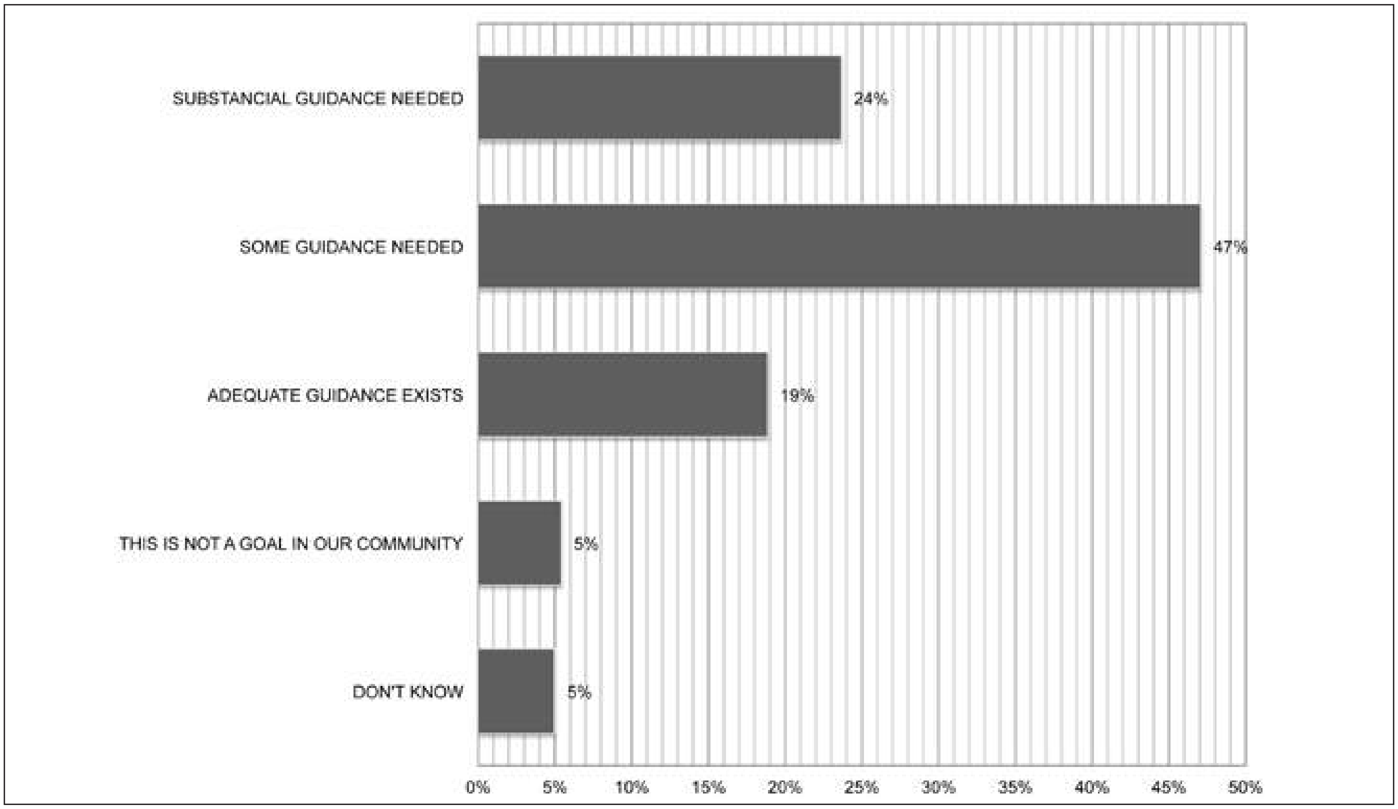


Table A-6. Are Better Guidelines, Policies, and Ordinances Needed?



tunity to walk or bike to school if the facilities for those modes of transportation are provided and barriers are removed or negated.

A.6 Are Better Guidelines, Policies, and Ordinances Needed

Table A-6 shows the responses to the question asking if better guidelines, policies, and ordinances are needed to support walkable, community-based schools. Overall, 71 percent responded "some" or "substantial" guidance is needed to help in the design of schools in their communities. Nineteen percent responded they already have adequate guidelines, polices, and ordinances in their communities to create walkable, community-based school designs and for school site selection. Interestingly, in the third survey group of school facilities professionals, only 11 percent stated substantial guidance is needed, while 31 percent stated adequate guidelines, policies, and ordinances already exist.

Five percent of respondents stated creating walkable, community-based schools is not a goal in their communities. While it is disappointing anyone would give this response, at least the number is low.

A.7 Types of Guidelines, Policies, and Ordinances Needed

Respondents who stated "substantial" or "some" additional guidance was needed for school site selection and design, were asked to identify the types of guidelines, policies, and ordinances needed. Participants were given eleven categories of responses from which to choose and were encouraged to offer other responses to this inquiry. Multiple responses were allowed from each respondent. An attempt was made to group those responses which listed "other" (with a description of the needed guidance), into one of the eleven general categories of responses. Those who did not specify a response are listed as "other." The results are shown in **Table A-7** below in descending order. At least half of the respondents indicated there was a need for improved guidance in crosswalks and pedestrian access, bus and student loading design, sidewalks, school site land selection, and connectivity requirements. The only topic that fell below a 24 percent response rate was security needs. These responses highlight a need for guidance involving a number of the topics covered in this report.

Table A-7. Types of Guidelines, Policies, and Ordinances Needed.

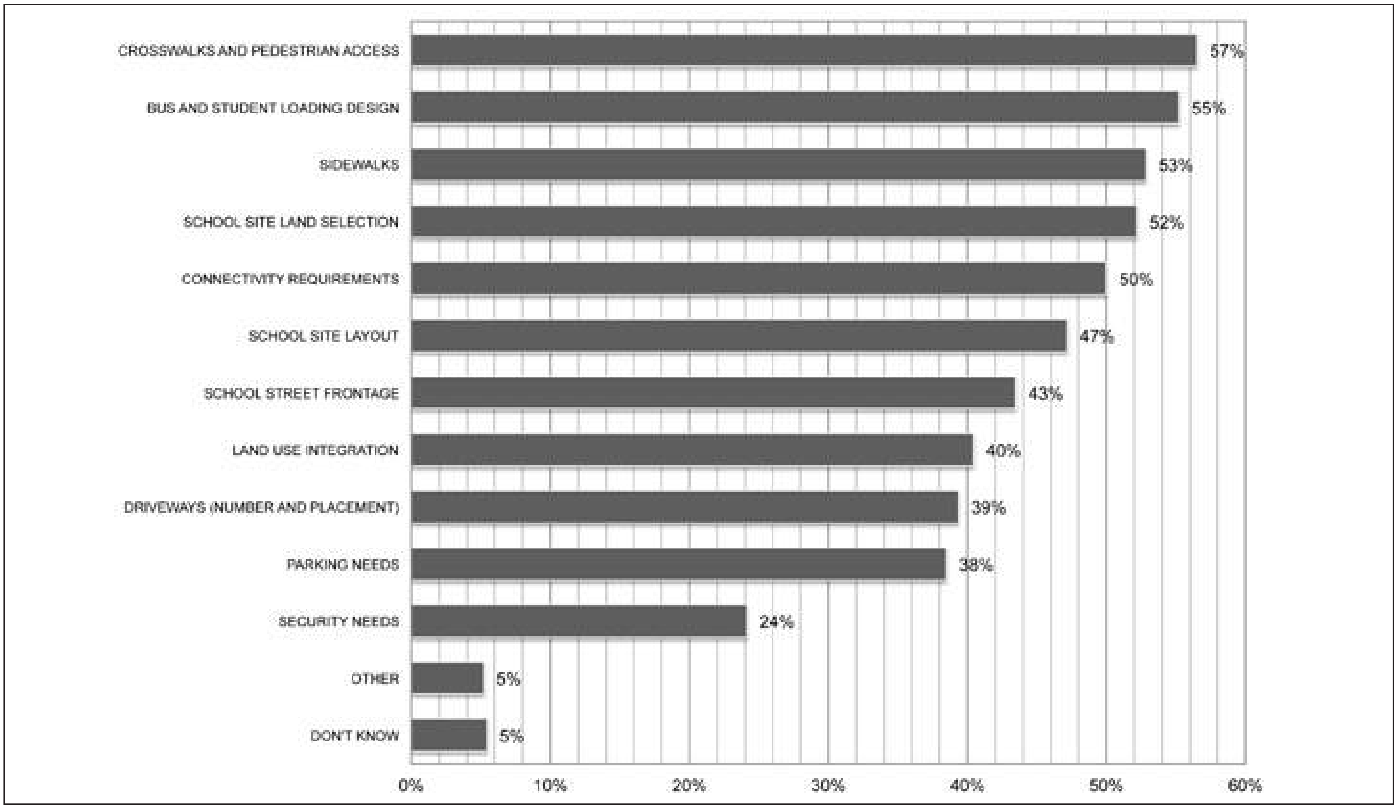


Table A-8. Do Existing Guidelines, Policies, and Ordinance Work Counter to the Principles of Walkable, Community-Based Schools?

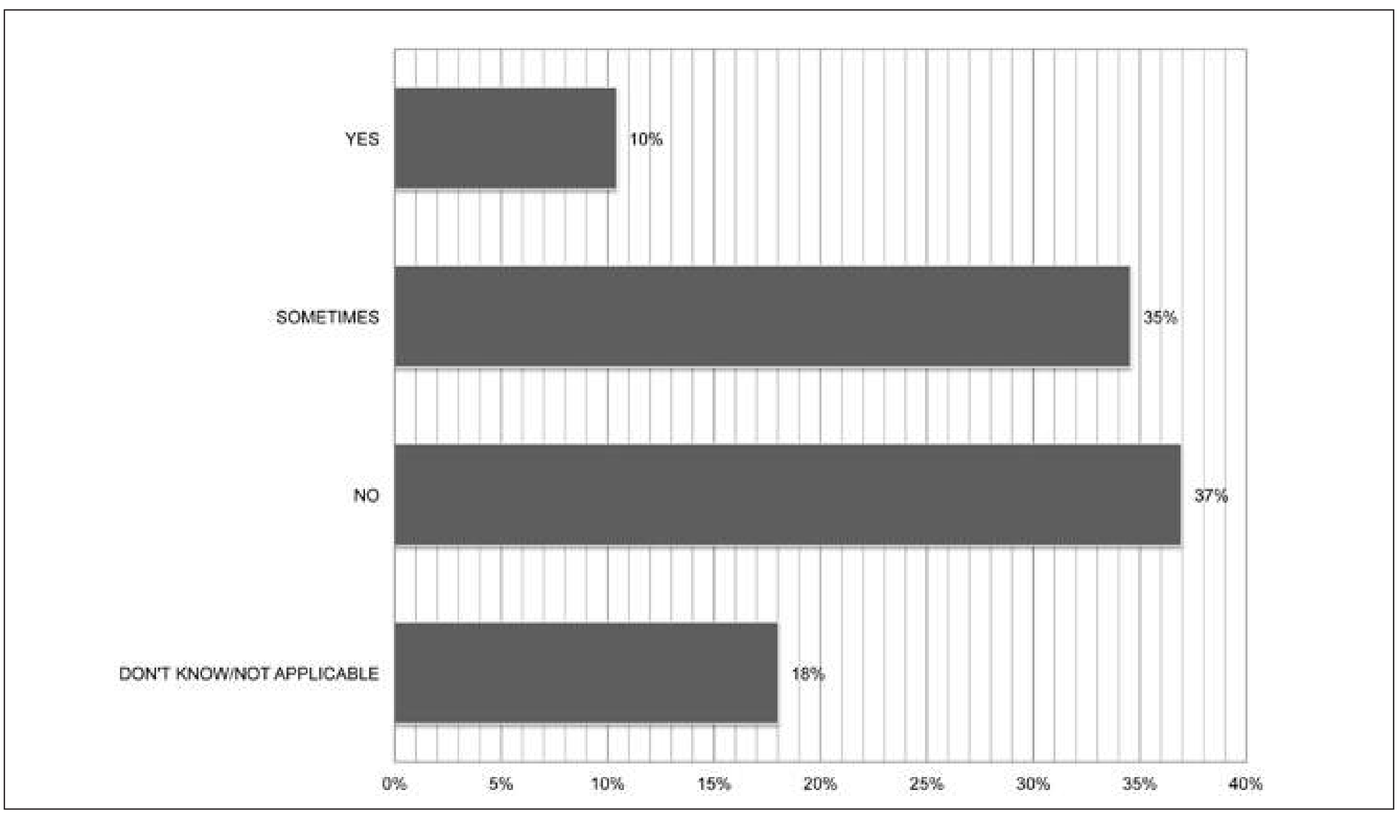
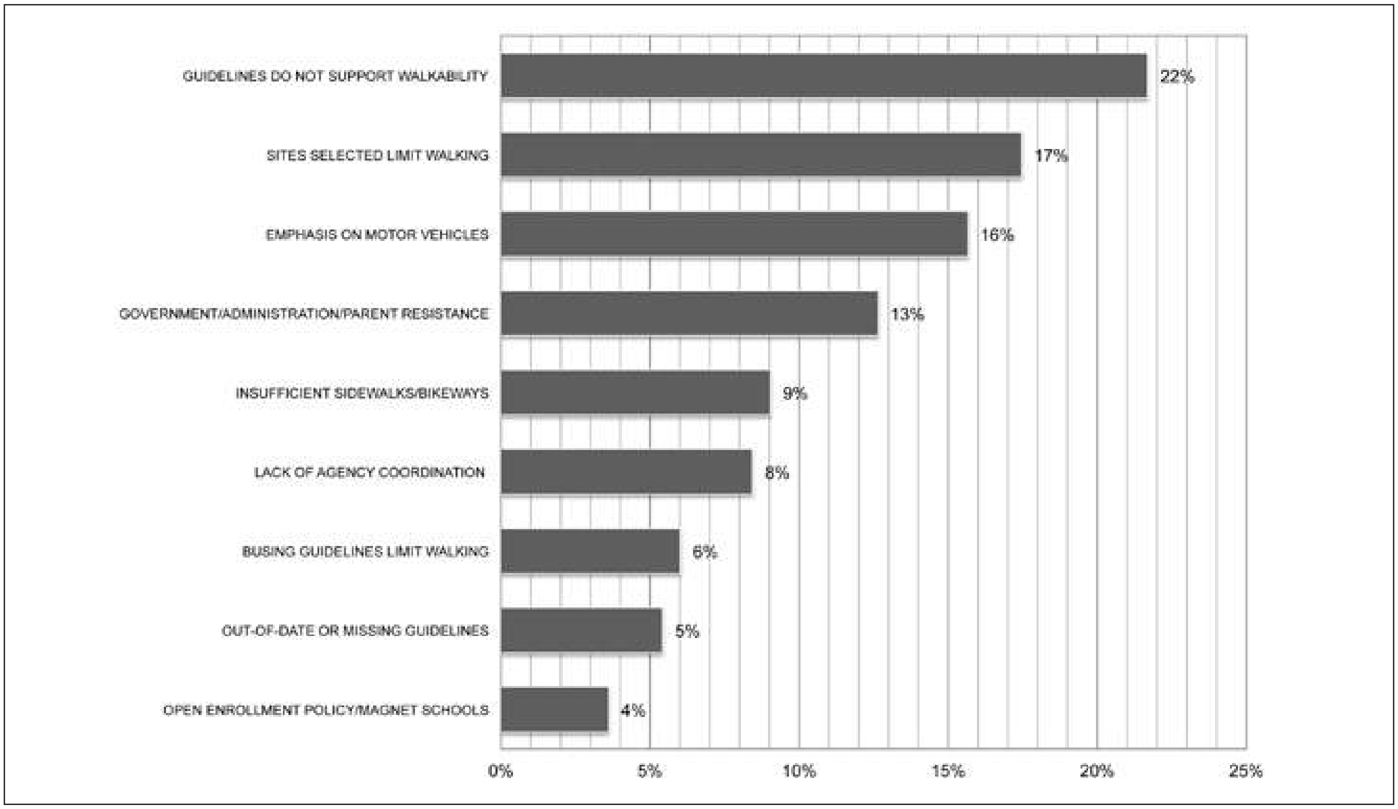


Table A-9: How Guidelines, Policies, and Ordinances Counter Walkable, Community-Based Schools.



A.8 Are Existing Guidelines, Policies, and Ordinances Counter-Productive

Another question asked if existing guidelines, policies, and ordinances work counter to the principles of walkable, community-based schools in their communities. Almost half (45 percent) of the survey participants answered "yes" (10 percent) or "sometimes" (35 percent). Another 37 percent responded that existing guidelines, policies, and ordinances in their communities did not work counter to the principals of walkable, community-based schools. This illustrates a need to change or improve the guidance, policies, or ordinances in many communities. A relatively sizable propotion of respondants (18 percent) stated either they did not know or that this question was not applicable to their community.

A.9 How Guidelines, Policies, and Ordinances Are Counter-Productive

The 207 respondents who answered "yes" or "sometimes" to the prior question were asked to explain how existing guidelines, policies, and ordinances worked counter to the principles of walkable, community-based schools. **Table A-9** is a listing of responses. No response categories were provided in the survey tool. Instead, the respondents were asked to describe or explain the areas where guidelines, policies, and ordinances created undesirable results and an attempt was made to create groups or categories of responses. A total of 166 responses were received and some individuals may have provided more than one response, while other individuals did not respond. The most common responses were existing guidelines do not support walking, favor sites that inherently discourage walking, and focus on vehicular traffic. Some respondents reported a resistance to walkable, community-based schools either from parents, government agencies, or school officials (13 percent).

A.10 Barriers to Walkable, Community-Based Schools

Respondents were asked to list the primary barriers to building walkable, community-based schools in their communities. Eleven response categories were provided and the survey respondents were asked to check all that applies. A total of 1,395 responses were provided, indicating several individuals provided multiple responses. Those who responded "other" and specified a reason were evaluated to determine if their responses could be grouped into one of the listed categories. If not, or if no further explanation was provided for their response, it remained listed as "other." The list of barriers is shown in **Table A-10** in descending order. The two most prevalent barriers to building walkable schools were difficulty in coordinating with multiple parties and cost. This may also indicate the cost of the school

Table A-10. Barriers to Walkable, Community-Based Schools.

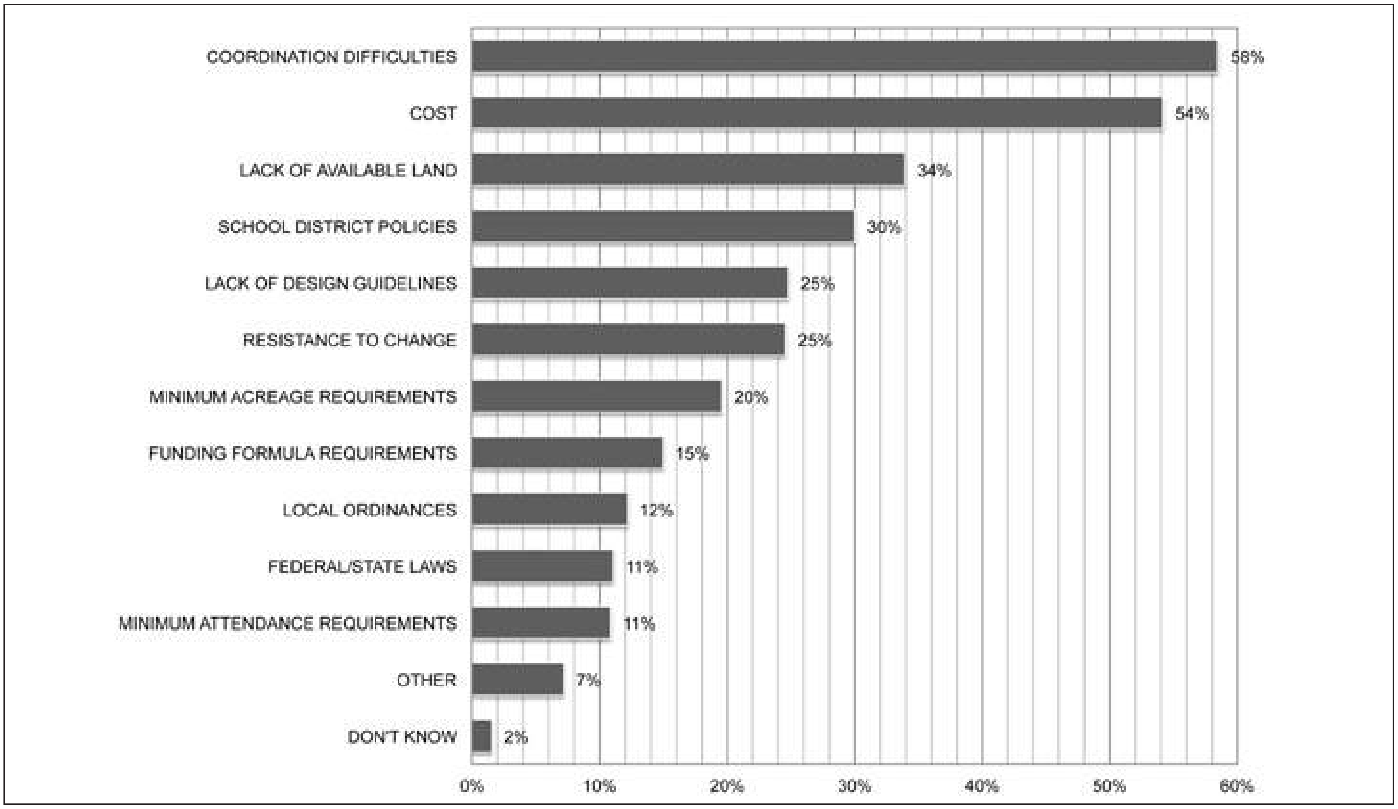


Table A-11. Local Government Involvement in School Site Review Prior to Land Acquisition.

