Appendix I

Traffic Impact Analysis

2539 EAST GARVEY AVENUE PROJECT TRAFFIC IMPACT ANALYSIS

City of West Covina

October 1, 2020

ganddini

Traffic Engineering ● Transportation Planning ● Parking ● Noise & Vibration
Air Quality ● Global Climate Change ● Health Risk Assessment

2539 EAST GARVEY AVENUE PROJECT TRAFFIC IMPACT ANALYSIS

City of West Covina

October 1, 2020

prepared by
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EXECUTIVE SUMMARY

The purpose of this Traffic Impact Analysis is to provide an assessment of traffic operations resulting from development of the proposed 2539 East Garvey Avenue Project and to identify measures necessary to mitigate potentially significant traffic impacts. This report analyzes traffic impacts for the anticipated project opening year in Year 2021. Although this is a technical report, effort has been made to write the report clearly and concisely. A glossary is provided in Appendix A to assist the reader with terms related to transportation engineering.

Project Description

The 3.67-acre project site is located at 2539 East Garvey Avenue North in the City of West Covina, California.

The proposed project consists of redeveloping the project site with 42,455 square feet of commercial retail and 4,500 square feet of fast-food restaurant with drive-thru. The project site has existing structures that are currently vacant and will be demolished. The proposed project is anticipated to be constructed and fully operational by year 2021.

The project proposes two driveways at East Garvey Avenue. The driveway on the southwest portion of the project site is proposed to provide full access. The driveway on the northeast portion of the project site is proposed to provide right turns in/out and left turns out only (no left turns in).

Existing Conditions

The study intersection currently operates at Levels of Service C or better during the peak hours for Existing conditions (see Table 1).

Project Trips

The proposed project is forecast to generate a total of approximately 2,563 daily trips, including 126 trips during the AM peak hour and 121 trips during the PM peak hour (see Table 2).

Forecast Levels of Service

The proposed project is forecast to result in Level of Service operational impacts at the study intersection during the weekday AM and PM peak hours for the scenarios evaluated.

Congestion Management Program

The proposed project would result in no operational CMP impact as it does not meet the thresholds requiring a traffic impact analysis for CMP purposes and no further CMP analysis is warranted. A transit impact review was conducted for compliance with the CMP requirements and found that the proposed project is forecast to have a nominal impact on transit service.

Site Access and Circulation

The proposed project shall construct the following improvements as project design features to provide project site access:

- Construct the Project Driveway (NS) at East Garvey Avenue (EW) (located on the southwest portion of the project site) to provide one inbound lane and one outbound lane with southbound stop-control and the following lane configurations:

- Northbound: not applicable
- Southbound: one shared left/right turn lane
- Eastbound: one shared left/through lane
- Westbound: one shared through/right turn lane.

- Construct the East Garvey Avenue (NS) at Project Driveway (EW) (located on the northeast portion of the project site) to provide one inbound lane and one outbound lane with eastbound stop-control and the following lane configurations:

  - Northbound: one through lane
  - Southbound: one shared through/right turn lane
  - Eastbound: one shared left/right turn lane
  - Westbound: not applicable

To provide for truck turning templates to function without encroaching across the centerline on Garvey Avenue, the centerline of Garvey Avenue will need to be restriped south approximately 4 feet. It will be the responsibility of the project applicant to provide striping and signing plans for Garvey Avenue to the City of West Covina for review that shows this restriping of the centerline, including centerline striping transitions east-west on Garvey Avenue

Operational Improvements

No off-site operational improvements were identified since the proposed project is forecast to result in no operational traffic impact at the study intersection for the scenarios analyzed.

VMT Assessment

The proposed project satisfies the screening criteria for local-serving retail and may be presumed to result in a less than significant VMT impact in accordance with City of West Covina VMT guidelines.

1. INTRODUCTION

This section describes the purpose of this traffic impact analysis, project location, proposed development, and study area. Figure 1 shows the project location map. Figure 2 illustrates the project site plan.

PROJECT DESCRIPTION

The 3.67-acre project site is located at 2539 East Garvey Avenue North in the City of West Covina, California.