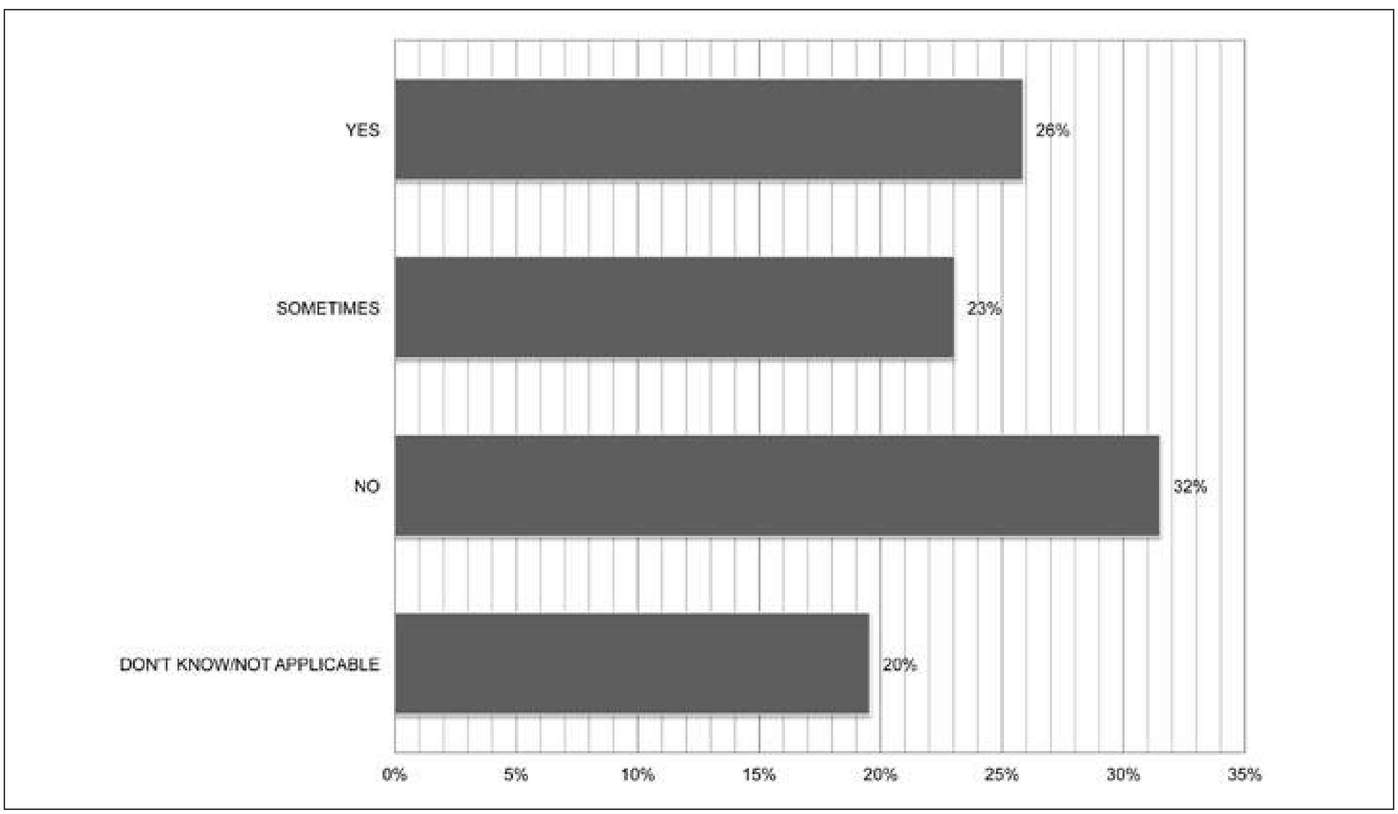
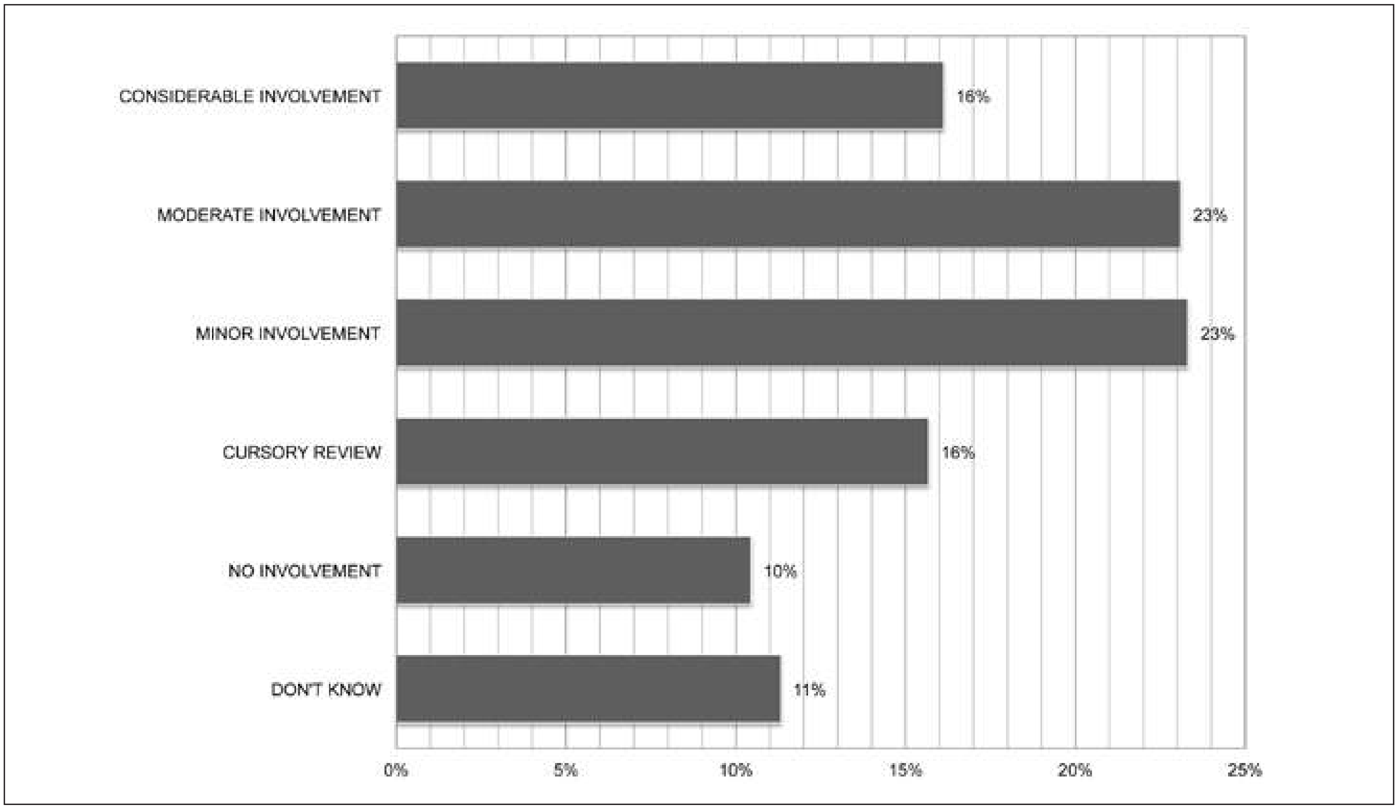


Table A-12. Level of Local Government Involvement in School Site Location and Design.



land parcel and initial construction is often short-sighted and might not consider the long-term costs of busing or community/societal costs resulting from a large portion of parents driving children to and from school. Other common responses included the lack of an available land parcel or school district policies that are counterproductive to establishing walkable, community-based schools. A lack of good design guidelines was also listed by 25 percent of the participants who responded to this question and a resistance to change was listed by 25 percent as well.

A.11 Local Government Involvement in School Site Review

Survey participants were asked the level of local governmental involvement in the review of school sites prior to a school district (or other school agency) acquiring land. While a sizable percent of the respondents (32 percent) did not know the practice in their jurisdiction (20 percent), nearly one third of the respondents stated the local govenrment agency did not review the school site prior to land acquisition by the school organization. Another 23 percent stated the local government was only sometimes involved in the review of land parcels prior to the acquisition by the school district. While local government assistance might not be as vital for experienced school districts with staff who know what to look for in a good land parcel, it leaves the local agency out of the picture for the purposes of planning and traffic safety. Additionally, it can be problematic if the school district is not experienced in selecting land parcels that best serve as walkable, community-based schools.

Slightly more than one out of four resondents (26 percent) reported the school always consults with the local agency before acquiring a parcel for a new school site. This response was higher (34 percent) from the third survey group directed to individulas in school-facility organizations.

A.12 Level of Local/County Involvement in School Location and Design

Table A-12 summarizes the responses to the level of involvement of local (or county) government in the location and design of new school sites or the reconstruction or rehabilitation of existing schools in the respondent's community. Five levels of responses were provided to this question. Only 16 percent responded there is a high level of local government involvement, while 39 percent stated the reviews by local governments are minor or cursory. Another 10 percent stated there is virtually no local government review of school sites. Eleven percent of the respondents stated they did not know the level of local government involvement in the location and design of school sites.

Table A-13. Level of State/Provincial Government Involvement in School Site Location and Design.

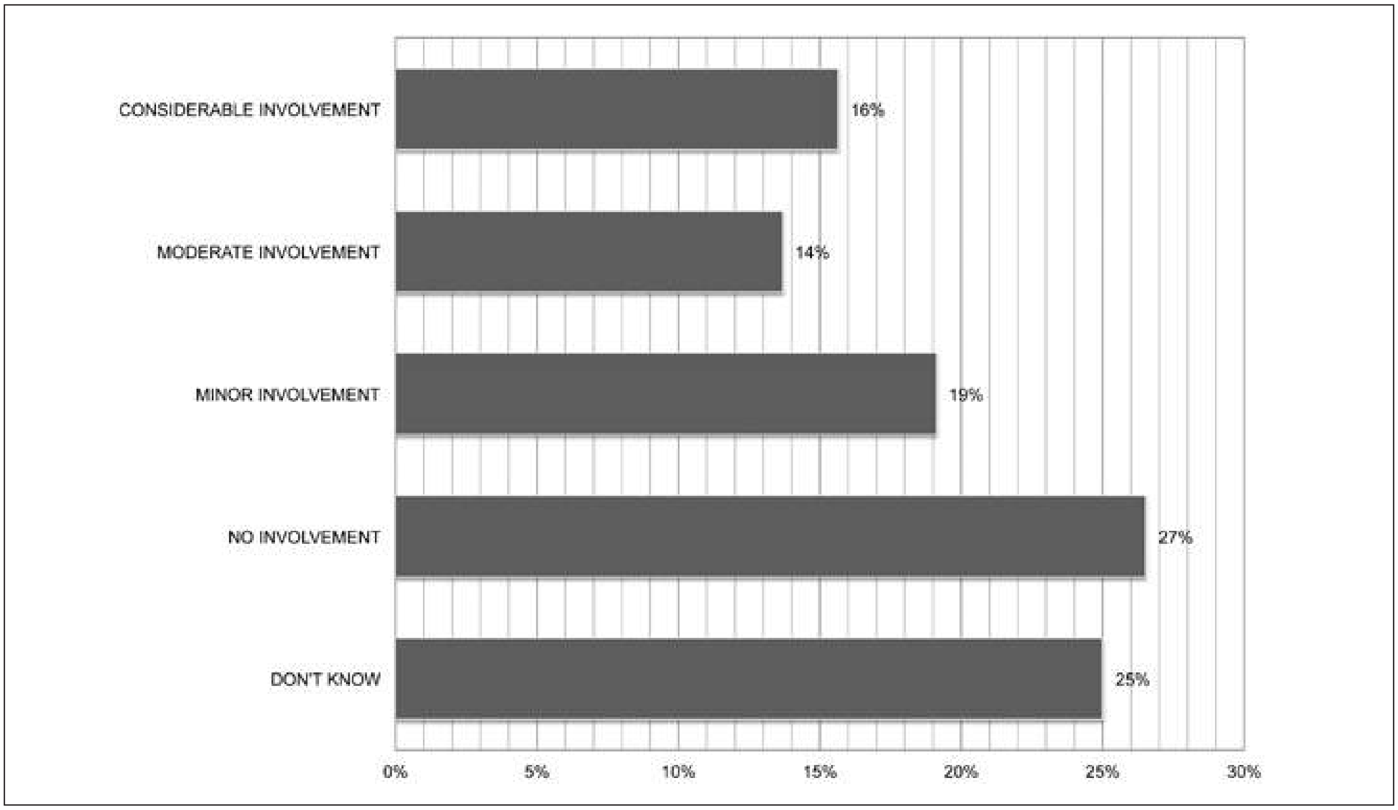


Table A-14. Level of Local Authority in Specific Areas of School Site Selection and Design.

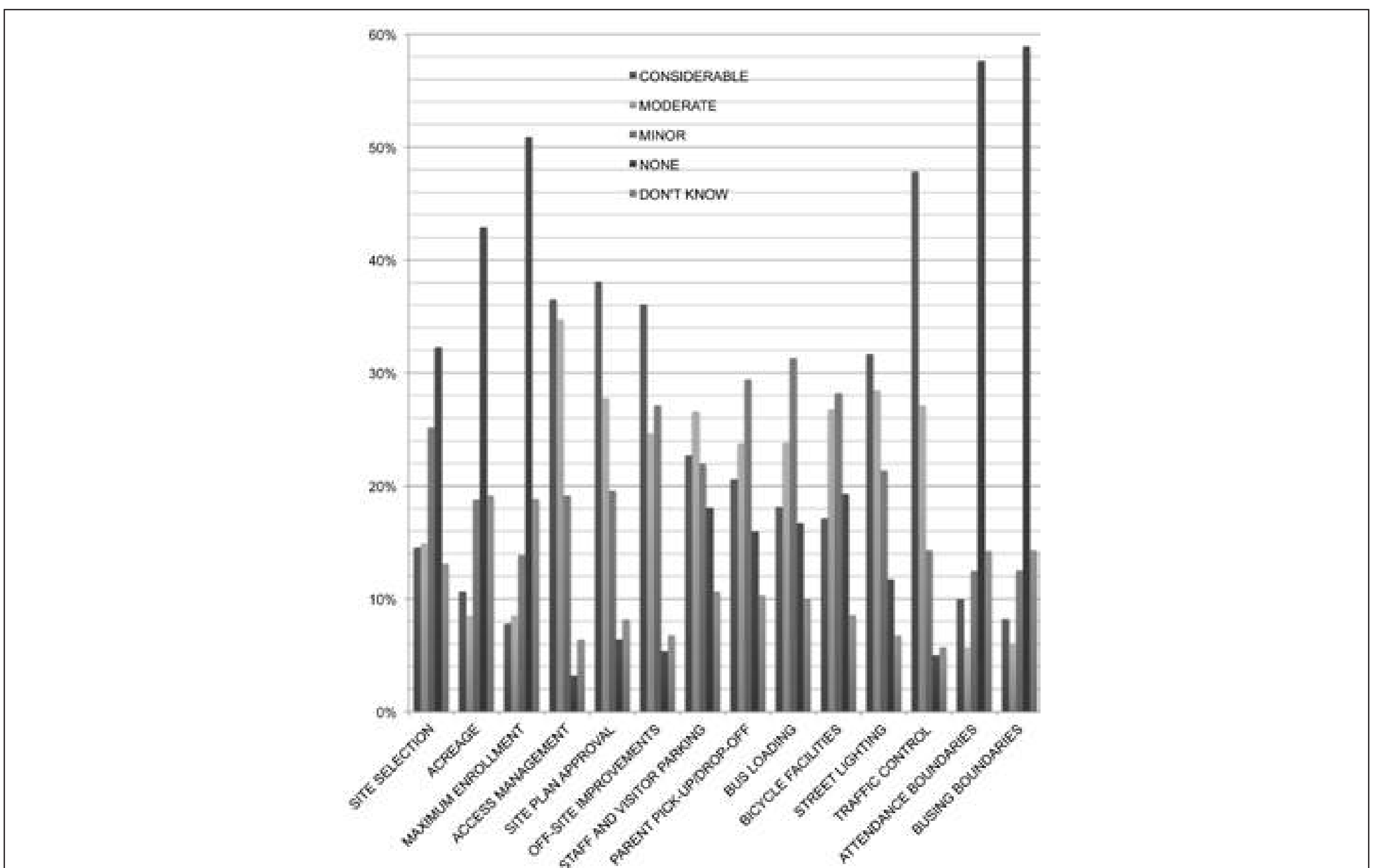
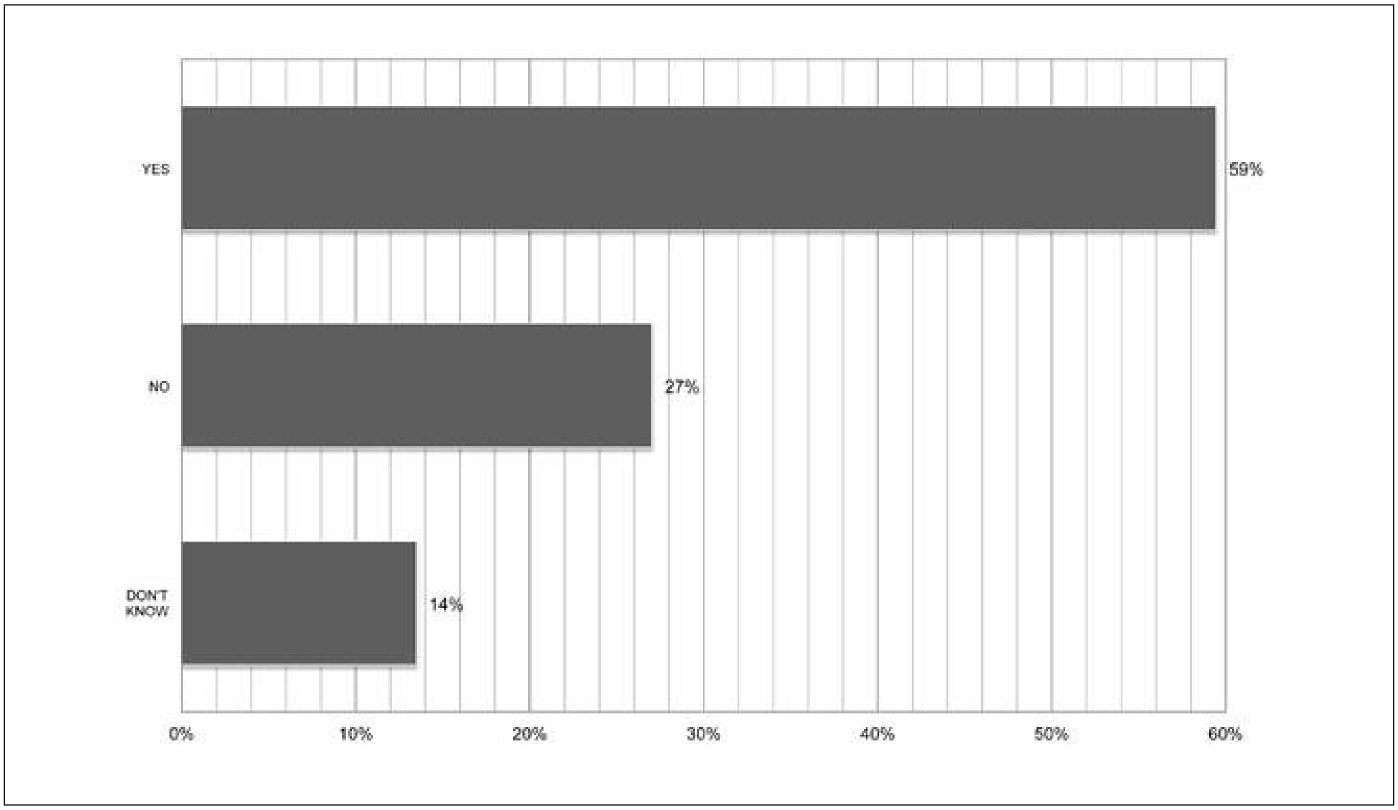


Table A-15. Are Schools Required to Comply with Local Zoning Codes/By-Laws?



A.13 Level of State/Provincial Involvement in School Location and Design

Respondents were also asked to identify the level of state or provencial government involvement in the location and design of school sites or the rehabilitation or reconstruction of schools in their communities. Four levels of responses were provided for this question. **Table A-13** presents the survey responses. About 30 percent reported the state or provincial government has moderate to high involvement in the location and design of school sites or rehabilitation/reconstructoin of schools, while 46 percent reported state or provincial government involvement appears to be minimal or nonexistant. One quarter of the respondents did not know the level of state or provincial involvement in their jurisdiction.

A.14 Level of Local/County Authority in School Location and Design

Table A-14 provides the responses to the question on the level of local/county government in various aspects of the school site selection, design, and layout. The respondents stated the local or county government agencies have the highest level of authority in issues such as school area traffic control, site plan approval, driveway approval/access management, off-site street and sidewalk improvements, and street lighting near the school facility. Respondents stated the local or county governments had the least amount of authority in issues such as busing boundaries, attendance boundaries, school size (maximum student enrollment), school size (acreage), and, to a lesser extent, school site selection.

A.15 Are Schools Required to Comply with Zoning Codes/By-Laws

Sections A.15 through A.19 summarize the responses to questions asked only in the second and third surveys distributed to organizations representing school officials in the U.S. and Canada (148 total survey responses).

Nearly 60 percent of the respondents stated schools are required to comply with local zoning codes or by-laws, while 27 percent stated schools are exempt from some or all of the zoning codes with respect to developments in their communities. Another 14 percent responded they did not know if schools had to comply with local zoning codes for new developments in their communities.

A.16 Ultimate Authority for School Site Selection

Table A-16 provides responses on who has the final authority on school site selection. The responses were largely provided by representatives from members of school facility organiza-

Table A-16. Ultimate Authority on School Site Selection.