The proposed project consists of redeveloping the project site with 42,455 square feet of commercial retail and 4,500 square feet of fast-food restaurant with drive-thru. The project site has existing structures that are currently vacant and will be demolished. The proposed project is anticipated to be constructed and fully operational by year 2021.

The project proposes two driveways at East Garvey Avenue. The driveway on the southwest portion of the project site is proposed to provide full access. The driveway on the northeast portion of the project site is proposed to provide right turns in/out and left turns out only (no left turns in).

STUDY AREA

Based on the study intersections identified in the approved scoping agreement (Appendix B), the study area consists of the following study intersection within the City of West Covina:

Study Intersections[1]	Jurisdiction
1. Citrus Street (NS) at Garvey Avenue (EW)	West Covina

ANALYSIS SCENARIOS

In accordance with scoping discussions with City of West Covina engineering staff, this study includes the following analysis scenarios:

a) Existing conditions;
b) Existing Plus Project;
c) Opening Year (2021) Without Project; and
d) Opening Year (2021) With Project.

[1] (NS) = North-South roadway; (EW) = East-West roadway

Legend

Study Intersection

Figure 1
Project Location Map

Figure 2
Site Plan

2539 East Garvey Avenue Project
Traffic Impact Analysis
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2. METHODOLOGY

This section discusses the analysis methodologies used to assess transportation facility performance as adopted by the respective jurisdictional agencies.

INTERSECTION CAPACITY UTILIZATION

In accordance with City of West Covina requirements, analysis of signalized intersections is based on the Intersection Capacity Utilization (ICU) methodology. The ICU methodology compares the volume of traffic using the intersection to the capacity of the intersection. The resulting volume-to-capacity (V/C) ratio represents that portion of the hour required to provide sufficient capacity to accommodate all intersection traffic if all approaches operate at capacity. The volume-to-capacity ratio is then correlated to a performance measure known as Level of Service based on the following thresholds:

Level of Service	Volume/Capacity Ratio
A	≤ 0.600
B	0.601 to 0.700
C	0.701 to 0.800
D	0.801 to 0.900
E	0.901 to 1.000
F	> 1.000

Source: Transportation Research Board, Interim Materials on Highway Capacity, Transportation Research Circular No. 212, January 1980.

Level of Service is used to qualitatively describe the performance of a roadway facility, ranging from Level of Service A (free-flow conditions) to Level of Service F (extreme congestion and system failure). ICU analysis was performed using the Vistro software. Consistent with County of Los Angeles guidelines, this analysis uses the following input parameters for the ICU analysis: 1,600 vehicles per hour per lane for through and turn lanes, 2,880 vehicles per hour for dual left-turn lanes, and a total clearance time of 10 percent.

PERFORMANCE STANDARDS

The City of West Covina has not established minimum acceptable Level of Service standards during peak hour conditions, but has typically used LOS E as the threshold in assessing projects in the past. Therefore, LOS E or better is considered acceptable and LOS F is considered unacceptable.

NEED FOR IMPROVEMENTS

To address operational impacts associated with a project at signalized study intersections within the City of West Covina, a project is required to provide improvements if:

- The addition of project generated trips is forecast to cause an increase in volume-to-capacity of 0.02 or greater when the intersection is operating at Level of Service F in the baseline condition.

3. EXISTING CONDITIONS

EXISTING ROADWAY SYSTEM

Figure 3 identifies the lane geometry and intersection traffic controls for Existing conditions based on a field survey of the study area. Regional access to the project area is provided by the I-10 Freeway south of the project site, The key north-south roadway providing local circulation is Citrus Street. The key east-west roadway providing local circulation is Garvey Avenue.

Citrus Street is a 4-lane to 6-lane divided roadway in the study area. Citrus Street is classified as a Commercial/Mixed-Use Thoroughfare in the City of West Covina Circulation Element. On-street parking is prohibited in the project area. No bicycle facilities are provided in the study area. Sidewalks are provided on both sides of the roadway.

Garvey Avenue is a 2-lane undivided to 4-lane divided roadway in the study area. Garvey Avenue is not classified west of Citrus Street and is classified east of Citrus Street as a Commercial/Mixed-Use Main in the City of West Covina Circulation Element. On-street parking is prohibited in the project area. No bicycle facilities are provided in the study area. Sidewalks are provided on both sides of the roadway east of Citrus Street and provided on the north side of the road west of Citrus Street.

PEDESTRIAN FACILITIES

Existing pedestrian facilities in the project vicinity are shown on Figure 4.

BICYCLE ROUTES

Bicycle routes are proposed along Citrus Street in the study area. The City of West Covina Proposed Bicycle Network is depicted on Figure 5.

TRANSIT FACILITIES

Figure 6 shows the existing transit routes available in the project vicinity provided by Foothill Transit. As shown on Figure 6, Routes 281 and 480 service Citrus Street adjacent to the project site.

Figure 7 shows the existing transit routes available in the project vicinity provided by Go West Shuttle. Go West Shuttle Red Route services Citrus Street adjacent to the project site.

The Los Angeles County Metropolitan Transportation Authority has Routes 190/194 along Workman Avenue, with bus stops locate at the intersection of Citrus Street and Workman Avenue. This intersection is located approximately 600 feet north of the project site.

GENERAL PLAN CONTEXT

Figure 8 shows the City of West Covina General Plan Circulation Element roadway classifications map. This figure shows the nature and extent of arterial and collector highways that are needed to adequately serve the ultimate development depicted by the Land Use Element of the General Plan.

EXISTING TRAFFIC VOLUMES

Figure 9 shows the Existing average daily traffic volumes. Existing average daily traffic volumes have been obtained from the California Department of Transportation (Caltrans) Traffic Volumes on California State Highways (2017) and factored from peak hour intersection turning movement volumes using the following formula for each intersection leg:

PM Peak Hour (Approach Volume + Exit Volume) x 10 = Leg Volume.

Existing peak hour volumes are based upon AM peak period and PM peak period intersection turning movement counts. The AM peak period was counted between 7:00 AM and 9:00 AM and the PM peak period was counted between 4:00 PM and 6:00 PM. The actual peak hour within the peak period is the four consecutive 15-minute periods with the highest total volume. Thus, the weekday PM peak hour at one intersection may be 4:45 PM to 5:45 PM if those four consecutive 15-minute periods have the highest combined volume. Intersection turning movement count worksheets are provided in Appendix C.

The current COVID-19 pandemic and related stay-at-home orders imposed by state and local municipalities have resulted in a substantial decrease in traffic volumes. In addition to the current public health restrictions, it is anticipated that the pandemic may have a lasting effect on travel behaviors, such as an increase telecommuting. To provide a conservative analysis, the Existing conditions traffic volumes used in this analysis are based on historic counts with adjustments applied with the intent to represent pre-pandemic conditions for the current year. This approach is likely to overestimate actual volumes for the near future since many commuters are expected to continue working from home even as stay-at-home orders are eased.

Historical intersection turning movement counts conducted in 2016 were obtained for the study intersection from the West Covina General Plan Update: Revised Draft Traffic Study (Nelson/Nygaard Consulting Associates, Inc., August 29, 2016). The AM and PM peak hour traffic volumes based on these historical counts were adjusted by a growth rate of one percent per year over a four-year period to reflect existing year 2020 conditions prior to issuance of statewide stay-at-home orders.

Historical counts could not be obtained for the study intersection of Hollenbeck Avenue and Garvey Avenue; therefore, the intersection has been removed from this analysis based on correspondence with City of West Covina staff. Furthermore, the project peak hour trip contribution at this intersection is less than the 50 peak hour trip threshold commonly used for identification of study intersections.

Figure 10 and Figure 11 show the Existing AM peak hour and PM peak hour intersection turning movement volumes. Peak hour volumes shown in the figures and Level of Service calculations throughout this report are based on the measured count data with adjustments described above.