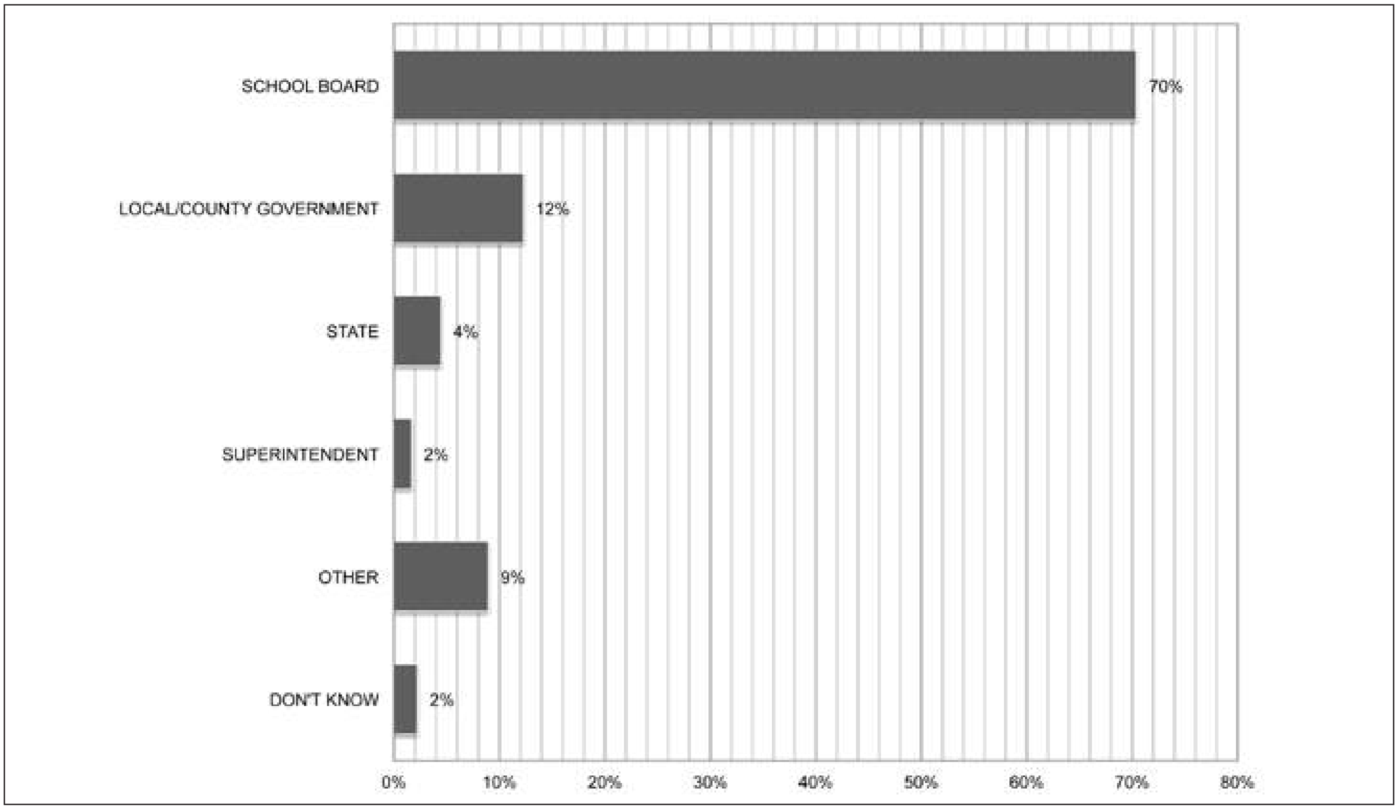


Table A-17. Are Off-Site Infrastructure Improvements Included in Construction Cost Estimates?

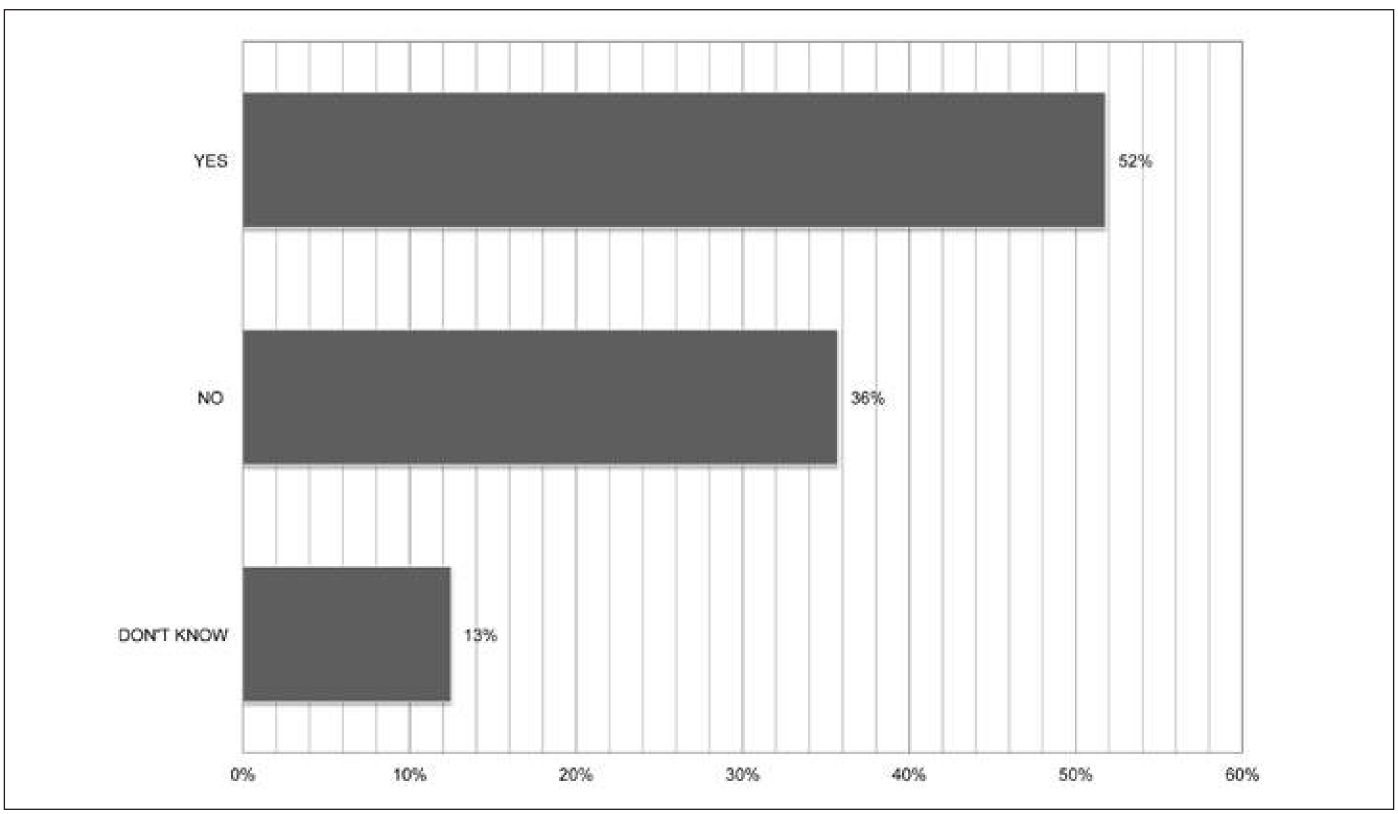
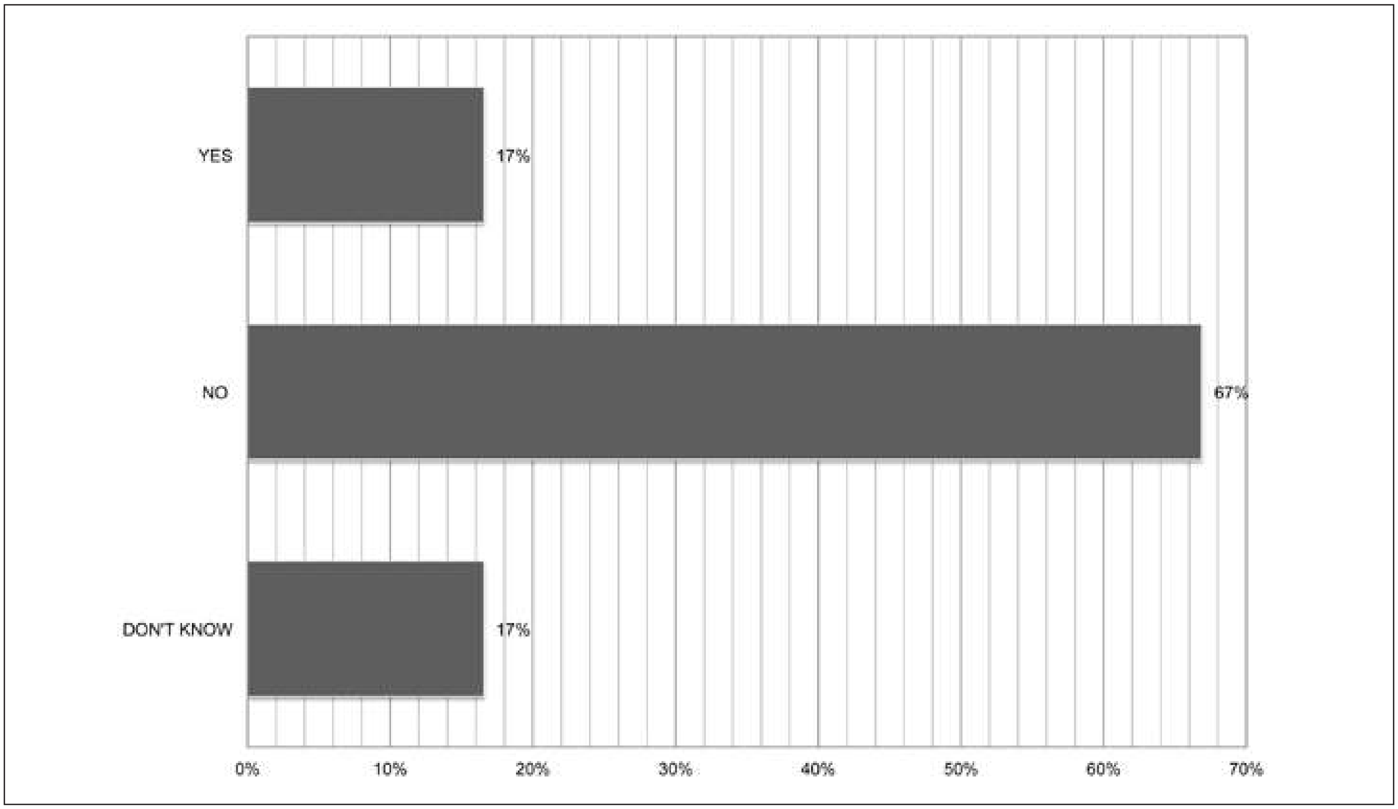


Table A-18. Are Long-Term Transportation Costs Included in School Site Cost Estimates?



tions. An overwhelming number of respondents stated the final decision on site selection rests with the school board or superintendent (72 percent). Twelve percent stated the local government has the final decision on school site selection, while nine percent reported some other entity or combination of the above has the final authority over individual school site selection in their communities. Very few individuals reported they did not know the answer to this question.

An overwhelming number of respondents stated the final decision on site selection rests with the school board or superintendent.

A.17 Are Off-Site Improvements Included in Construction Estimates

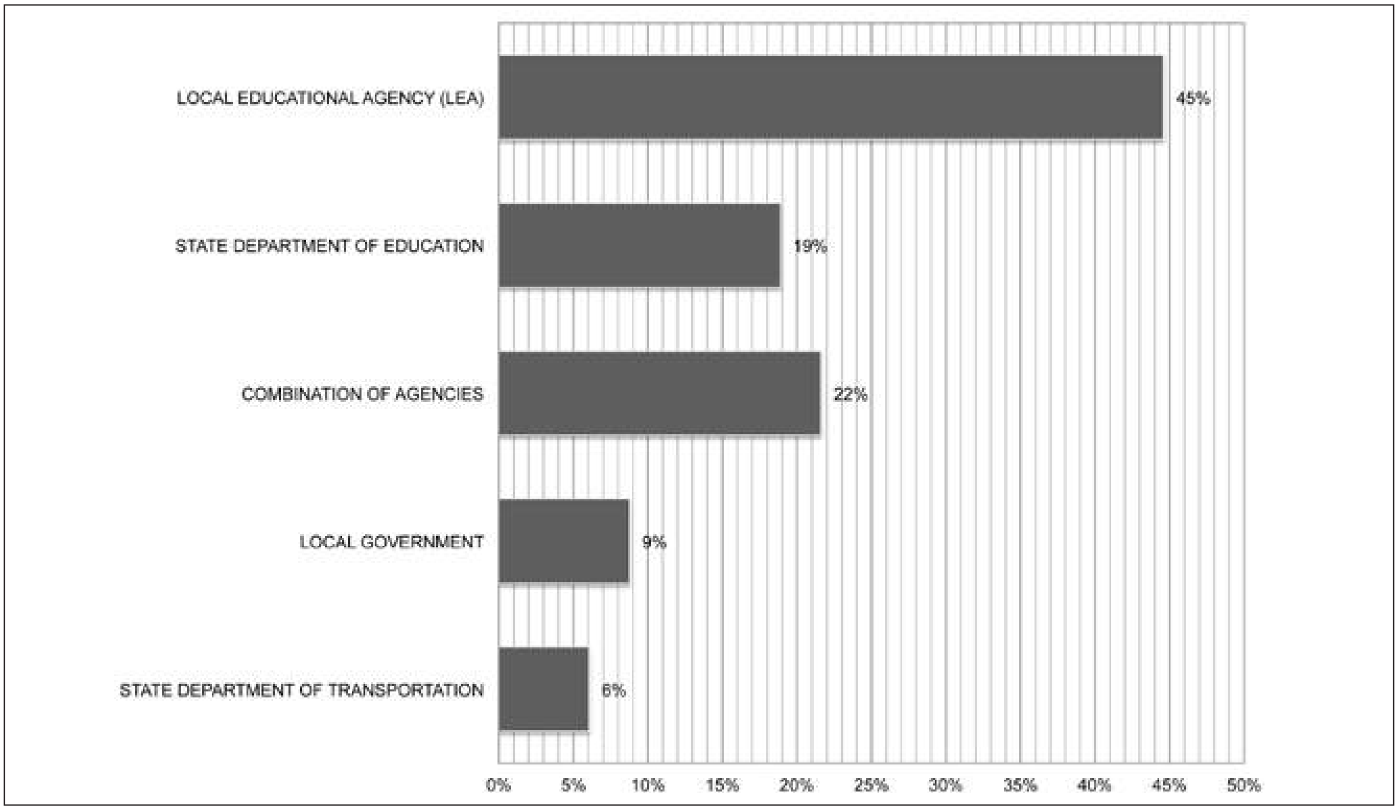
Respondents of surveys two and three were asked if street and other transportation infrastructure improvements are included in school construction cost estimates in their communities. Slightly more than half (52 percent) responded "yes", another 36 percent responded that they did not include transportation infrastructure important in school cost estimates, and 13 percent responded as "don't know." School districts that do not consider other roadway and transportation infrastructure costs in school construction cost estimates might be misled by the conclusions drawn when selecting a school site.

A.18 Are Long-Term Transportation Costs Included in Estimates

Respondents of surveys two and three were also asked if long-term transportation costs are included in the cost estimates for school site selection or construction decisions. Only 17 percent responded the long-term transportation costs are considered in the overall site-selection cost. Seventeen percent responded they did not know, while slightly more than two-thirds (67 percent) of those who responded reported long-term transportation costs are *not* considered in school site selection. These transportation costs, such as busing, are becoming more substantial as fuel costs rise and as the cost of buses and bus driver wages increase. In fact, the increase in transportation costs is leading to a reduction in busing in some school districts, requiring students to walk longer distances and face greater traffic challenges. These longer distances and greater roadway challenges subsequently encourage more parents to drive their children to school. This deprives students the opportunity to walk or ride their bikes to school and creates more traffic congestion and safety problems at the schools.

The group or individual making the decision regarding a school's size, enrollment, and boundaries of the school is not typically the same group or individual that will operate the school and live with those decisions. Consolidation of school

Table A-19. Source of School Transportation Funding.



sites, for example, might appear to reduce costs by eliminating redundant staff and resources. However, such a campus might prove to be more costly over the 20+ year life cycle of the school because of operating costs such as transportation, parking demands, and other ongoing operational expenses. Often, campus consolidation is not a cost saver for schools.

Often, campus consolidation is not a cost saver for schools.

A.19 Source of School Transportation Funding

Table A-19 summarizes the responses to the question asking respondents which entity funds school transportation in their districts. This transportation was intended to mean busing, either distance busing or "hazard" busing for students who have to cross challenging streets. Nearly half of the individuals reported local educational agencies (LEAs) are responsible for funding school transportation. The second most common response was a combination of agencies, with state agencies being the sole funding source in 25 percent of the responses. Obviously, if a parent decides to drive her children to school, that transportation cost is borne by the individual parent. As stated in the previous discussion, if busing is eliminated because of increasing costs, it often results in more parents driving their children to school.

A.20 Example Guidelines, Policies, Ordinances, and By-laws

Respondents in all three surveys were asked to provide examples of guidelines, policies, ordinances, and by-laws from their communities for school site selection that incorporate principles of walkable, community-based schools. The documents were then reviewed by the ITE Committee for consideration to be included in this report as a reference in an appendix. Sixty-seven individuals provided suggestions, documents, or examples of ordinances for review. The documents were distributed among volunteers to review and identify the provisions that best encourage good site selection and processes to encourage walkable, community-based schools. See **Appendix B** for the list of example guidelines, policies, and ordinances.

A.21 Observations and Conclusions of Survey

While not a scientific poll of professionals from across the U.S. and Canada, those surveyed working in school site selection and design provided valuable input. The overall responses reveal a need for additional guidance for both transportation officials and school officials. Decisions made concerning a school site might disrupt a community for years to come if careful thought and consideration is not given early in the process. A sizable portion of the professionals (19 percent) reported their communities are not using design elements that create walkable schools and another 43 percent state they "sometimes" use these design elements. A large portion of respondents stated they could benefit from some additional school site selection guidance (47 percent), while another 24 percent stated substantial guidance is needed to create walkable, community-based schools. Respondents stated they could benefit from more guidance in ten of eleven specific areas of guidance, with responses ranging from 47 percent to 69 percent of the survey participants. Areas of greatest need included crosswalks and pedestrian access, bus and student loading design, sidewalk design and placement, school site land selection, connectivity requirements, and school site layout.

The overall responses reveal a need for additional guidance for both transportation officials and school officials.

Nearly half of the respondents reported existing guidelines, polices, and ordinances work counter to the principles of walkable, community-based schools at least some of the time (45 percent of respondents), with another 18 percent stating they did not know. For those who responded "yes" or "sometimes" to this question, the major problem is existing guidelines are not designed to encourage walkable schools and others reported poor site selection often prevents many students from walking and biking to school.

When asked about the primary barriers to creating walkable, community-based schools, the most common response included coordination among the agencies involved in the school site selection and design (school district, developer, local government, and parents). This is a barrier agencies should be able to overcome, especially if improved guidelines are developed. The second most common response was cost. However, the surveys demonstrate many school districts do not consider the cost of roadway and transportation infrastructure improvements in the overall school construction cost estimate and a large proportion do not include long-term transportation (operating) costs when evaluating a site. This is short-sighted, but not uncommon. Other barriers to good school site design included lack of available land parcel, existing school district policies that work counter to walkable schools, lack of good guidelines, and resistance to change.

For improved school site selection and design, it is imperative for school officials to work closely with local agencies, especially in the development process, to identify the best school sites. However, 32 percent of the respondents reported this coordination does not take place in their communities and another 23 percent reported this coordination only occurs "sometimes." This is not to imply school officials are the sole agencies to blame in this matter. In some communities, local officials might consider school site selection and design the responsibility of the school district along with their design consultants and architects. Ultimately, the survey responses indicate a desire to implement new guidelines.

Ultimately, the survey responses indicate a desire to implement new guidelines.

APPENDIX B: ADDITIONAL REFERENCES

There are numerous references, studies, ordinances, and other resources available concerning school site selection, design, and transportation. Readers of this informational report are encouraged to seek further information on this topic to provide additional support for the necessity of designing walkable, community-based schools for the safety, health, and general well-being of all school children and the communities in which they live. The resources included in this appendix include the collective references used throughout this informational report, as well as the documents suggested by the participants of the three surveys described in Appendix A, as well as other studies and resources recommended by the ITE-TENC 105-1 committee members and ITE Traffic Engineering Council. The resources have been categorized by the following types for ease of use:

Americans with Disabilities Act (ADA) and Accessible Design Resources

Attendance Boundary/Catchment Areas and Walking Distances

Barriers to Walking Students

Benefits of Walkable, Community-based Schools

Bicycle Facility Design

Environmental and Health Impacts of School Siting

Enrollment, Size, and Number of Schools

Financial Impacts of School Siting

Parking Demands and Requirements

Pedestrian Safety Studies

Ordinance and Policy Guidance

Safe Routes to School Information

Student Safety Patrols

School Site Selection, Design, Access, and Operations Studies and Guidance

School Vehicle Trip Generation

Social Inequity Impacts

Student Drop-Off and Pick-Up Area Studies

Traffic Control Devices

Walking, Bike Riding, and Driving Trends and Studies

Walk to School Day Events

Walkability Recommendations, Checklists, and Tools

Americans with Disabilities Act (ADA) and Accessible Design Resources

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Traffic Engineering Council

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix F

ITRE School Traffic Trip Generation Calculator

Evaluation and Data Collection

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RESEARCH & DEVELOPMENT

School Traffic Trip Generation Calculator Evaluation and Data Collection

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Supplementary Notes:		

16. Abstract

This project focused on the collection of new data to add to the NCDOT School Traffic Calculator (STC), with a specific focus on estimates generated for vehicular rates and queue length. School travel data was collected at schools across North Carolina. This sample included schools of various types in varied geographic areas. Schools continue to be constructed at a rapid pace across North Carolina as the state experiences population growth, particularly in urban regions. Furthermore, existing schools throughout North Carolina and the U.S. continue to experience increases in child passenger pick-up and drop-off, regardless of school age or location (NHTSA, 2009). As a result, accurate estimation of school site queue length needs and trip generation rates are critical to maintaining and improving the transportation safety of North Carolina's communities.

This work is significant for NCDOT due to the potential for enhanced accuracy of school travel mode and queue length estimation. Increased accuracy in queue length needs will lead to school site design and traffic management plans that better accommodate school travel demand and corresponding needs. Effectively accommodating passenger vehicle queues will promote improved traffic safety and operations in communities throughout North Carolina with new school construction and existing schools that have difficulties with queue spillover into surrounding roadways.

The most robust estimates and updates to the calculator recommended based on this research study are drawn from the public elementary school sample (n = 13, while all other samples had seven or less observations). For this category, the existing STC high demand length estimate is comparable to the high demand length projected from the field data. To ensure a conservative estimate of queue lengths, a 95th percentile estimator was implemented in the calculator recommendations.

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DISCLAIMER

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EXECUTIVE SUMMARY

This project focused on the collection of new data to add to the NCDOT School Traffic Calculator (STC), with a specific focus on estimates generated for vehicular rates and queue length. School travel data was collected at a total of 27 schools across North Carolina. This sample included schools of various types in varied geographic areas. Schools continue to be constructed at a rapid pace across North Carolina as the state experiences population growth, particularly in urban regions. Furthermore, existing schools throughout North Carolina and the U.S. continue to experience increases in child passenger pick-up and drop-off, regardless of school age or location (NHTSA, 2009). As a result, accurate estimation of school site queue length needs and trip generation rates are critical to maintaining and improving the transportation safety of North Carolina's communities. This work is significant for NCDOT due to the potential for enhanced accuracy of school travel mode and queue length estimation. Increased accuracy in queue length needs will lead to school site design and traffic management plans that better accommodate school travel demand and corresponding needs. More effective accommodation of passenger vehicles will promote improved traffic safety and operations in communities throughout North Carolina with new school construction and existing schools that have difficulties with queue spillover into surrounding roadways.

The most robust estimates and updates to the calculator recommended based on this research study are drawn from the public elementary school sample (n = 13, while all other samples had seven or less observations). For this category, the existing STC high demand length estimate is comparable to the high demand length projected from the field data. To ensure a conservative estimate of queue lengths, a 95th percentile estimator was implemented in the calculator recommendations stemming from this research. The queue and survey data collected by the research team was used to validate the existing STC. Based on the validation results, two major computational changes to the calculator model are proposed: 1) calculating the max queue length from the 95th percentile of available data and 2) using a weighting system based on grades instructed at a school.

An on-going NCDOT research project, 2021-15: Evaluation of School Travel Patterns and Preferences, will provide further updates to the calculator. The updated calculator provided with this report is intended as an interim deliverable, and with the exception of public elementary school predictions, should not be used for school design until RP 2021-15 is complete. The specific efforts include expanding the sample size of locations with highly variable estimates, evaluating trends related to school travel, comparing loading/unloading zone techniques, and developing recommendations for modeling school locations in Synchro. In RP 2021-15, school travel data will be collected by the research team at schools across North Carolina, varying by school type and geography with a focus on school types/characteristics that have highly variable queue length estimates. This new data will be paired with existing STC data. Loading/unloading zones will also be studied to help identify and quantify the most beneficial practices. A couple of additional measures are recommended for a future update of the STC: 1) surveying a sample of schools to determine the distribution of student drivers by grade level and 2) visiting a larger sample of private/non-urban charter and urban charter schools. Both of these actions will be included in NCDOT RP 2021-15 which will further expand the sample size for the STC.

TABLE OF CONTENTS

INTRODUCTION

A school site's capacity for managing traffic during intensive, peak intervals is a traffic safety issue that has efficiency and safety implications for all modes of school travel. In North Carolina, the NCDOT Municipal School Transportation Assistance (MSTA) group reviews Transportation Impact Assessments (TIA) submitted during school site planning for public, private, and charter school systems. Each TIA includes estimates of queue length needs from the MSTA School Traffic Calculator. These estimates are derived from school-specific factors, such as type of school (e.g. Public, Urban Charter, Non-Urban Charter, Private) and student population size. NCDOT approval of proposed school site plans often depends on the projected campus storage capacity to accommodate TIA-estimated passenger vehicle queue lengths and school bus parking.

To support the school siting process, the NCDOT MSTA group developed the School Traffic Calculator (STC) to help predict the vehicle-trips that will be generated by a new school. The highly-utilized planning tool is embedded in the NCDOT approval process for proposed school sites in North Carolina. However, the STC was developed based on a relatively small school travel dataset, with less than 10 observations for both urban and non-urban charter and private schools. Additionally, the public school data used to generate the calculator's estimates were collected more than 10 years ago, yet the prevalence and demand for passenger vehicle pick-up and drop-off may fluctuate as travel behaviors change over time. Consequently, the STC needed to be evaluated and updated to ensure the accuracy of the school travel mode rate and queue length estimations. North Carolina General Statute 136-18(29a)[1] guides the work of the MSTA group.

[1] The introduction of North Carolina General Statute 136-18(29a) includes:
To coordinate with all public and private entities planning schools to provide written recommendations and evaluations of driveway access and traffic operational and safety impacts on the State highway system resulting from the development of the proposed sites. All public and private entities shall, upon acquiring land for a new school or prior to beginning construction of a new school, relocating a school, or expanding an existing school, request from the Department a written evaluation and written recommendations to ensure that all proposed access points comply with the criteria in the current North Carolina Department of Transportation "Policy on Street and Driveway Access."

LITERATURE AND DATA REVIEW

The safe arrival and departure of students to and from school is a traffic safety and operational design focus that relies on transportation infrastructure (e.g., driveways, unloading and loading zones, parking lots, walkways, etc.) on the school's campus to manage traffic during intensive, peak intervals. This includes all modes of school travel – pedestrians, bicyclists, school buses, and passenger vehicles. School travel safety research indicates that passenger vehicles account for 84% of all student travel injuries and 75% of student travel fatalities (Rhoulac, 2005). Therefore, designing school sites capable of safely managing passenger vehicle traffic is a key factor in the safety of all students traveling to and from school. Accordingly, the planning, selection, and design of a school site should reflect safety considerations for all students.

Passenger Vehicles and School Safety

Transportation safety at schools becomes a primary concern when campuses must handle a substantially greater volume of passenger vehicles than they were designed to manage (Isebrands, 2007). Passenger vehicles can impact school safety in two specific ways. First, on-site congestion can result in passenger vehicle crashes with pedestrians, as sidewalk networks may intersect with passenger vehicle queue areas and school entrances. Second, a school's capacity to store passenger vehicle traffic at peak periods directly impacts the safety of adjacent roadways due to queue spillback. Queue spillback onto roadways can reduce the function and safety of routes, particularly during afternoon pick-up due to concurrency with afternoon commute traffic and the concentration of afternoon pick-up of students (Tsai et al., 2004).

While school buses have a dedicated loading and unloading zone, child passenger pick-up and drop-off can require a significant portion of a school site's footprint to accommodate queue lengths that may be extensive, particularly during afternoon release. While the issue of adequate queue length and corresponding implications for traffic safety is generally understood by traffic engineers and planners, many school sites cannot currently accommodate the high demands of arrival and dismissal (Isebrands, 2007). This is due to the nature of planning, as forecasted travel choice can vary from actual travel behavior, select schools may experience overcrowding, and other factors such as rapid population growth within a region. A study of school traffic in North Carolina discovered that "about 50% of the schools experienced queues in the afternoon that exceeded their on-campus vehicle storage space" (Tsai et al., 2004).

School Travel Data

The National Center for Safe Routes to Schools (National Center) collects a robust dataset of student mode choice at a sample of schools in North Carolina. Homeroom teachers surveyed homeroom students to determine which mode they used to travel to and from school on the day of the survey. The dataset contains data from the tallies that schools collected, including the month and year they were collected, the teachers who completed the tallies, the teacher-reported weather, the time of day, and the number of students who used various travel modes to get to and from school.

The National Center provided the research team with data from schools that participated in the tally gathering effort for one to five years between 2007 and 2019. The research team used the tally dataset along with school population data to estimate the schools' student mode split during morning (AM) drop-off and afternoon (PM) release periods. Average mode split by grade was derived from the reported homeroom student mode choice, which was then used to estimate the total students at the school traveling by each mode. The methodology used to calculate the estimated mode split by school is outlined in the following equations.

Equation 1. Average Mode Split by Grade:

$$MS_{ia} = \frac{\sum_{x=1}^{n} \frac{Students\ in\ Class_x\ Traveling\ by\ Mode_i}{Total\ Student\ Responses\ in\ Class_x}}{n}$$

Where,
MS_{ia} = Mode split of students in grade a traveling to school by mode i
n = total homeroom classes in grade a

Equation 2. Average Mode Split by School:

$$MS_i = \frac{\sum_{a=k}^{12} MS_{ia} * MLD_a}{\sum_{a=k}^{12} MLD_a}$$

Where,
MS_i = Mode split of students at school travelling to school by mode i
a = grade
MLD = Membership of grade a on last day of month

The frequency of student school travel by mode (Figure 1) shows that the highest proportion of PM trips are made by bus (average of approximately 50% of trips), followed closely by personal vehicle trips (average of approximately 40% of trips). Non-motorized trips represent approximately 10% of trips, on average. Using this data, the schools with travel mode share significantly above the mean in the PM period are shown in Figure 2 (personal vehicle), Figure 3 (bus), and Figure 4 (non-motorized)[2].

Observations

The results of this analysis show that single family mode share at schools varies based on geography and student population. An online web application with summary statistics is available at ArcMap Online. Researchers made the following observations regarding school travel in North Carolina:

- The two most utilized modes of transportation are single family vehicles and school bus.
  - Schools with higher single family vehicle mode share had lower school bus mode share.
  - Rural schools had a higher school bus mode share than many urban schools.

[2] An ArcGIS Web Mapping Application summarizing results is available for viewing at the following website: https://ncsu.maps.arcgis.com/apps/webappviewer/index.html?id=396cd5338722429c8fa3882b238259ee

- Schools with higher rates of walking mode share are located in small town grids or within a fifteen-minute walking radius of denser single family residential developments.
- Very few schools had a bicycling mode share greater than 3%.
- No substantial changes in travel mode were noted over the time frame of the observations (2007 to 2019) available in this dataset.

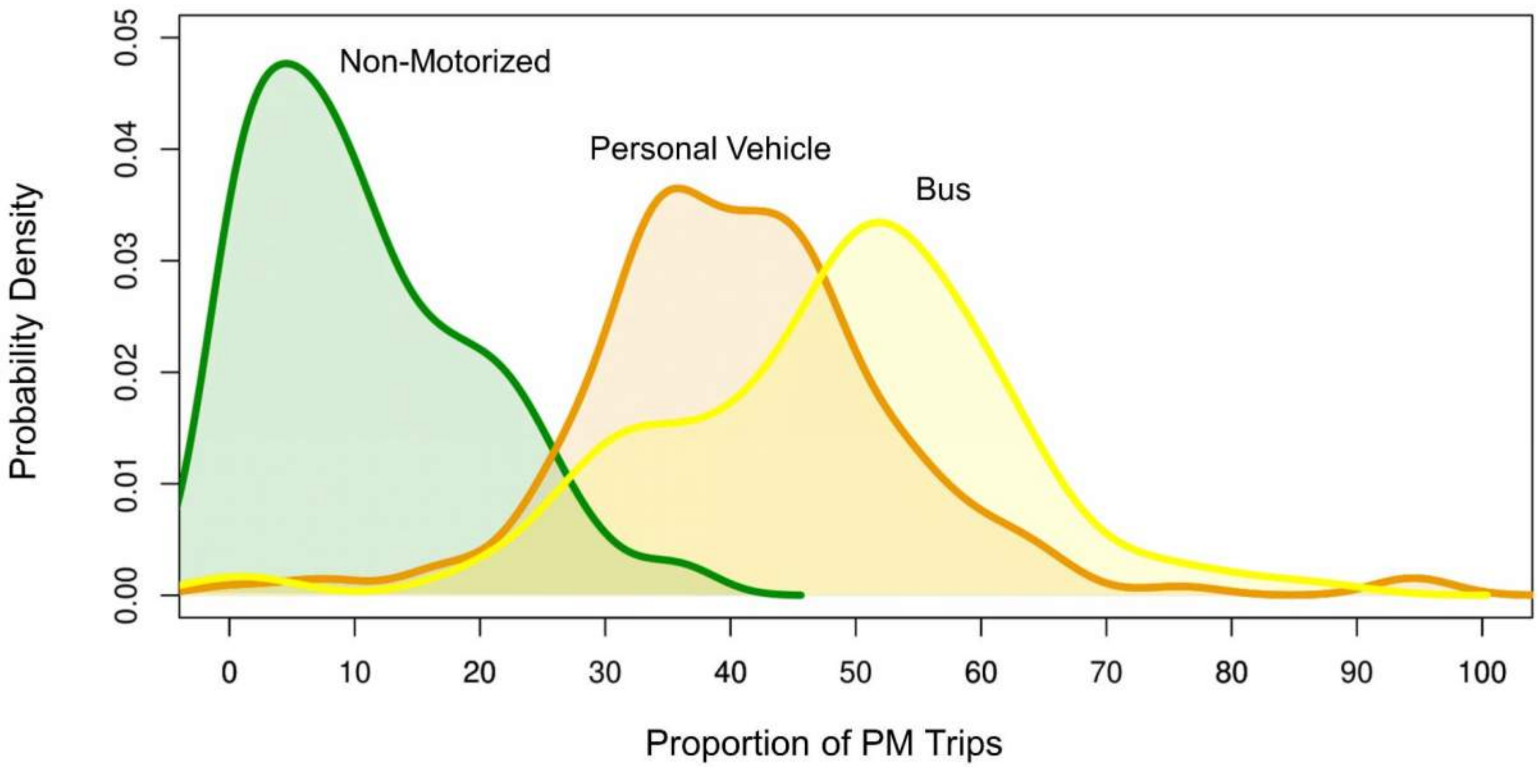

Figure 1. Frequency of Student School Travel by Mode in North Carolina [Non-Motorized, Personal Vehicle, and Bus]

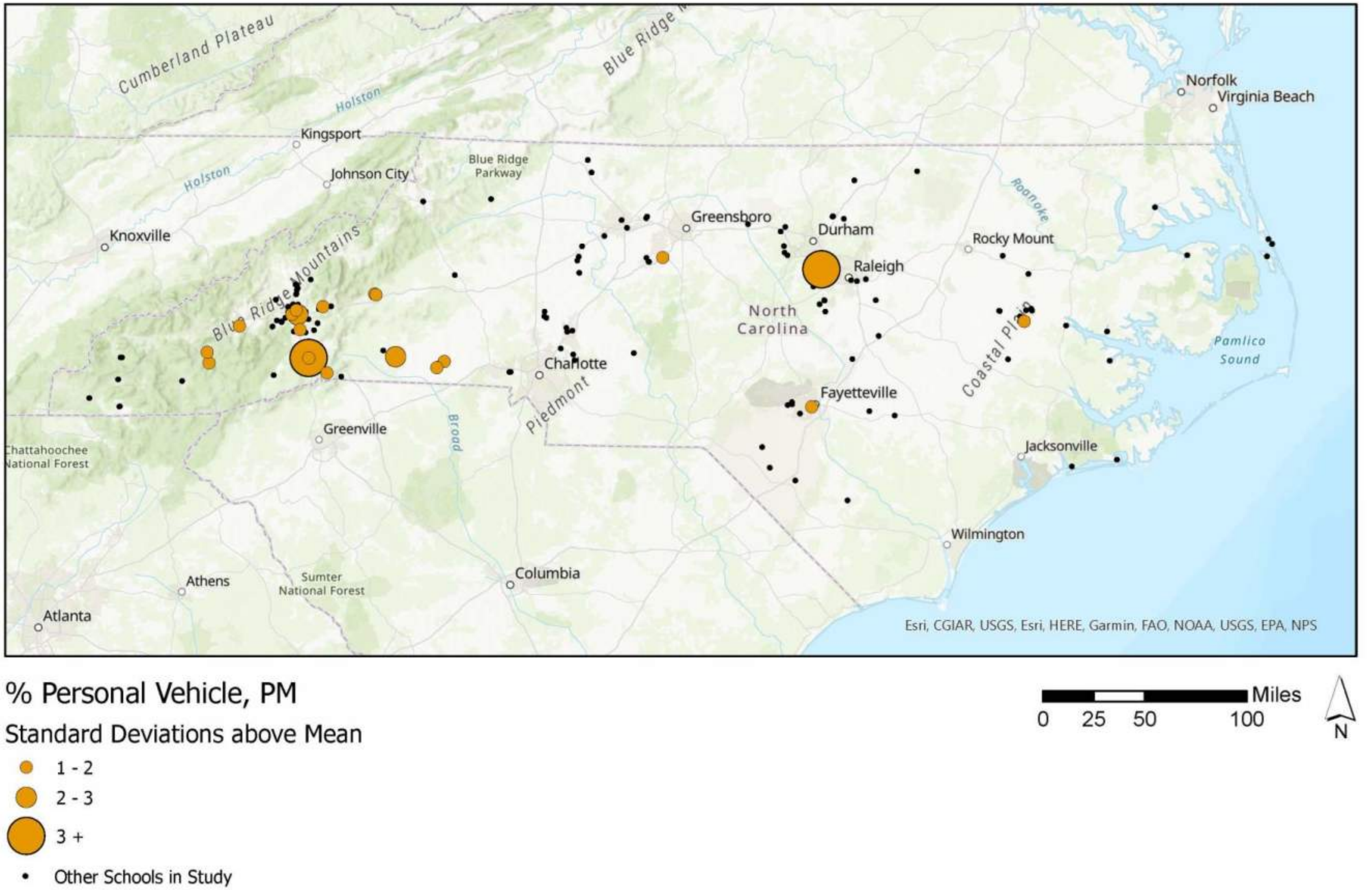

Figure 2. North Carolina School PM Personal Vehicle Travel [Schools with Student Travel Mode Share Significantly Above Mean]

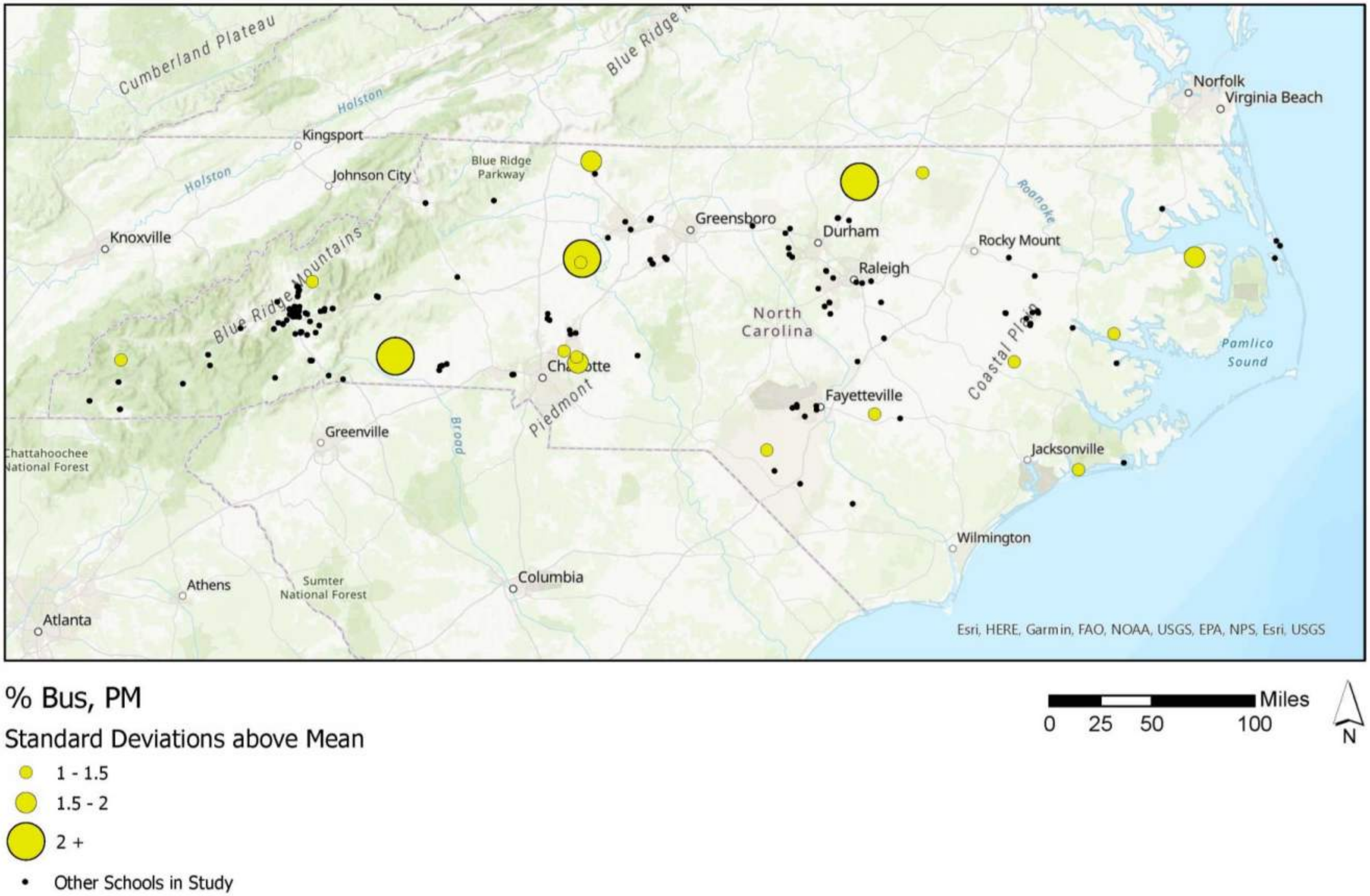

Figure 3. North Carolina School PM Bus Travel [Schools with Student Travel Mode Share Significantly Above Mean]