EXISTING INTERSECTION LEVEL OF SERVICE

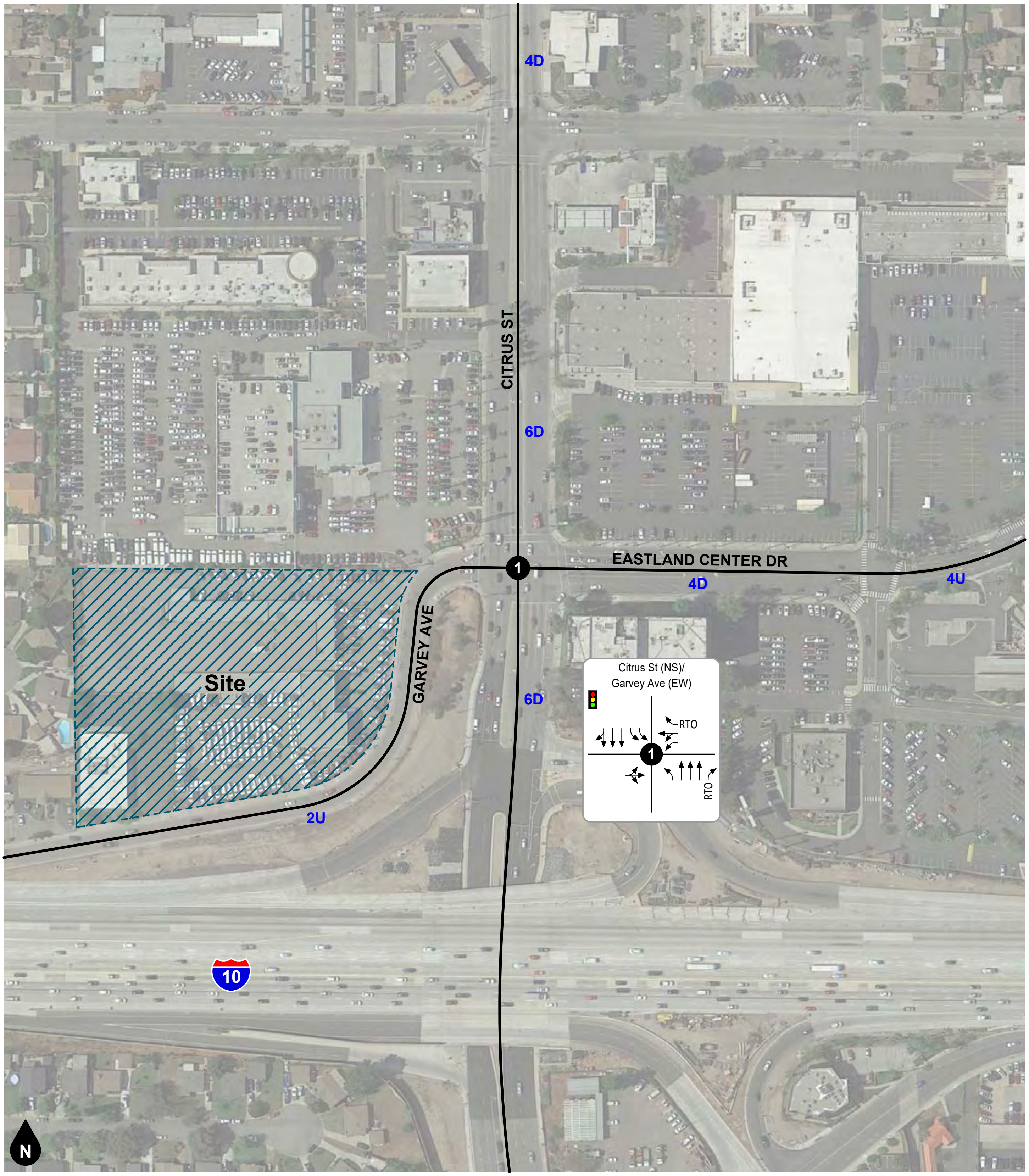
The intersection Levels of Service for Existing conditions have been calculated and are shown in Table 1. Existing intersection Level of Service worksheets are provided in Appendix D.

As shown in Table 1, the study intersections currently operate at Levels of Service C or better during the peak hours for Existing conditions.