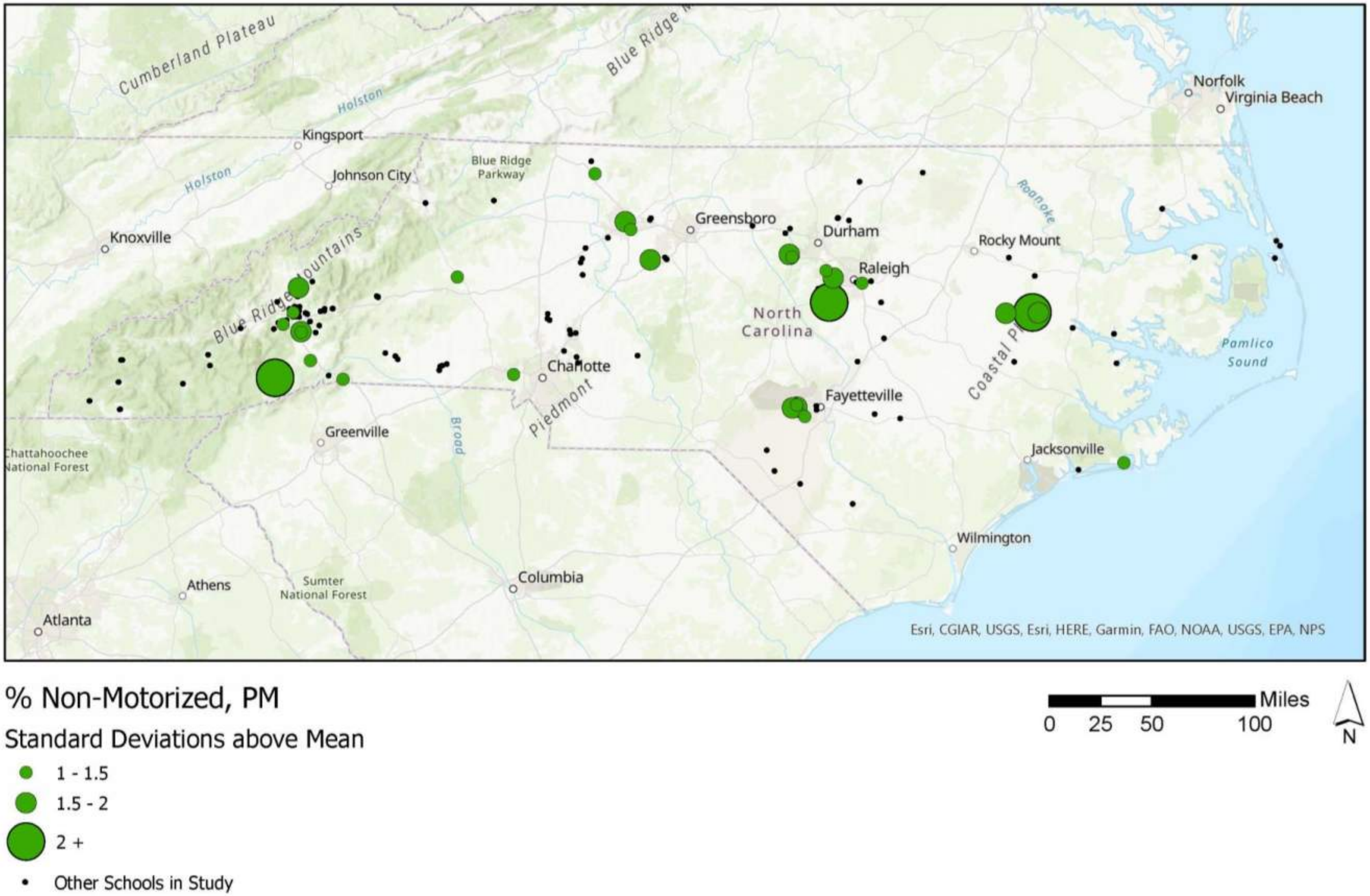

Figure 4. North Carolina School PM Non-Motorized Travel [Schools with Student Travel Mode Share Significantly Above Mean]

METHODOLOGY

School Site Identification and Sample Selection

The research team selected a geographically diverse sample of public, charter, and private schools across the state to develop a field-validated dataset. This dataset, in conjunction with records from the existing MSTA calculator, was used as the foundation for developing new data for an expanded queue and trip prediction tool.

Public schools were selected, prior to the COVID-19 pandemic, using a multi-stage sampling process. Records of public schools were extracted from the NC Department of Public Instruction (DPI)'s Educational Directory and Demographical Information Exchange (EDDIE) database. These records were combined with DPI's average daily membership data to estimate the number of students at each school. The population of public schools was further reduced using several criteria, including:

1. Only public schools teaching grades K-5, 6-8, or 9-12 (without any overlap between the categories or missing years) were sampled.
2. Only schools following the traditional calendar (as opposed to year-round or hybrid calendars) were sampled.
3. Vocational, alternative education, and hospital schools were excluded.
4. Fully or partially virtual schools were excluded.

Out of 2,704 total schools in EDDIE, 1,556 public schools were eligible for data collection based on this selection process. From this sample, the following process was used to develop a reasonable distribution based on geographic location with the goal of developing a smaller, targeted sample of eligible schools:

1. North Carolina was divided into western, central, and eastern regions. The number of eligible elementary, middle, and high schools in each region was divided by the total number of eligible schools in EDDIE to determine what proportion of the 60-school sample would be drawn from each combination of region and school type.
2. Within each region, two counties were deterministically selected.
3. The eligible schools within both counties were pooled, then stratified by elementary, middle, and high school. Within each school type stratum, the final set of schools was selected by simple random sample. A selection of backup schools was also chosen in case any of the sampled schools could not be investigated.

Charter and private schools were not included in this sampling process. Schools in these two categories were selected deterministically based on each school's location and willingness to participate in the study. The traditional-calendar and non-virtual restrictions were relaxed for charter schools due to limited sample size.

Data collection efforts after March 2020 were discontinued because of COVID-19 and the resulting transition from in-person to online school instruction. As a result, the public schools sampled from Mecklenburg County were not visited and data were therefore not collected for these schools. A small number of schools were not included in the analysis in cases where the collected video footage from the schools was unusable (from camera malfunctions or inaccurate location placement) and could not be recollected. The research team sampled public schools in six counties (Franklin, Mecklenburg, New Hanover, Rowan, Wake, and Wayne) as well as nine Charter schools. The following table (Table 1) shows the 27 schools by date of collection that were collected, the date of the data collection, student population, queue length, and the number of vehicles entering and exiting the campus during the data collection period. All of the schools in Table 1 were visited during the afternoon.

Table 1. School Data Collection Information (Sorted by Collection Date)

School Name	County	Collection Date	Student Population	Attendance Method	Grades Instructed	Total Vehicles In	Total Vehicles Out	Max Queue (Vehicles)	Max Queue (Feet)
Bunn Elementary	Franklin	2/25/2020	543	ADM Estimate	K - 5	98	98	69	1733
Laurel Mill Elementary	Franklin	3/4/2020	293	Reported by School	K - 5	58	58	23	517
Edwin Anderson Elementary	New Hanover	3/10/2020	680	ADM Estimate	K - 5	101	102	62	1868
Holly Shelter Middle	New Hanover	3/2/2020	731	Reported by School	6 - 8	68	68	51	1558
Walter L. Parsley Elementary	New Hanover	3/9/2020	649	ADM Estimate	K - 5	92	94	60	1294
Charles C. Erwin Middle	Rowan	10/29/2019	869	ADM Estimate	6 - 8	96	93	65	1344
Isenberg Elementary	Rowan	10/30/2019	407	Reported by School	K - 5	84	84	40	952
West Rowan Elementary	Rowan	10/28/2019	574	ADM Estimate	PK - 5	112	112	76	2080
West Rowan Middle	Rowan	10/28/2019	672	ADM Estimate	6 - 8	117	116	56	1358
Apex High	Wake	11/19/2019	2097	ADM Estimate	9 - 12	94	93	56	1210
Apex Friendship High	Wake	1/30/2020	2572	ADM Estimate	9 - 12	138	138	70	2064
Bryan Road Elementary	Wake	12/12/2019	478	Reported by School	PK - 5	97	97	56	1454
Reedy Creek Middle	Wake	11/20/2019	813	ADM Estimate	6 - 8	145	143	77	2108
East Millbrook Middle	Wake	12/10/2019	775	ADM Estimate	6 - 8	85	84	34	840
Leesville Road Middle	Wake	12/3/2019	906	ADM Estimate	6 - 8	94	91	38	944
Lynn Road Elementary	Wake	1/22/2020	476	Reported by School	PK - 5	105	104	53	1410
Northwoods Elementary	Wake	1/23/2020	656	Reported by School	PK - 5	81	79	43	1139
Richland Creek Elementary	Wake	12/9/2019	481	ADM Estimate	PK - 5	103	105	55	1579
Wakefield Middle	Wake	2/3/2020	886	Reported by School	6 - 8	75	74	49	1238
Wakefield High	Wake	2/3/2020	1870	ADM Estimate	9 - 12	89	88	57	1701
Wakelon Elementary	Wake	12/5/2019	536	Reported by School	K - 5	79	80	45	1206
Wildwood Forest Elementary	Wake	12/4/2019	600	Reported by School	K - 5	125	122	66	1491
York Elementary	Wake	12/2/2019	411	Reported by School	PK - 5	131	130	75	1850
Eastern Wayne High	Wayne	2/11/2020	875	ADM Estimate	9 - 12	60	60	55	1121
Pinnacle Classical Academy (Lower Elem Campus)	Cleveland	5/22/2019	317	Reported by School	K - 2	157	159	107	2562
Ignite Innovation Academy	Pitt	5/23/2019	184	ADM Estimate	K - 8	15	15	14	322
Lake Lure Classical Academy	Rutherford	9/17/2019	496	ADM Estimate	K - 12	45	45	33	852

School Traffic Data Collection

After determining which schools would be sampled, the research team contacted the relevant school district offices (when applicable) to notify them of the data collection intentions and gain approval for the data collection effort. Once the school districts approved the data collection effort, individual schools were contacted approximately two weeks prior to data collection to notify them of the dates and times that researchers would be at the school to install and remove camera equipment. Vehicles that did not travel through the designated queuing area were counted as trips to the extent they were observed, but were not included in the queue length. The research team also worked with each school to gather information regarding any pertinent scheduling conflicts that could affect the data collection or result in atypical drop-off or pick-up behavior, such as holidays or special events. During the initial phone call with individual schools, the research team was able to ask about the queue length and queuing process, which allowed for ideal queue observation during data collection. A summary of the data collection process is presented in Figure 5.

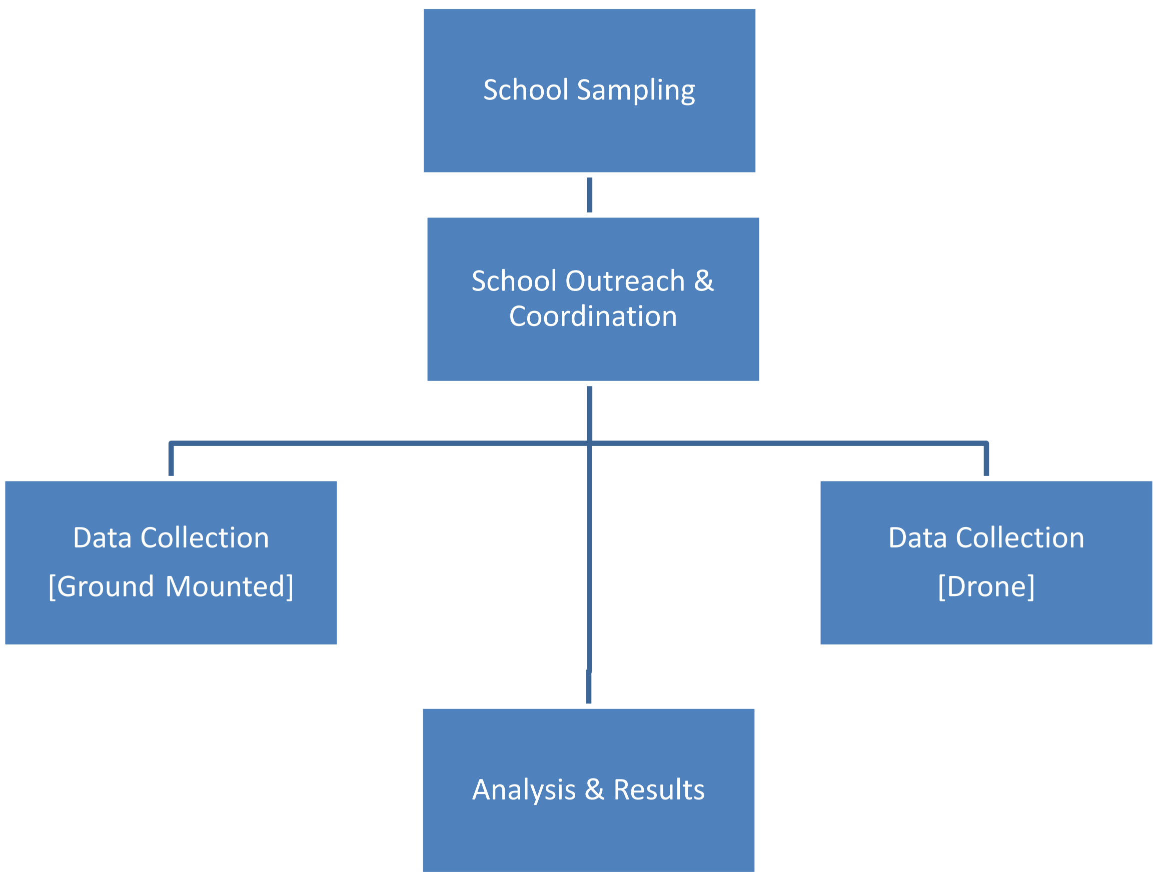

Figure 5. School Traffic Data Collection Process

A reminder email was sent to schools the day before data collection with information regarding the monitoring equipment installation process and the planned length of collection. Many schools sent email notifications to parents to inform them of the research team's presence on campus, per school or district protocol. However, no equipment was installed or removed during the drop-off or pick-up process at any schools.

The video camera installation process typically occurred during mid-morning or late afternoon, when parents and/or students were not arriving to or leaving from the school campus area. If only using static cameras for data collection, the data collection team was not on campus during the drop-off or pick-up times. However, when a drone was used for data collection at a school, research team members were on or near campus during these times to operate the drone, always at a distance from the vehicle queue.

To avoid any abnormal behavior related to the weekend plans of students or their families, data was not collected on Monday mornings or Friday afternoons. Data was most often collected on Tuesdays and Thursdays. This allowed for the installation of video cameras on Monday afternoon for the Tuesday schools, with equipment removal for these schools occurring on Tuesday afternoon or Wednesday morning. Another round of video camera installation typically occurred on Wednesday afternoon for the Thursday schools, with equipment removal for these schools occurring on Thursday afternoon or Friday morning. Once the video cameras were picked up and brought back to the research team's office from the Thursday schools, data were downloaded from the video cameras for both the Tuesday and Thursday schools. At most, three schools were observed on any given day (when proximity and schedules allowed), while most data collection days consisted of data collection at two schools.

Approval was provided for drone data collection later in the project timeline. Therefore, data at some schools was collected via a combination of drone and static cameras while only drones or static cameras were uses at others. The only time that standard ground-mounted video cameras were used to supplement drone data collection was when the research team was unsure of the extent of the vehicle queue. Most often, supplemental standard video cameras were not used because the drone could typically capture the full extent of the vehicle queue.

For ground-mounted video, static cameras were installed on either light posts or trees at or around each campus. These cameras were positioned to ensure, whenever possible, capture of the entire queue. The cameras were fixed to objects using hose clamps that are adjustable and do not require permanent changes to the environment. Each camera was initially positioned with an approximate field of view and was further calibrated after the camera was securely attached to the pole or tree.

After attaching the camera to the pole or tree, settings could be adjusted using a computer connected to the camera via ethernet. Generally, the only settings that needed adjustment were the recording schedule (depending on the arrival and departure times of students), the infrared settings (if the morning drop-off started before or during the dawn hours), and the image quality (to ensure that no faces or vehicle license plates were identifiable, while still being able to adequately observe the drop-off or pick-up process). The video recordings were stored on an SD card inserted into the camera housing. Once the camera settings were adjusted as needed, the box holding the camera batteries was closed, locked, and chained to a fixed object nearby for security purposes. This box is low profile and inconspicuous. An example of a typical camera installation is shown in the Figure 6, while Figure 7 shows the typical views from the ground-mounted cameras.

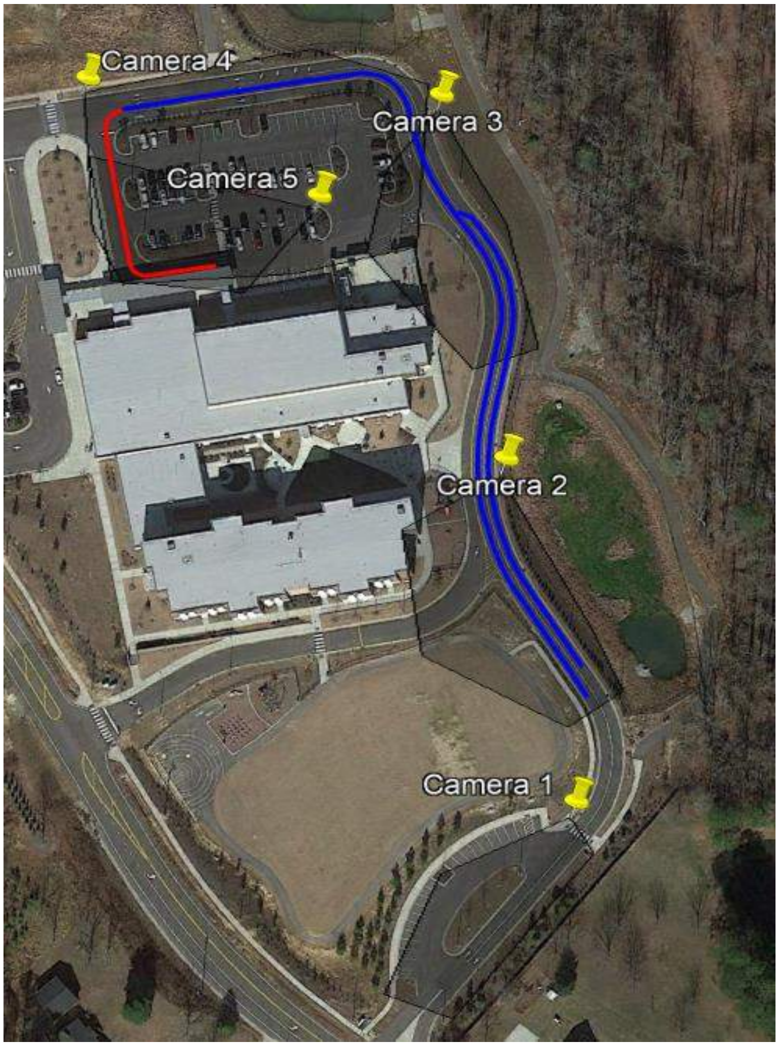

Figure 6. Typical Camera Installation

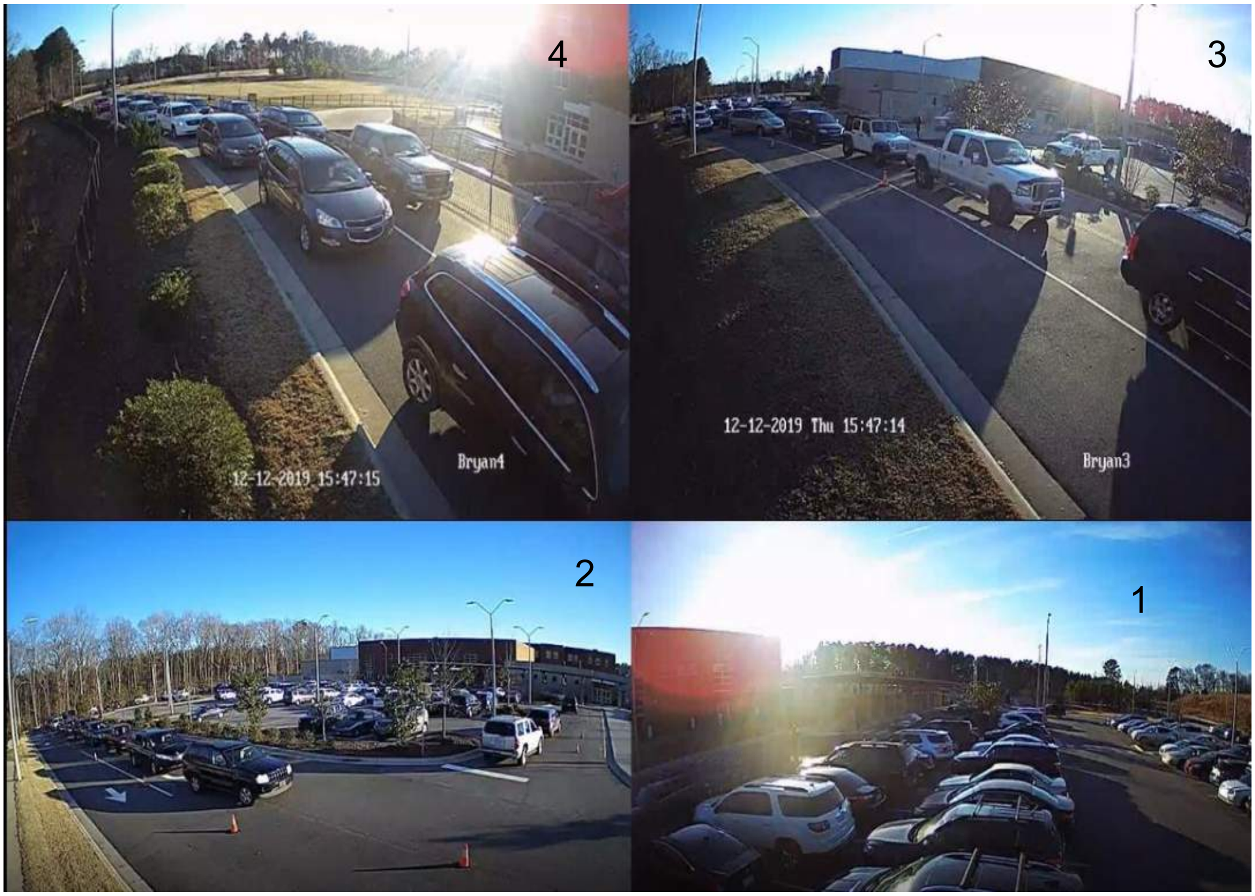

Figure 7. Typical Camera Views

When a drone was used for data collection, the data collection team selected an inconspicuous location to avoid confusion from parents, which could potentially impact the drop-off or pick-up process. The data collection team would deploy the drone as queueing began and, when possible, would not bring the drone down until the queue had completely dissipated. Each drone was tethered or connected to the ground with an FAA-licensed pilot who operated the drone throughout the duration of the data collection. Compared to ground-based cameras, drones offered substantial improvements to visual continuity. The use of drones also reduced data collection installation time. Figure 8 shows an example of the view from the drone during data collection.