Table 1
Existing Intersection Level of Service

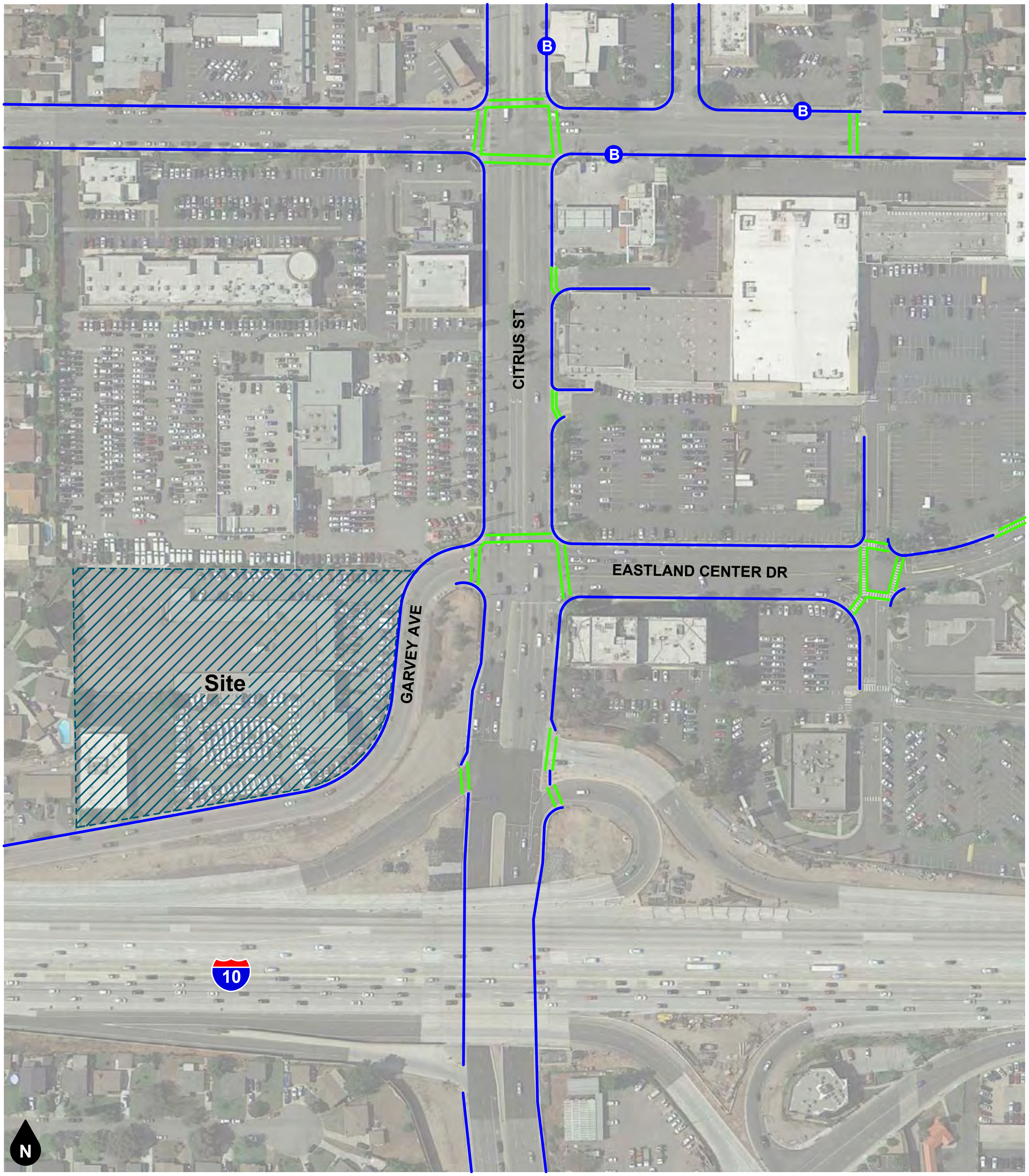
ID Study Intersection	Traffic Control[1]	AM Peak Hour		PM Peak Hour	
		ICU[2]	LOS[3]	ICU[2]	LOS[3]
1. Citrus St at Garvey Ave	TS	0.434	A	0.755	C

Notes:
(1) TS = Traffic Signal
(2) ICU = Intersection Capacity Utilization
(3) LOS = Level of Service



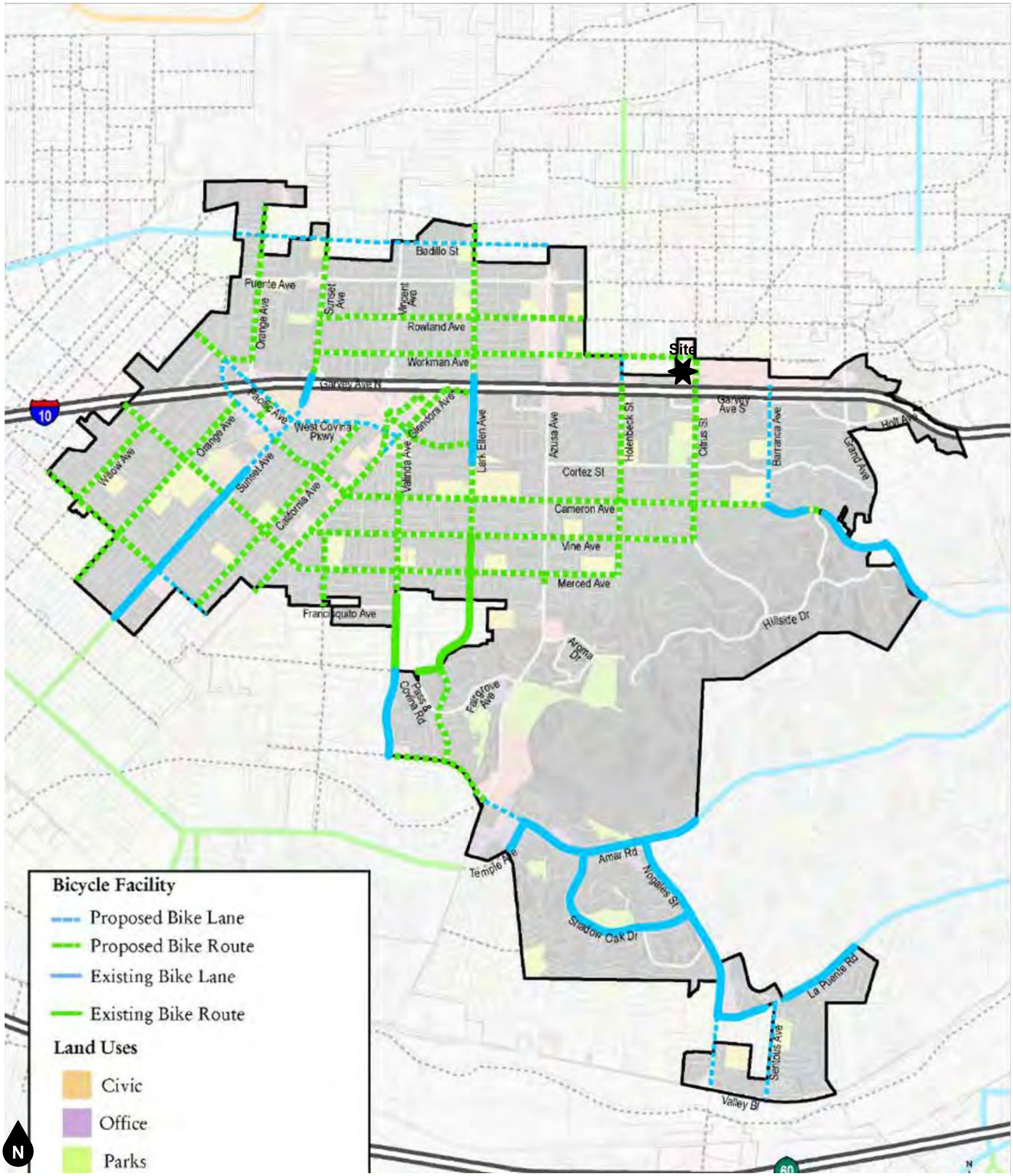
Legend
- Traffic Signal
- #D #-Lane Divided Roadway
- #U #-Lane Undivided Roadway
- Existing Lane
- RTO Right Turn Overlap