Figure 8. Example Drone View

For both ground-based camera and drone data collection, efforts were made to avoid capturing identifiable information like faces and vehicle details as much as possible. In the case of drones, the research team was able to position the drones in locations farther away from the actual pick-up and drop-off locations, such as athletic fields and sidewalks.

Once data collection for a school was complete, individual video files representing separate camera views were combined into one video for analysis using physical cues in the videos to ensure accurate synchronization of the views. An online map was created for each school so the research team could document and communicate what each camera view captured. An analyst watched each video twice to fully capture entrances and then exits of the queue using timestamps. Vehicle entrances were marked when they reached the back of the queue and marked as exiting when they entered the loading zone.

After the timestamps of the entrances and exits were collected, the raw queue data were recorded for each school. The total entrances and exits were compared to identify if any errors occurred during data collection. Each school was reviewed to ensure that the difference between entrances and exits never exceeded 3 vehicles. The video data were reduced into a spreadsheet to also capture the Total In, Total Out, Max Q (cars), and Max Q (Feet) data points for each school. The spreadsheet calculated the maximum queue length based on number of vehicles. After the timestamps were collected and checked, a polygon following the path of the queue to the furthest queuing point was created in an online mapping tool to find the maximum queue length in feet.

Data collectors did not record student attendance on the day of field data collection. Estimates of student attendance were made using NC DPI records, based on the lowest monthly average daily membership (ADM) record of the school year. At the end of the project, schools were contacted to retrieve student counts on the day of data collection where available, and correction factors were generated to adjust ADM estimates to the actual attendance values.

Table 2, below, shows the correction factors estimated. Private/non-urban charter and urban charter schools were calculated as a group, rather than by grade level, due to small sample sizes. No public high schools responded to the request for records, so a correction factor of 1 was assumed. Table 3 shows the same data, but in disaggregated form.

Table 2. ADM Correction Factors (Aggregate)

Category	Sample Size	Average Correction Factor	Lower 95% CI of Correction Factor	Upper 95% CI of Correction Factor
Public Elementary	8	1.0096	0.9667	1.0525
Public Middle	2	0.9998	0.2221	1.7774
Public High	0	1.0000	N/A	N/A
Private/Non-Urban Charter	1	1.0567	N/A	N/A
Urban Charter	2	1.0115	0.7024	1.3206

N/A = Not Applicable

Table 3. ADM Correction Factors (Disaggregate)

School Name	Collection Date	ADM Estimate (Students)	Reported Attendance (Students)	Correction Factor
Laurel Mill Elementary	3/4/2020	276	293	1.0616
Harold D Isenberg Elementary	10/30/2019	406	407	1.0025
Bryan Road Elementary	12/12/2019	475	478	1.0063
Lynn Road Elementary	1/22/2020	493	476	0.9655
Northwoods Elementary	1/23/2020	601	656	1.0915
Wakelon Elementary	12/5/2019	518	536	1.0347
Wildwood Forest Elementary	12/4/2019	641	600	0.9360
York Elementary	12/2/2019	420	411	0.9786
Holly Shelter Middle School	3/2/2020	689	731	1.0610
Wakefield Middle	2/3/2020	944	886	0.9386
Pinnacle Classical Academy (Lower Elem Campus)	5/22/2019	300	317	1.0567
Pinnacle Classical Academy (Upper Campus)	5/29/2019	530	549	1.0358
Envision Science Academy	3/7/2019	703	694	0.9872

The practical effect of the ADM correction factor adjustment on queue predictions is minimal. In addition to the low magnitude of the correction factors, adjusted data only made up part of the dataset; historic calculator data that was included in the proposed STC was not affected. As a result of applying the correction factors to the proposed school traffic calculator, the predicted queue lengths decreased by 0.95% at public elementary schools, increased by 0.02% at public middle schools, and decreased by 5.36% for private and non-urban charter school grade categories PK-K, 1-10, and 12. All other categories were unaffected.

Data Collection Considerations

A variety of factors may be useful when considering whether to use ground-mounted video cameras or a drone to collect school queueing and trip information. For short-duration counts, drones can provide lower set-up costs and data processing (due to one, seamless camera view during post-processing). Drones also provide a more flexible setup with a camera angle that can be adjusted in real-time as the operational conditions change. However, for longer duration counts, ground-mounted cameras may be advantageous because they can be left unattended for an extended time period.

Grade Categorization

Every public school sampled by the research team fit neatly into a single grade category (i.e. grades K-5 for public elementary schools, or 9-12 for public high schools.) However, the private and urban charter schools generally did not; for example, one school instructed grades 3-11. To allocate those schools' queue data among the appropriate categories, a weighting algorithm was developed. For each category, the school's weight was calculated as the number of grades instructed in that category divided by the number of grades instructed by the school.

Given a school of type $s \in \{$Public, Private/Non-Urban Charter, Urban Charter$\}$, instructing a set of grades $\{ G \in N \mid 0 \leq G \leq 12\}$ where both pre-kindergarten and kindergarten evaluate to Grade 0 and all other grades are evaluated as their numeric equivalent, the weight W for each category can be calculated as:

$$W(Public\ Elementary) = \begin{cases} \dfrac{|G \cap \{0,1,2,3,4,5\}|}{|G|} & s = Public \\ 0 & s \neq Public \end{cases}$$

$$W(Public\ Middle) = \begin{cases} \dfrac{|G \cap \{6,7,8\}|}{|G|} & s = Public \\ 0 & s \neq Public \end{cases}$$

$$W(Public\ High) = \begin{cases} \dfrac{|G \cap \{9,10,11,12\}|}{|G|} & s = Public \\ 0 & s \neq Public \end{cases}$$

$$W(Private\ or\ Non\ Urban\ Charter\ PK-K) = \begin{cases} \dfrac{|G \cap \{0\}|}{|G|} & s = Private\ or\ Non\ Urban\ Charter \\ 0 & s \neq Private\ or\ Non\ Urban\ Charter \end{cases}$$

$$W(Private\ or\ Non\ Urban\ Charter\ Grades\ 1-10) = \begin{cases} \dfrac{|G \cap \{1,2,3,4,5,6,7,8,9,10\}|}{|G|} & s = Private\ or\ Non\ Urban\ Charter \\ 0 & s \neq Private\ or\ Non\ Urban\ Charter \end{cases}$$

$$W(Private\ or\ Non\ Urban\ Charter\ Grade\ 11) = \begin{cases} \frac{|G \cap \{11\}|}{|G|} & s = Private\ or\ Non\ Urban\ Charter \\ 0 & s \neq Private\ or\ Non\ Urban\ Charter \end{cases}$$

$$W(Private\ or\ Non\ Urban\ Charter\ Grade\ 12) = \begin{cases} \frac{|G \cap \{12\}|}{|G|} & s = Private\ or\ Non\ Urban\ Charter \\ 0 & s \neq Private\ or\ Non\ Urban\ Charter \end{cases}$$

$$W(Urban\ Charter\ Grades\ K-10) = \begin{cases} \frac{|G \cap \{0,1,2,3,4,5,6,7,8,9,10\}|}{|G|} & s = Urban\ Charter \\ 0 & s \neq Urban\ Charter \end{cases}$$

$$W(Urban\ Charter\ Grade\ 11) = \begin{cases} \frac{|G \cap \{11\}|}{|G|} & s = Urban\ Charter \\ 0 & s \neq Urban\ Charter \end{cases}$$

$$W(Urban\ Charter\ Grade\ 12) = \begin{cases} \frac{|G \cap \{12\}|}{|G|} & s = Urban\ Charter \\ 0 & s \neq Urban\ Charter \end{cases}$$

The sum of category weights at a given school always adds up to 1. For example, the urban charter school instructing grades 3-11 introduced above would be weighted as shown in Table 4.

Table 4. Example Weighting Scheme (Urban Charter School with Grades 3 to 11)

Category	Overlap	Weight
Grades K-10	8	8/9 = 0.8889
Grade 11	1	1/9 = 0.1111
Grade 12	0	0/9 = 0.0000

RESULTS

School Traffic Data Analysis

Field data collection concentrated only on afternoon (PM) queue lengths and trip generation, following the assumption in the existing calculator that afternoon carpool queues are generally more severe than their morning (AM) counterparts. Queue length data were calculated for the same categories as the current STC:

- Public: Elementary (PK-5), Middle (6-8), and High (9-12)
- Private/Non-Urban Charter: PK-K, Grades K-10, Grade 11, and Grade 12
- Urban Charter: Grades K-10, Grade 11, Grade 12

Of the categories above, data was available for all except Urban Charter: Grade 11 and Urban Charter: Grade 12. For those categories, parameters were estimated from the existing MSTA calculator. Table 1, listed previously, contains the vehicle trips and queue lengths for each school included in the study.

Several schools generated queues with parallel lines of vehicles throughout some length of the queue. Additionally, some schools served afternoon carpool traffic with multiple separate loading zones. In the case where one loading zone served multiple lines of traffic, analysis proceeded similarly to a school with only a single line of vehicles. Vehicles were recorded as they entered either line of the queue or departed from the queue without specifying which line they were in, generating a combined cumulative arrival curve. The queue length in feet was generated by taking the furthest-back point in each line of the queue that cars reached and adding them together. In the case where multiple loading zones were used, the maximum queue lengths in feet from all component queues were added together, under the assumption that a length of queue equivalent to the combined maximums would be generated if only a single loading zone was available.

The queue and survey data collected by the research team were used to validate the existing STC. Based on the validation results, two major computational changes are proposed to the calculator model:

1. Calculating the max queue length from the 95th percentile of available data, rather than the mean of the sampled schools with an additional 30% safety factor, is necessary due to high variability in school queue lengths.
2. Using a weighting system based on grades instructed at a school captures the unique effects of schools not falling exactly into the STC's "grades instructed" bins.

The PM queue lengths observed by the research team, normalized to a per-student basis, are listed in Table 5.

Table 5. PM Queue Lengths

Category	PM Queue (Weighted n)	Original STC Data: Mean + 30% Safety Factor (Queue Length in Feet Per Student)	95th Percentile
Public Elem	13.000	3.578	4.501
Public Middle	7.000	2.195	2.593
Public High	4.000	1.160	1.281
Private PK-K	0.410	8.933	8.082
Private Grades 1-10	1.436	6.010	8.082
Private Grade 11	0.077	2.113	1.626
Private Grade 12	0.077	2.113	1.626
Urban Charter Grades K-10	1.000	2.249	1.730
Urban Charter Grade 11	0.000	N/A	N/A
Urban Charter Grade 12	0.000	N/A	N/A

N/A = Not Applicable

Corresponding values were generated from Version 04012021 of the existing STC by inputting test student volumes and assuming the recommended number of staff, students, and student drivers. In Table 6, the rightmost column compares the percent change in high demand length, or average queue length with a 30% safety factor, from the existing STC to the field data collected by the research team. Sample sizes are only listed for public elementary, public middle, public high, and private school Grades 1-10 because the other categories appear to be predicted from rules-of-thumb or point estimates in the existing STC calculator. Additionally, the sample sizes do not include known duplicates (one school was repeated twice in the existing STC public elementary dataset, but was not counted towards total sample size here.)

Table 6. PM Queue Length Comparison to Current Calculator

Category	Original STC Data: Mean + 30% Safety Factor (Queue Length in Feet Per Student)	Change from Original STC Data to Research Project Analysis/Data
Public Elem	3.281 (n = 23)	9%
Public Middle	2.451 (n = 7)	-10%
Public High	1.875 (n = 3)	-38%
Private PK-K	5.497	63%
Private Grades 1-10	2.848 (n = 3)	111%
Private Grade 11	4.621	-54%
Private Grade 12	2.250	-6%
Urban Charter Grades K-10	5.497	-59%
Urban Charter Grade 11	4.621	N/A
Urban Charter Grade 12	2.250	N/A

Figure 9 and Figure 10 compare the distribution of the field data to the existing STC. Figure 9 depicts the queue length cumulative distribution functions for public elementary, public middle, and public high schools, comparing existing STC datasets (red) to ITRE field data (blue). All queues are normalized to a per-student basis.

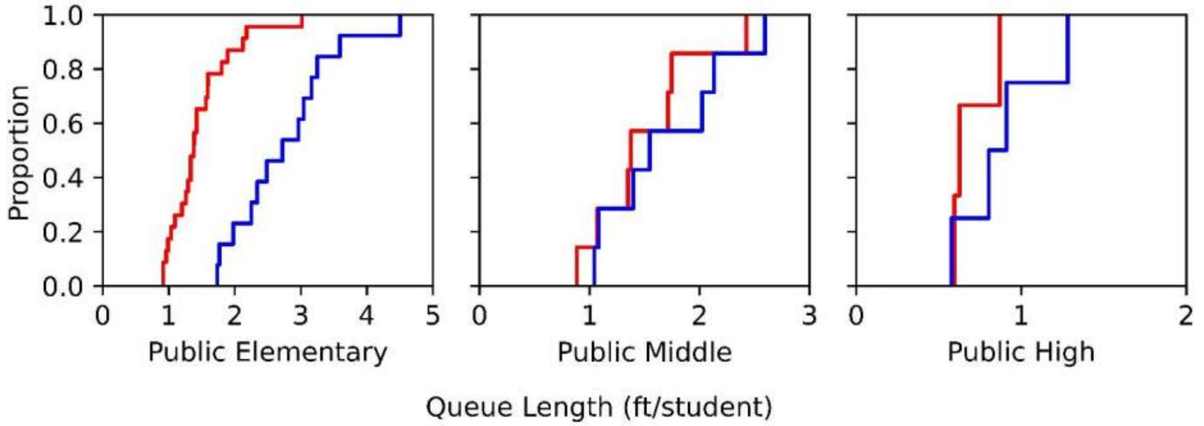

Figure 9. Cumulative Distribution Functions of Queue Length in Feet Per Student (Public Elem, Middle, and High School) [Red = STC Data and Blue = ITRE Field Data]

Figure 10 shows a similar CDF comparison for private schools. However, due to small sample sizes, all grade categories were combined.

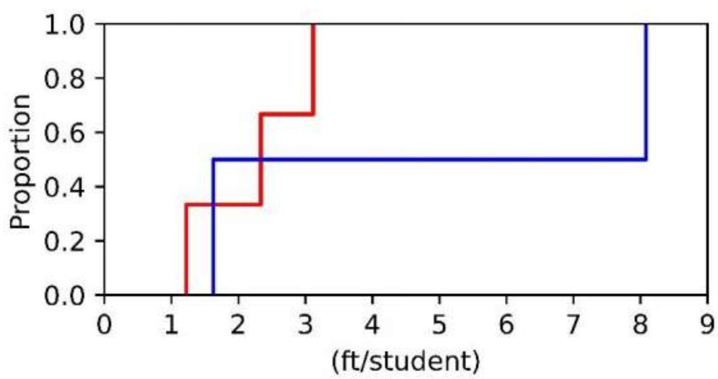

Figure 10. Cumulative Distribution Functions of Queue Length in Feet Per Student (Private Schools) [Red = STC Data and Blue = ITRE Field Data]

Kolmogorov-Smirnov two-sample tests were conducted to determine the degree of similarity between the existing STC data and ITRE field data for public elementary, middle, high, and private schools.

There was a statistically significant difference between the elementary school STC dataset and ITRE field-collected data ($D = 0.783$, $p < 0.001$). There were no statistically significant differences between the middle school STC dataset and ITRE field-collected data ($D = 0.286$, $p = 0.963$), the high school STC dataset and ITRE field-collected data ($D = 0.500$, $p = 0.657$), or the private school STC dataset and ITRE field-collected data ($D = 0.500$, $p =$

0.900). However, all of the tests above should be interpreted with caution due to very small sample sizes.

The strongest conclusions can be drawn from the public elementary school sample (n = 13, while all other samples had seven or less observations). For this category, the existing STC high demand length estimate is comparable to the high demand length projected from the field data, despite the statistically significant difference between the sample distributions. However, the high demand length algorithm itself, at least at the default 30% safety factor setting, does not appear sufficient to capture the upper end of the school queue length distribution. Two of the thirteen sampled schools have longer PM queue lengths than the existing STC high demand length.

To ensure a conservative estimate of queue lengths, a 95th percentile estimator was implemented in the calculator update. In almost all cases, this will result in the predicted queue being based off the longest-queue school in the sample.

Several parameters contribute to total trips generated:

- Number of staff
- Number of student drivers
- Number of buses
- Number of carpool vehicles

Table 7, Table 8, Table 9, and Table 10 compare the mean and 95th percentile of field data, from either queue field studies or surveys of schools, with the data in the current STC.

Table 7. Mean and 95th Percentile Data – Staff per Student

Staff per Student	Survey Weighted (n)	Existing Calculator	Survey Weighted (Mean)	Survey Weighted (95th Percentile)
Public Elem	17.000	0.118	0.146	0.202
Public Middle	4.000	0.102	0.119	0.163
Public High	4.000	0.092	0.096	0.102
Private PK-K	0.577	0.131	0.108	0.114
Private Grades 1-10	3.484	0.131	0.097	0.114
Private Grade 11	0.470	0.114	0.089	0.112
Private Grade 12	0.470	0.103	0.089	0.112
Urban Charter Grades K-10	4.735	0.125	0.118	0.135
Urban Charter Grade 11	0.188	0.114	0.125	0.134
Urban Charter Grade 12	0.077	0.103	0.112	0.112

The yellow-highlighted cells in Table 8 are unrealistically high (exceeding the practical limit of 1 car per student and in consideration of the other schools sampled) and were therefore manually adjusted down to one student driver per student in the updated calculator. The updated calculator assumes an even proportion of student drivers between 11th and 12th grade if both grades are instructed at a school; surveys are planned for the next phase of this project to determine the true split of drivers between grade levels.

Table 8. Mean and 95th Percentile Data – Student Drivers per Student

Student Drivers/Student	Survey Weighted (n)	Existing Calculator	Survey Weighted (Mean)	Survey Weighted (95th Percentile)
Public Elem	N/A	N/A	N/A	N/A
Public Middle	N/A	N/A	N/A	N/A
Public High	4.000	0.160	0.238	0.282
Private PK-K	N/A	N/A	N/A	N/A
Private Grades 1-10	N/A	N/A	N/A	N/A
Private Grade 11	0.470	0.320	0.505	0.874
Private Grade 12	0.470	0.850	0.505	0.874
Urban Charter Grades K-10	N/A	N/A	N/A	N/A
Urban Charter Grade 11	0.188	0.320	1.250	1.765
Urban Charter Grade 12	0.077	0.850	0.506	0.506

Table 9. Mean and 95th Percentile Data – PM Buses per Student

PM Buses/Student	Survey Weighted (n)	Existing Calculator	Survey Weighted (Mean)	Survey Weighted (95th Percentile)
Public Elem	16.000	0.014	0.013	0.038
Public Middle	3.000	0.022	0.012	0.013
Public High	4.000	0.016	0.011	0.014
Private PK-K	0.500	0.014	N/A	N/A
Private Grades 1-10	2.214	0.014	N/A	N/A
Private Grade 11	0.143	0.022	N/A	N/A
Private Grade 12	0.143	0.016	N/A	N/A
Urban Charter Grades K-10	4.735	0.014	0.007	0.019
Urban Charter Grade 11	0.188	0.022	N/A	N/A
Urban Charter Grade 12	0.077	0.016	N/A	N/A

Table 10. Mean and 95th Percentile Data – PM Cars per Student

PM Cars/Student	Queue Weighted (n)	Existing Calculator	Queue Weighted (Mean)	Queue Weighted (95th Percentile)
Public Elem	13.000	0.250	0.192	0.319
Public Middle	7.000	0.160	0.122	0.178
Public High	4.000	0.106	0.054	0.069
Private PK-K	0.410	0.392	0.419	0.495
Private Grades 1-10	1.436	0.263	0.276	0.495
Private Grade 11	0.077	0.347	0.086	0.086
Private Grade 12	0.077	0.136	0.086	0.086
Urban Charter Grades K-10	1.000	0.392	0.081	0.081
Urban Charter Grade 11	0.000	0.347	N/A	N/A
Urban Charter Grade 12	0.000	0.136	N/A	N/A

As with queue lengths, the updated calculator generates 95th percentile estimates for each of the above parameters. However, it should be noted that due to the combination of multiple parameters in estimating the total trips generated, the final result does not correspond neatly to a 95th percentile estimate like the queue length estimator does.

CONCLUSIONS AND RECOMMENDATIONS

Schools continue to be constructed at a rapid pace across North Carolina as the state experiences population growth, particularly in urban regions. Furthermore, existing schools throughout North Carolina and the U.S. continue to experience increases in child passenger pick-up and drop-off, regardless of school age or location (NHTSA, 2009). As a result, accurate estimation of school site queue length needs and trip generation rates are critical to maintaining and improving the transportation safety of North Carolina's communities. This work is significant for NCDOT due to the potential for enhanced accuracy of school travel mode and queue length estimation. Increased accuracy in queue length needs will lead to school site design and traffic management plans that better accommodate school travel demand and corresponding needs. More effective accommodation of passenger vehicles will promote improved traffic safety and operations in communities throughout North Carolina with new school construction and existing schools that have difficulties with queue spillover into surrounding roadways.

The most robust estimates and updates to the calculator recommended based on this research study are drawn from the public elementary school sample (n = 13, while all other samples had seven or less observations). For this category, the existing STC high demand length estimate is comparable to the high demand length projected from the field data. To ensure a conservative estimate of queue lengths, a 95^{th} percentile estimator was implemented in the calculator recommendations stemming from this research. The queue and survey data collected by the research team was used to validate the existing STC. Based on the validation results, two major computational changes to the calculator model are proposed: 1) calculating the max queue length from the 95th percentile of available data and 2) using a weighting system based on grades instructed at a school.