Figure 3
Existing Lane Geometry and Intersection Traffic Controls



Legend
- Sidewalk
- Cross Walk
- Bus Stop

Figure 4
Existing Pedestrian Facilities

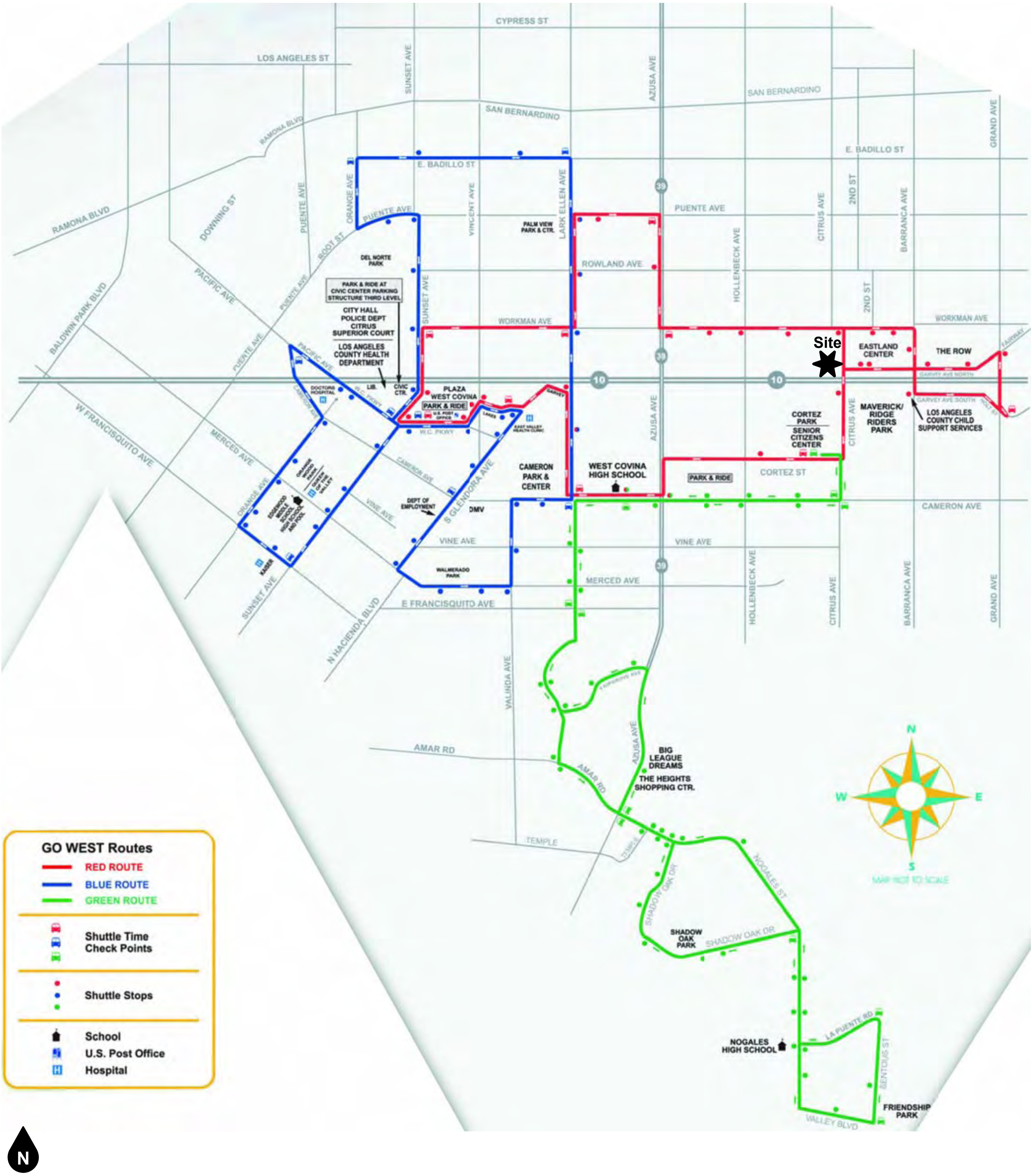


Source: City of West Covina