To the extent possible, field data collection excluded holidays, school events, early-release days, and Fridays, but other atypical activities that the research team was unaware of may have influenced the observed values. The research project was completed during the COVID-19 pandemic. However, data collection was completed prior to school impacts from the pandemic, except for a small data collection effort specifically focused on exploring the impacts of the pandemic (which were not included in this analysis).

This research aimed to measure demand for student drop-off and pick-up, which is most directly expressed in terms of the queue length and trips generated. However, student drop-off and pick-up activities can also occur in locations other than the areas designated by the school, such as nearby parking locations, curbs, and other areas that students can walk to and from campus to avoid the queuing process. The research team counted trips generated in this manner as much as possible but due to the nature of these unapproved activities, some of this travel was likely unobserved and is therefore not included in the project data.

An on-going NCDOT research project, 2021-15: Evaluation of School Travel Patterns and Preferences, will provide further updates to the calculator. The updated calculator provided with this report is intended as an interim deliverable, and with the exception of public elementary school predictions, should not be used for school design until RP 2021-15 is complete. The specific efforts include expanding the sample size of locations with highly variable estimates, evaluating trends related to school travel, comparing loading/unloading zone techniques, and developing recommendations for modeling school locations in Synchro. In RP 2021-15, school travel data will be collected by the research team at schools across North Carolina, varying by school type and geography with a focus on school types/characteristics that have highly variable queue length estimates. This new data will be paired with existing STC data. Loading/unloading zones will also be studied to help identify and quantify the most beneficial practices. A couple of additional measures are recommended for a future update of the STC: 1) surveying a sample of schools to determine the distribution of student drivers by grade level and 2) visiting a larger sample of private/non-urban charter and urban charter schools. Both of these actions will be included in NCDOT RP 2021-15 which will further expand the sample size for the STC.

Several future research ideas were identified during this research project. One idea is to further understand and estimate the impacts of vehicles/students who did not travel through the designated queuing area (which could be the result of various school and community factors). Estimates of student drivers by grade and school permitting designations would also be beneficial. Investigations of travel behaviors at schools that have queue lengths that are insufficient to accommodate the demand (i.e., over-capacity) may be useful to better understand how travel behavior may be impacted (which could include mode shift or using alternative drop-off/pick-up locations). Additional student data, such as the distance from the school, mode options, and other built-environment factors could provide useful insights into school travel.

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APPENDIX A: SCHOOL OUTREACH

School Outreach Template

Hello,

My name is ______ and I am contacting you on behalf of the Municipal and School Transportation Assistance Calculator Validation Team. Your school has been selected for data collection to re-calibrate the Municipal and School Transportation (MSTA) Calculator.
The MSTA Calculator provides estimates about a school's projected vehicle queue length at school pick-up and drop-off based on maximum student population and other school characteristics. Data required to re-calibrate the current MSTA Calculator is a combination of school operation characteristics and observations of pick-up and release times. We are reaching out to your school to collect preliminary school characteristic data through an online questionnaire as well as schedule a day for Institute of Transportation Research and Education (ITRE) staff to install camera equipment at your school site to collect observational data.

School Travel Questionnaire
We are asking a representative from our partner schools (principal, asst. principal, or other administrator) to complete a questionnaire and participate in a short phone call in order to accurately collect school operations characteristics. Linked below is our current MSTA School Traffic Operations Questionnaire. You are welcome to complete this questionnaire independently or during a short follow-up phone call with the assistance of an ITRE team member. Of note, questions can be skipped if necessary and edited afterwards. Overall, it should take about 15 minutes to fill out the questionnaire. MSTA School Traffic Operations Questionnaire

Scheduling Questionnaire / Site Plan Review
We are also requesting time to engage in a short phone call with your school transportation specialist in order to clarify questionnaire responses, gather more information about your school's pick-up and drop-off operations, and learn more about upcoming special events or other activities that may impact the pick-up and drop-off observation component of this project. Please identify blocks of time that your school transportation specialist is available to speak within the next week and we will schedule our call accordingly. We will also be discussing ideal dates in May to install camera equipment to collect observational data.

Data Collection Field Visit
Two ITRE staff members will be in contact with you to schedule a visit to your school within the next few weeks to collect data. Please inform these field staff of any special events like field trips or after school activities that may affect the length of the pick-up or drop-off queue.

Thank you and please let me know if you have any questions.

District Outreach Template

Hello [Administrative Official],

This is _____ and I am contacting you on behalf of the Municipal and School Transportation Assistance Calculator Validation Team at the Institute for Transportation Research and Education (ITRE). The Municipal and School Transportation Assistance (MSTA) Calculator provides estimates about a school's projected vehicle queue length at school pick-up and drop-off based on maximum student population and other school characteristics. Attached is the NCDOT/ITRE letter of collaboration outlining the project purpose and key contacts. Please be aware that due to staff change, the PI is currently Dr. Daniel Findley. Data required to re-calibrate the current MSTA Calculator is a combination of school operation characteristics and observations of pick-up and release times.

The research study is composed of three elements: a school travel questionnaire that is completed by a school administrator, a site plan review where school staff inform ITRE of any operations characteristics that may not have been reported in the questionnaire, and a queue observation study where ITRE field staff install research cameras on a school campus to observe the maximum queue length for morning and afternoon pick-up and drop-off cycles. The project is NC State University IRB approved. Observation cameras are set at a low enough resolution that distinguishing characteristics and license plate numbers are not detectable.

Are there any special authorizations from the district office that are required to sample schools in your county that are a good fit for the study? If your county is willing to work with us, would it also be possible to obtain some type of memo, email, or other document from the school district's office that we could share with principals demonstrating that the project has support from the district administration?

Thank you and please let me know if you have any questions.

APPENDIX B: USER GUIDE

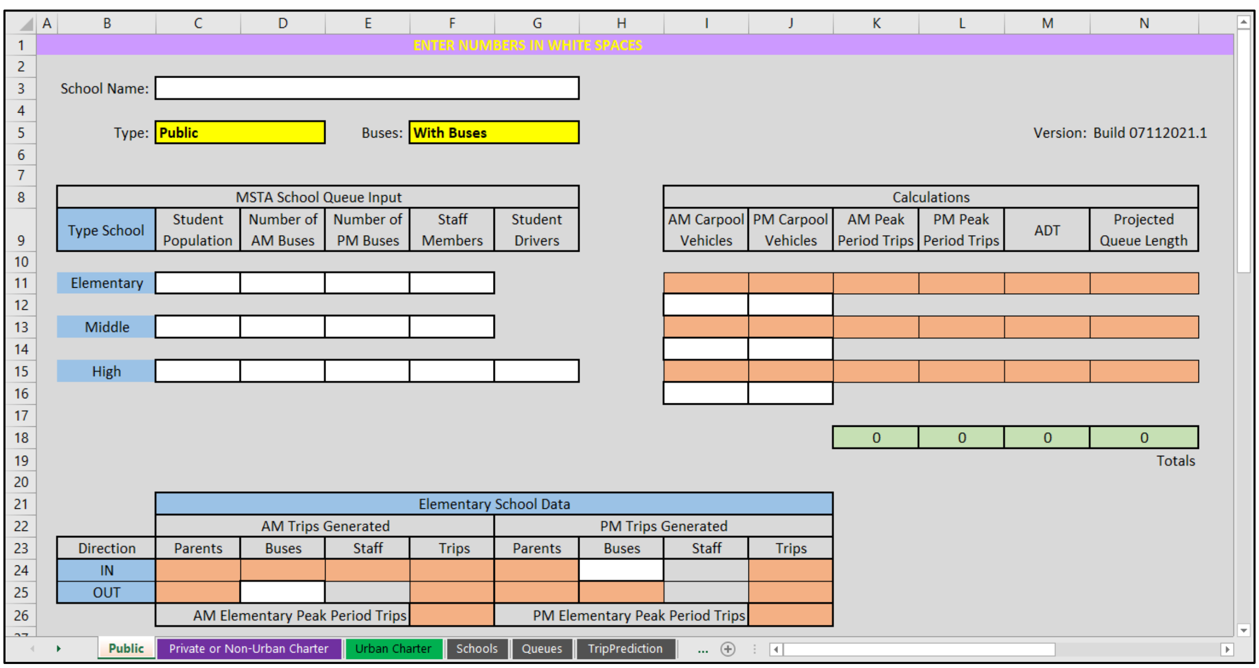
This section of the report serves as a user guide for the draft School Traffic Calculator. An expanded discussion of the design assumptions and decisions made during the update to the STC back-end is also provided.

The portion discussing the user-interface pages is also broadly applicable to the current NCDOT version of the School Traffic Calculator, although minor cosmetic differences exist between the two models.

User Interface
Almost all analyst interaction with the STC occurs on the *Public, Private or Non-Urban Charter*, or *Urban Charter* calculation tabs. These spreadsheets require either predicted student population, predicted number of AM carpool vehicles, or predicted number of PM carpool vehicles as an input. Three outputs are produced:

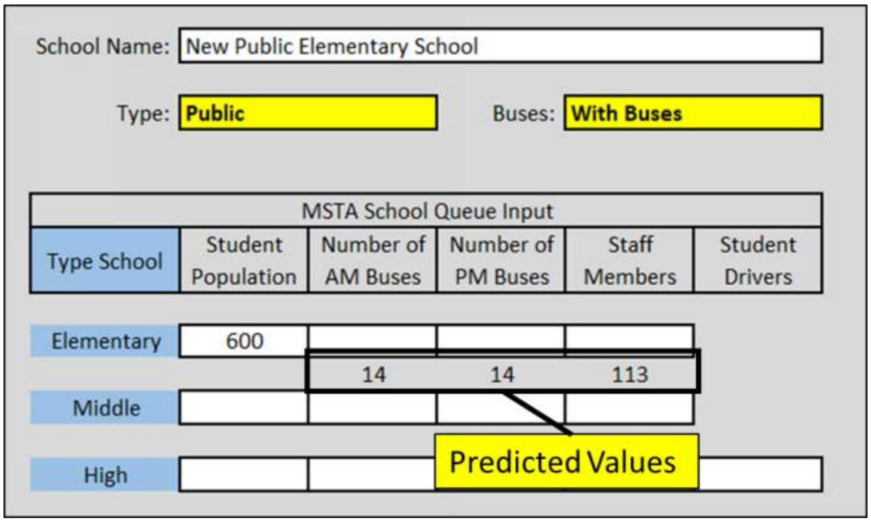
- The predicted maximum carpool queue length, in feet;
- The predicted number of trips generated by the school during the AM peak period;
- The predicted number of trips generated by the school during the PM peak period.

The layout of the tabs is best displayed by example. Consider the design of a new 600-student public elementary school. Buses will be provided. Based on these inputs, the *Public* tab should be selected.

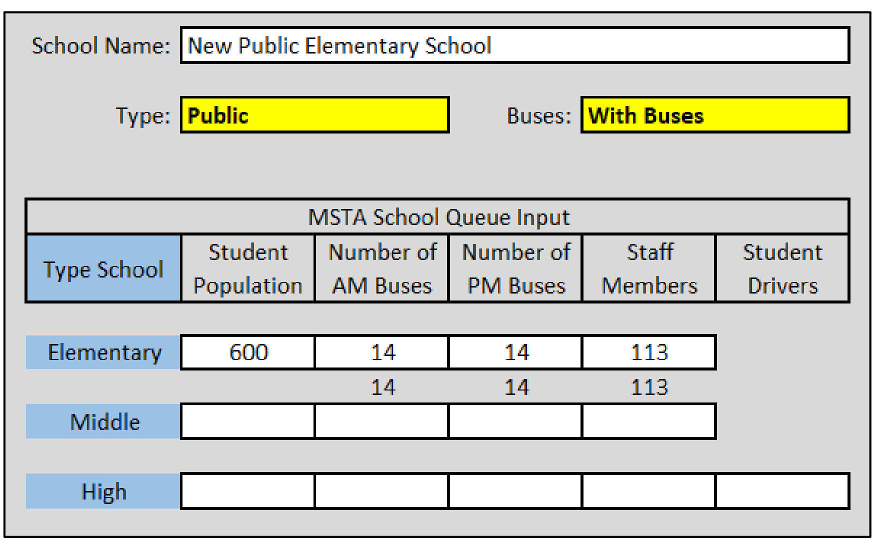


The top left of the page contains input blocks for student population, number of buses, number of staff members, and number of student drivers. Of these, the only value the analyst must know initially is the student population. If the student population is unknown, it can be estimated based on the predicted number of AM or PM carpool vehicles, using the input boxes under the "Calculations" section. Inputs are divided by grade type; elementary school data (K-5) is entered on the first row, middle school data (6-8) is entered on the second row, and high school data (9-12) is entered on the third row. If a school fits into more than one category (e.g. a school instructs kindergarten through eighth grade), multiple rows should be used, with the total student population divided between both, or all three, rows depending on predicted grade split.

After entering the student population, predicted values are generated for the other parameters.



If information about these parameters is available, it should be entered; otherwise, the predicted values can be used. None of the fields in a grade type row should be left blank if that row's student population has been completed.



The "Buses" drop-down option is provided as a data-entry convenience, but does not impact the calculations. If it is known that a school does not provide buses, this option can be adjusted to change all bus predictions to zero.

School Name:	New Public Elementary School				
Type:	Public		Buses:	Without Buses	

MSTA School Queue Input					
Type School	Student Population	Number of AM Buses	Number of PM Buses	Staff Members	Student Drivers
Elementary	600	14	14	113	
		0	0	113	
Middle					
		0	0		
High					
		0	0		

The section below, *Elementary School Data*, must be filled out to ensure an accurate peak period trip estimate. The number of parents (carpool), bus, and staff trips to and from school are calculated, generating a total number of trips in the morning and afternoon. Most of these cells auto-calculate. However, the number of "Out" bus trips must be entered by the user. This value represents the number of buses that arrive in the morning, but do not stay on campus all day (i.e. they leave to serve another school or park somewhere off-campus after dropping off students.)

	Elementary School Data							
	AM Trips Generated				PM Trips Generated			
Direction	Parents	Buses	Staff	Trips	Parents	Buses	Staff	Trips
IN	273	14	113	400	168			168
OUT	273			273	168	14		182
	AM Elementary Peak Period Trips			673	PM Elementary Peak Period Trips			349

If this value is not known, the most conservative option is to enter the full number of "In" buses. This will generate the largest number of peak period trips and corresponding ADT. In most cases, bus trips make up a very small percentage of total trips in and out of a school. As with the previous section, these cells should not be left blank, or the total trip volume will be underestimated.

	Elementary School Data							
	AM Trips Generated				PM Trips Generated			
Direction	Parents	Buses	Staff	Trips	Parents	Buses	Staff	Trips
IN	273	14	113	400	168	14		182
OUT	273	14		287	168	14		182
	AM Elementary Peak Period Trips			687	PM Elementary Peak Period Trips			363

The upper-right of the page displays the results of the calculator. The predicted number of peak period trips, ADT generated by the school, and projected queue length are provided in the row of green cells below the table.

Calculations					
AM Carpool Vehicles	PM Carpool Vehicles	AM Peak Period Trips	PM Peak Period Trips	ADT	Projected Queue Length
273	168	687	363	1163	2174
		687	363	1163	2174
					Totals

At the base of the page, a standalone tool is provided for estimating the number of cars passing the school per minute during the peak hour of traffic. It is not affected by other calculations on the page.

Roadway ADT	Peak-Hour Traffic Volumes		
	15% of ADT	Major Direction	Minor Direction
500	75	45	30
	Split	60%	40%
	Cars / Min.	0.8	0.5
	0	0	0
	Split	60%	40%
	Cars / Min.	0.0	0.0

AASHTO: On rural roads with average fluctuation in traffic flow, the 30th highest hourly volume is typically 15 percent of the ADT.

Use a 60/40 split unless additional information is available.

The design of the *Public, Private or Non-Urban Charter*, and *Urban Charter* tabs are generally similar. However, the private and non-urban charter tab provides the option to omit pre-kindergarten and kindergarten students from the carpool queue. In some cases, parents of these students will park and walk their students in, bypassing the carpool line. This option should only be selected if sufficient parking spots are provided to serve the pre-kindergarten and kindergarten parents, and it is expected that they will actually use them. The example below shows a private elementary school where PK/K students have been dropped from queue calculations.

Type: **Private or Non-Urban Charter**

Version: Build 07112021.1

PK & K Park and Walk: **Yes**

	MSTA School Queue Input					Calculations					
Grade Level	Student Population	Number of AM Buses	Number of PM Buses	Staff Members	Student Drivers	AM Carpool Vehicles	PM Carpool Vehicles	AM Peak Period Trips	PM Peak Period Trips	ADT	Projected Queue Length
PK & K	50	0	0	10		22	26	53	52	116	0
				7							
Grades 1-10	300	0	0	40		130	160	300	320	660	2562
				39							
Grade 11											
Grade 12											
Totals								353	372	775	2562

Back-End Design

In most cases, the sampled schools' metadata, queue lengths, trip generation surveys, and associated calculations do not need to be viewed by the analyst. However, some familiarity with the design paradigm used to structure the STC back-end may provide analysts with a greater understanding of how the calculator's queue length and trip generation predictions are derived.

The back-end is made up of a *Schools, Queues, TripPrediction, ADMCorrectionFactor,* and *Calculations* tab. The first four tabs form a relational database containing data gathered during RP 2019-27, along with data from the previous version of the School Traffic Calculator. The calculations tab aggregates data from all of the sampled schools and interfaces with the public, private/non-urban charter, and urban charter spreadsheets.

<u>Schools Database</u>

The schools sheet contains one record for every school in the School Traffic Calculator.

- sch_ID: A unique identifier used within the STC
- School Name
- EDDIE School ID: A shorthand code taken from the NC DPI EDDIE database; not necessarily unique for multi-campus schools.
- Address
- County
- School Type: Either Public, Private/Non-Urban Charter, or Urban Charter.
    - The NC DPI EDDIE database was used to separate schools visited during RP 2019-27 into public and charter categories. Charter schools were divided into non-urban or urban categories based on the 2010 Census Urban Areas map (1). No private schools were included in the STC update.
        - The previous MSTA School Traffic Calculator used the 2013 North Carolina Urbanized Area Boundaries map (2). Based on discussion with MSTA staff, charter school characterization is location-dependent, and may not correspond to geographic location.
    - Schools extracted from the previous School Traffic Calculator already had school types assigned.
- MSTA Project: Either RP 2019-27, indicating collection by the research team, or Historic, indicating the school was extracted from the previous School Traffic Calculator.
- Removed From Sample: Indicates a school was initially sampled or had data collected during RP 2019-27, but was removed from the sample before data collection could occur or scrubbed afterwards due to further information indicating it violated the sampling frame rules.
    - Only two schools were flagged. One was dropped from the sampling frame before data collection could occur because permission to visit the campus could not be obtained. The other was included in an e-mail survey, but the results were scrubbed because the school had a year-round schedule.
- Notes

The image below shows the upper-left corner of the *Schools* spreadsheet.

sch_ID	SchoolName	EDDIESchoolID	Address	County	SchoolType
1	Millbridge Elementary School	800366	155 Ed Deal Rd, China Grove, NC 28023	Rowan	Public
2	West Rowan Elementary	800406	480 Mimosa St, Cleveland, NC 27013	Rowan	Public
3	Winget Park Elementary	600588	12235 Winget Rd, Charlotte, NC 28278	Mecklenburg	Public
4	Lake Wylie Elementary	600436	13620 Erwin Rd, Charlotte, NC 28273	Mecklenburg	Public
5	Dorothy J. Vaughan Academy of Technology	600475	8601 Old Concord Rd, Charlotte, NC 28213	Mecklenburg	Public
6	Reid Park Academy	600517	4108 W Tyvola Rd, Charlotte, NC 28208	Mecklenburg	Public
7	Harold D Isenberg Elementary	800358	2800 Jake Alexander Blvd N, Salisbury, NC 28147	Rowan	Public
8	Hawk Ridge Elementary	600406	9201 Bryant Farms Rd, Charlotte, NC 28277	Mecklenburg	Public
9	Rama Road Elementary	600512	1035 Rama Rd, Charlotte, NC 28211	Mecklenburg	Public

Over time, one school can occupy multiple addresses, or one address can host multiple schools. For example, a campus may be used as a middle school for a few years, the school move to a new campus, and an elementary school move into the same building(s). The research team attempted to manually remove any cases where this occurred from the final sample out of concern that they would result in correlated observations. Most of the observations dropped from the previous School Traffic Calculator were removed because the school metadata was ambiguous, and there was no way to rule out the possibility of "duplicate" sampling.

Queues Database

Queue records represent a unique combination of school, queue line, and collection date. Data in this tab were either gathered by field data collection or extracted from the previous School Traffic Calculator.

The following fields are provided for each record:

- sch_ID: The school's unique identifier number. Links the queue record to the appropriate school record on the Schools tab.
- Short Description: Generally the school's name, but may also include descriptions such as "Front Queue" or "Side Queue" at schools with multiple queues.
- AM/PM: Indicates whether the queue was measured during morning drop-off or afternoon pick-up.
- Multi Queue: Indicates whether the queue is part of a multi-queue school.
    - The research staff counted schools as having multiple queues if students loaded from spatially separated pick-up locations (i.e. one pick-up zone on the side of the school, and one pick-up zone at the front of the school.) A single pick-up zone where the queue had multiple lines was counted as a single queue.
    - No records of single or multiple queue status were available for queues extracted from the previous School Traffic Calculator.
- Collection Date: Lists the date when field data was collected.
- School Year: Calculated during post-processing; contains the two years that the school year falls into (i.e. 2018-2019 represents the August 2018 – May 2019 school year.)
- Student Population: Lists the number of students present at school on the day the queue data was collected.
- Pop Collection Method: Indicates the method used to capture the student population.

- The populations of all schools visited during RP 2019-27 were estimated using Average Daily Membership records from NC DPI. ADM records from all months in the collection school year were compared, and the month with the lowest student membership was selected.
  - The method used to estimate student population in the previous School Traffic Calculator is unknown. Based on discussion with MSTA staff, it appears that data collectors checked with the front office on the day they collected data at each school, obtaining the number of students actually present on that day directly. Compared to this method, ADM is likely to overestimate student populations.
- Grades Instructed: The grades instructed by the school at the time the queue was collected. Generally determined by reviewing EDDIE records, reviewing survey data for schools that responded, and checking the school's website.
  - For many locations, it was difficult to determine to a high degree of confidence whether the school instructed pre-kindergarten students or not. The draft STC combines kindergarten and pre-kindergarten groups for most analysis purposes to reduce the effects of this uncertainty on results.
- Total Vehicles In: The total number of carpool vehicles entering the queue.
- Total Vehicles Out: The total number of carpool vehicles exiting the queue after pick-up or drop-off. This value is close to or equal to the total vehicles in; minor differences may occur due to measurement error or vehicles entering or leaving the queue.
- Max Queue (Vehicles): The maximum number of vehicles in the queue.
  - The updated School Traffic Calculator bases queue predictions on the maximum queue length in feet, normalized to a per-student basis. The maximum queue in vehicles was collected for backwards compatibility with the previous version of the School Traffic Calculator.
- Max Queue (Feet): The maximum length of the queue.
  - The maximum length in feet may not occur at the same time as the maximum number of vehicles due to queue shockwaves (i.e. vehicles may be departing the queue at a faster rate than they arrive, but the queue shockwave has not reached the back of the queue yet.)
- Notes

The image below shows the upper-left corner of the *Queues* spreadsheet.

sch_ID	ShortDescription	AM/PM	Multi Queue	CollectionDate	SchoolYear	StudentPopulation	PopCollectionMethod
2	West Rowan Elementary	PM	No	10/28/2019	2019-2020	574	ADM Estimate
7	Harold D Isenberg Elementary	PM	No	10/30/2019	2019-2020	406	ADM Estimate
13	West Rowan High School	PM	No	10/20/2019	2019-2020	1058	ADM Estimate
15	Charles C Erwin Middle School	PM	No	10/29/2019	2019-2020	869	ADM Estimate
24	York Elementary	PM	No	12/2/2019	2019-2020	420	ADM Estimate
27	Bryan Road Elementary	PM	No	12/12/2019	2019-2020	475	ADM Estimate
30	Abbotts Creek Elementary School	PM	No	12/4/2019	2019-2020	865	ADM Estimate
31A	Laurel Mill Elementary (Front Queue)	PM	Yes	3/4/2020	2019-2020		
31B	Laurel Mill Elementary (Side Queue)	PM	Yes	3/4/2020	2019-2020		
31	Laurel Mill Elementary	PM	Yes	3/4/2020	2019-2020	276	ADM Estimate

Trip Prediction Database

The trip prediction database contains bus, staff, and student driver data based on an email survey sent to schools, along with records reconstructed from the previous School Transportation Calculator.

The following fields are provided for each record:

- sch_id: The school's unique identifier number. Links the queue record to the appropriate school record on the Schools tab.
- School Name: The school's name.
    - Database links are based on the sch_id field, not the name field, so there is no guarantee that the school name is exactly identical among spreadsheets.
- Timestamp: The date and time the school survey was submitted by school administrators back to the research team.
- School Year: This field is similar to the School Year field in the "Queues" sheet.
- Attendance Fields (PK/K, 1, 2, ... , 11, 12): Indicates the student attendance by grade.
    - Data for schools surveyed by the research team was gathered from NC DPI records.
      Grade breakdowns for schools in the historic STC were not available; however, total student population was. An even distribution among all grades was assumed unless more detailed information was available in the school records.
- Pop Collection Method: This field is similar to the Pop Collection Method field in the "Queues" sheet.
- Program: Describes the calendar type for the school.
    - All schools surveyed by the research team were either classified as Regular Calendar or Year Round schools.
        - Only one Year Round school was surveyed. It was later dropped from the final calculations to maintain consistency with the original sampling frame rules, which restricted sampling to traditional-calendar schools, but is retained on the data spreadsheet in case future updates expand the model to account for the effects of year-round scheduling.
    - School records extracted from the previous STC were labeled as Unknown, since no corresponding calendar records were available.
- School Staff: The self-reported number of staff members serving at the school.
- AM Buses: The number of buses serving the school in the morning.
- PM Buses: The number of buses serving the school in the afternoon.
- Student Drivers: The total number of student drivers, across all grades, attending the school.
    - For private/non-urban charter and urban charter schools: Attendance by grade is used to split the student drivers up into 11^{th} and 12^{th} grade "bins." The draft STC divides student drivers among grades 11 and 12 equally, or assigns all drivers to one grade if the other is not served by the school.
    - For public schools: Student drivers are calculated on a student driver per high school student basis.
- Notes

The image below shows the upper-left corner of the *TripPrediction* spreadsheet.

sch_id	School Name	Timestamp	School Year	PK/K	1	2	3	4
74	Aberdeen Elementary	HistoricData	HistoricData	118	118	118	118	X
75	Alexander Wilson	HistoricData	HistoricData	100	100	100	100	100
76	Altamahaw-Ossipee	HistoricData	HistoricData	100	100	100	100	100
77	Archdale Elementary	HistoricData	HistoricData	78	78	78	78	78
64	Envision Science Academy	2019/05/01 12:56:59 PM AST	2018-2019	75	76	80	80	79
66	Maureen Joy Charter School	2019/05/03 9:30:15 AM AST	2018-2019	63	63	66	73	74
63	Bradford Preparatory School	2019/05/07 12:26:18 PM AST	2018-2019	92	99	108	115	128
70	Oxford Preparatory School	2019/05/08 4:19:44 PM AST	2018-2019	X	X	X	X	X
68	Pinnacle Classical Academy (Lower Elem Campus)	2019/05/09 10:23:19 AM AST	2018-2019	109	104	87	X	X
67	Lake Lure Classical Academy	2019/05/10 4:31:12 PM AST	2018-2019	29	27	38	41	44
69	Pinnacle Classical Academy (Upper Campus)	2019/05/10 4:37:23 PM AST	2018-2019	X	X	X	84	90
62	Alpha Academy	2019/05/11 12:20:06 PM AST	2018-2019	81	112	99	93	63
71	Research Triangle High School	2019/05/14 4:17:48 PM AST	2018-2019	X	X	X	X	X
72	Youngsville Academy	2019/05/16 4:40:35 PM AST	2018-2019	60	54	59	56	40

ADM Correction Factor Database

The ADM correction factor spreadsheet compares the attendance reported by schools to the attendance at those locations estimated from NC DPI average daily membership records. Correction factors are also provided to apply the difference in reported attendance and ADM estimates to other schools visited during RP 2019-27.

Average daily membership data was collected from NC DPI records for all schools, and the lowest ADM over the school year was taken as an approximation for school attendance. At the end of the RP 2019-27 project timeline, schools where queue data had been successfully collected were contacted, and schools were asked to provide exact attendance records. The reported records include a mix of head counts and Principal's Monthly Record data, and are best interpreted as a slightly more accurate estimate than the ADM records.

Correction factors were generated for public elementary, public middle, private and non-urban charter, and urban charter schools to adjust the ADM estimates. No public high schools responded to the request for records, so a correction factor of 1 was assumed.

Student population records were present in two locations in the calculator: the queues database, and the trip prediction database. All student populations in both, with the exception of historic records inherited from the existing MSTA calculator, were updated using the correction factors. Where actual attendance data was available, it was applied to the queue database only, since the survey was generally filled out on a different day than the school was visited to collect queue data.

sch_ID	School Name	EDDIE School ID	School Type	Grades Instructed	Collection Date	ADM Estimate	Reported Attendance	Correction Factor
31	Laurel Mill Elementary	350330	Public	K - 5	3/4/2020	276	293	1.0616
7	Harold D Isenberg Elementary	800358	Public	K - 5	10/30/2019	406	407	1.0025
27	Bryan Road Elementary	920349	Public	PK - 5	12/12/2019	475	478	1.0063
18	Lynn Road Elementary	920488	Public	PK - 5	1/22/2020	493	476	0.9655
34	Northwoods Elementary	920520	Public	PK - 5	1/23/2020	601	656	1.0915
22	Wakelon Elementary	920597	Public	K - 5	12/5/2019	518	536	1.0347
20	Wildwood Forest Elementary	920618	Public	K - 5	12/4/2019	641	600	0.9360
24	York Elementary	920628	Public	PK - 5	12/2/2019	420	411	0.9786
60	Holly Shelter Middle School	650343	Public	6 - 8	3/2/2020	689	731	1.0610
43	Wakefield Middle	920594	Public	6 - 8	2/3/2020	944	886	0.9386
68	Pinnacle Classical Academy (Lower Elem Campus)	23A000	Private_or_NonUrbanCharter	K - 2	5/22/2019	300	317	1.0567
69	Pinnacle Classical Academy (Upper Campus)	23A000	UrbanCharter	3 - 11	5/29/2019	530	549	1.0358
64	Envision Science Academy	92Y000	UrbanCharter	K - 8	3/7/2019	703	694	0.9872

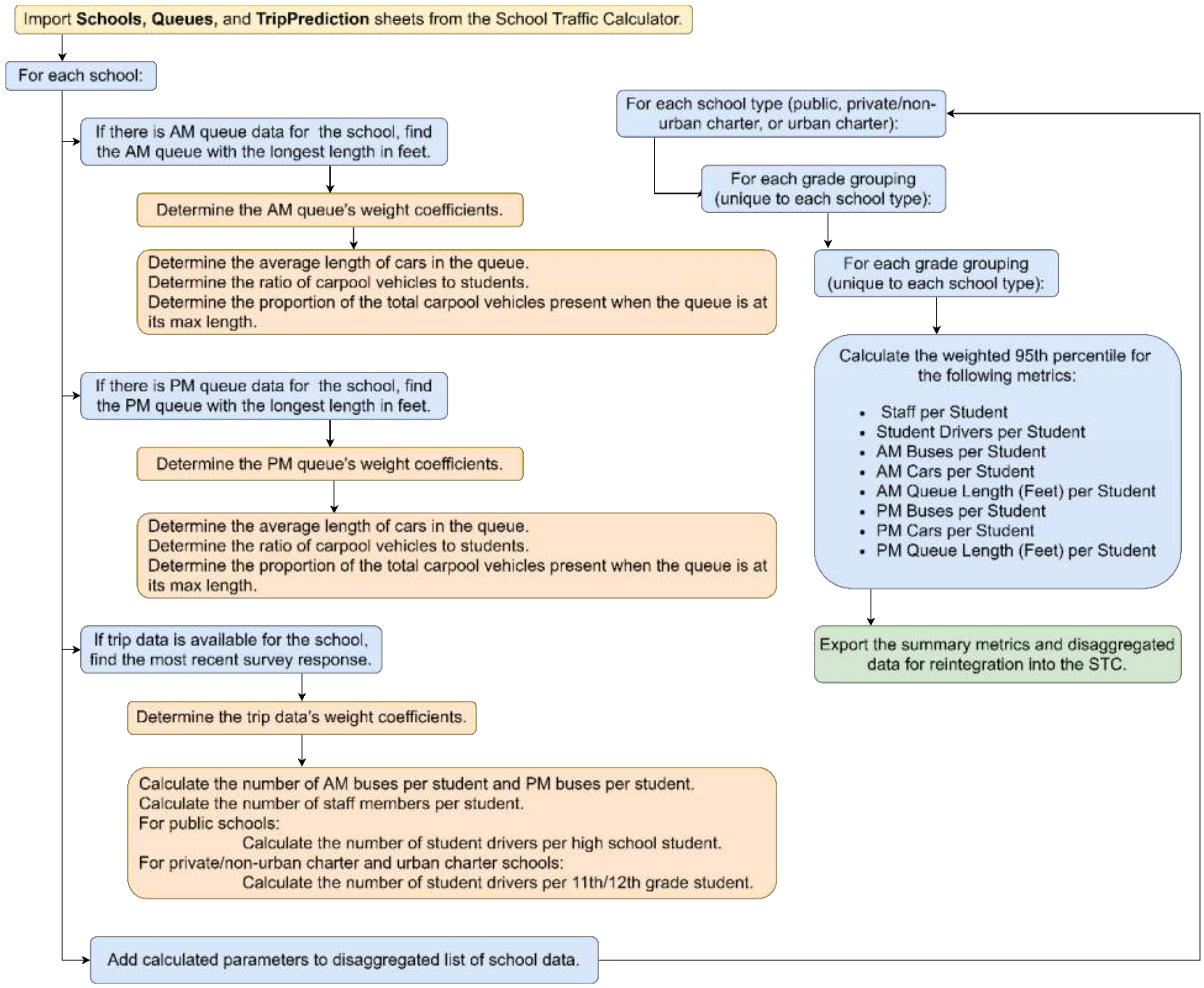
Category	Sample Size	Avg CF	Lower 95% CI	Upper 95% CI
Public Elementary	8	1.0096	0.9667	1.0525
Public Middle	2	0.9998	0.2221	1.7774
Public High	0	1.0000	N/A	N/A
Private/Non-Urban Charter	1	1.0567	N/A	N/A
Urban Charter	2	1.0115	0.7024	1.3206

Calculations Spreadsheet

The calculations spreadsheet contains the following summary metrics for each combination of school type and grade level:

- Staff per Student
- Student Drivers per Student
- AM Buses per Student
- AM Cars per Student
- AM Queue Length (Feet) per Student
- PM Buses per Student
- PM Cars per Student
- PM Queue Length (Feet) per Student

Individual statistical weights, along with the component variables used to calculate the metrics above, are also displayed for each school. Data aggregation is performed using an external script, rather than inside the workbook itself. The diagram below outlines the “behind-the-scenes” data analysis and aggregation process:



The following assumptions were made during data aggregation:

- Schools that did not have records for total number of carpool parents, average car length, and the ratio of carpool vehicles to total number of students (i.e. all components of a measured queue) were not used in calculating the average queue length per student in feet.
- Unrealistically high ratios (i.e. a ratio of student drivers to students greater than 1.00, or a ratio of carpool cars to students of greater than 1.00) were adjusted to 1.00.

The image below shows the upper-right corner of the *Calculation* spreadsheet, including the summary metrics. Note the yellow-highlighted cells; these represent unrealistically high ratios that were corrected to 1.00. The orange-highlighted cells represent values that were not available in the ITRE dataset; as a result, they were estimated from the current MSTA calculator and will be updated in future research.

AM has_buses	AM Buses per Student	AM Parents	AM Cars per Student	AM Avg Car Length	AM % Parents at Once	PM has_buses	PM Buses per Student	PM Parents	PM Cars per Student	PM Avg Car Length	PM % Parents at Once		Category	Staff per Student	Student Drivers per Student	AM Buses per Student	AM Cars per Student	AM Queue Length (Feet) per Student	PM Buses per Student	PM Cars per Student	PM Queue Length (Feet) per Student
													Public Elem	0.189	0	0.024	0.455	2	0.024	0.279	3.624
1	0.01					1	0.01	112	0.2	27.4	0.68		Public Middle	0.163	0	0.028	0.51	0.833	0.028	0.272	2.593
													Public High	0.115	0.378	0.022	0.148	0.188	0.022	0.069	1.281
													Private PK-K	0.131	0		0.433	0.333		0.523	8.54
													Private Grades 1-10	0.131	0		0.433	0.333		0.533	8.54
													Private Grade 11	0.131	0.924		0.433	0.333		0.533	5.45
								84	0.21	23.8	0.48		Private Grade 12	0.131	0.924		0.433	0.333		0.326	1.718
1	0.01					1	0.01						Urban Charter Grades K-10	0.392	0	0.018	0.575		0.019	0.51	4.255
													Urban Charter Grade 11	0.182	1.00	0.022	0.387		0.022	0.35	4.621
													Urban Charter Grade 12	0.182	0.511	0.016	0.143		0.016	0.14	2.25

Urban Charter | Schools | Queues | TripPrediction | Calculations

Section References:

(1) North Carolina Department of Transportation. (n.d.). *https://connect.ncdot.gov*. map. https://connect.ncdot.gov/projects/planning/TPB%20Documents/MPO_UZA_MAP_2013.pdf.

(2) Census Bureau. (2018, November 9). *2010 Census Urban Areas*. www.nconemap.gov. https://www.nconemap.gov/datasets/nconemap::2010-census-urban-areas

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix G

Intersection Sight Distance Calculations

Prepared for:

Wooten Engineering

Prepared By:

LEE ENGINEERING

INTERSECTION SIGHT DISTANCE CALCULATIONS

Reference: 2018 AASHTO “Green Book” chapter 9.5

Design Vehicle: Passenger Vehicles
Major Road Lanes:

Jefferson St: SB – 2 through lanes and 1 left turn lane
NB – 2 through lanes
14-ft. wide median with an opening at Presidential Dr/Site Exit allowing left turns

Major Road Speed:

Jefferson St: 35 MPH

Case B1: A stopped vehicle turning left from a minor street approach onto a major road
Case B2: A stopped vehicle turning right from a minor street approach onto a major road

FORMULA:

ISD= $1.47*V_{major}*t_g$
Units: ISD (ft), V_{major} (MPH), and t_g (seconds)
Time Gaps (t_g):

7.5 (for passenger vehicles turning left, crossing one lane of traffic)
6.5 (for passenger vehicles turning right)
0.5 (added for each additional lane or 12-ft. median crossed)

SITE EXIT

CASE B1 (LEFT TURN):

Time Gap (t_g)= 7.5 + 2
ISD= 1.47*35*9.5= 488.78 ft~ **490 ft**

CASE B2 (RIGHT TURN):

Assumption: Design vehicle is turning into the first lane of the major roadway.
Time Gap (t_g)= 6.5
ISD= 1.47*35*6.5= 334.43 ft~ **335 ft**

Neighborhood Impact Assessment (NIA) for Jefferson St Charter High School

Appendix H

MRCOG MTP Peak Hour Load Volumes

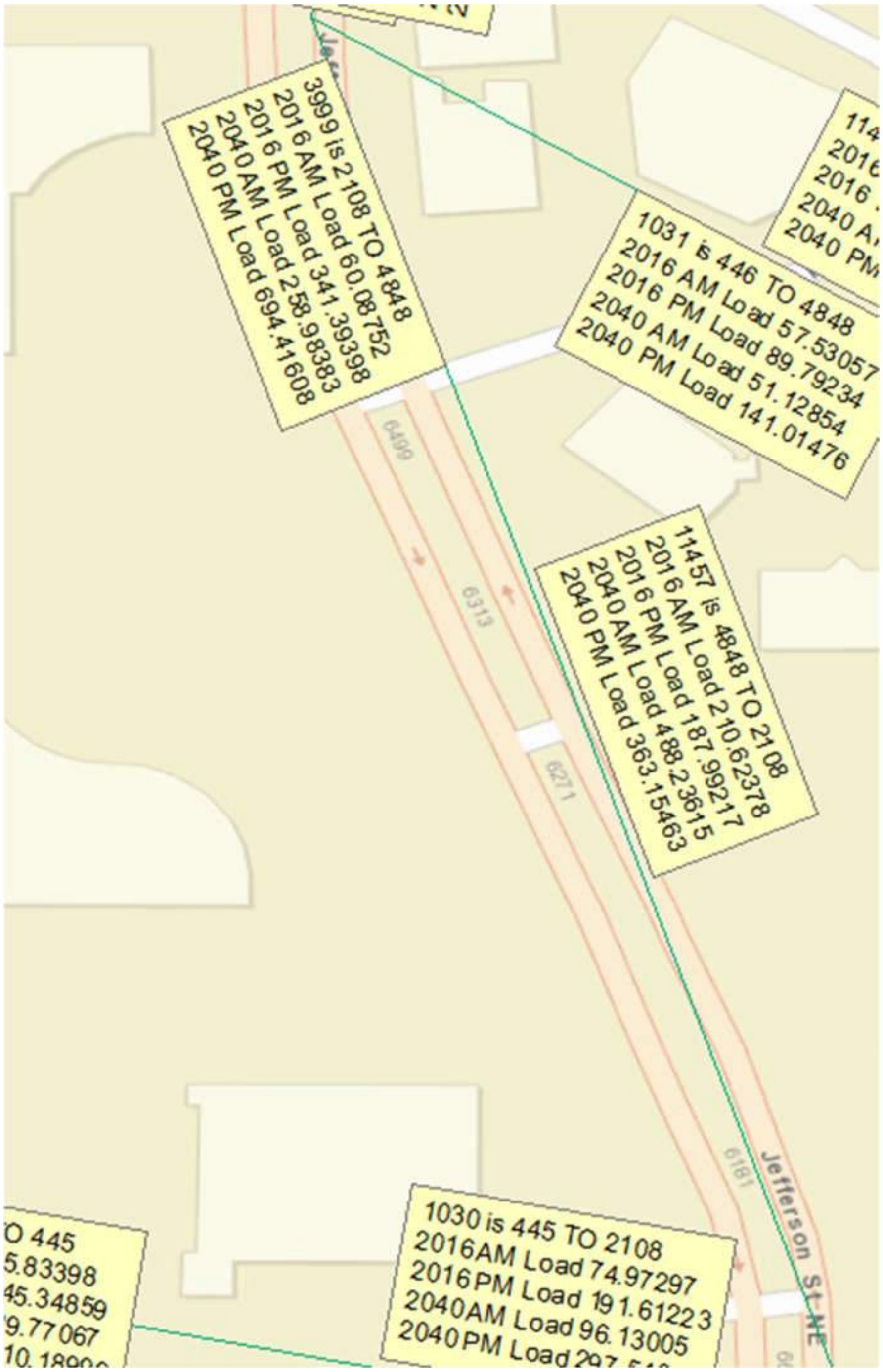
Prepared for:

Wooten Engineering

Prepared By:

LEE ENGINEERING

MRCOG MTP 2016 AM/PM Peak Hour Load Volumes & 2040 Projected AM/PM Peak Hour Load Volumes


3999 is 2108 TO 4848
2016 AM Load 60.08752
2016 PM Load 341.39398
2040 AM Load 258.98383
2040 PM Load 694.41608
1031 is 446 TO 4848
2016 AM Load 57.53057
2016 PM Load 89.79234
2040 AM Load 51.12854
2040 PM Load 141.01476
11457 is 4848 TO 2108
2016 AM Load 210.62378
2016 PM Load 187.99217
2040 AM Load 488.23615
2040 PM Load 363.15463
1030 is 445 TO 2108
2016AM Load 74.97297
2016PM Load 191.61223
2040AM Load 96.13005
6499
6313
6271
6181
Jefferson St NE