Figure 5
City of West Covina Proposed Bicycle Network

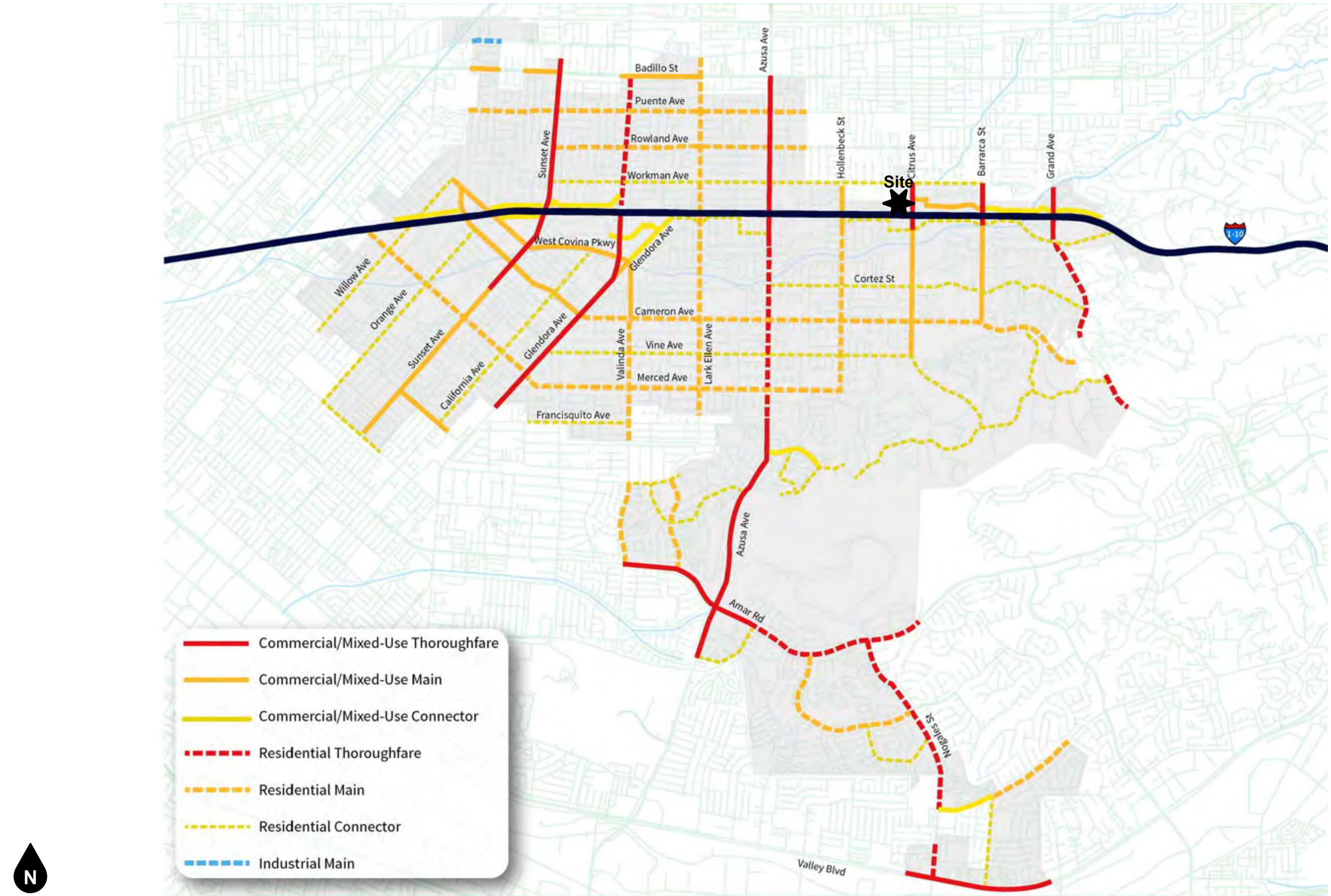
Source: Foothill Transit

Figure 6
Foothill Transit System Map



Source: Go West Shuttle

Figure 7
Go West Shuttle System Map

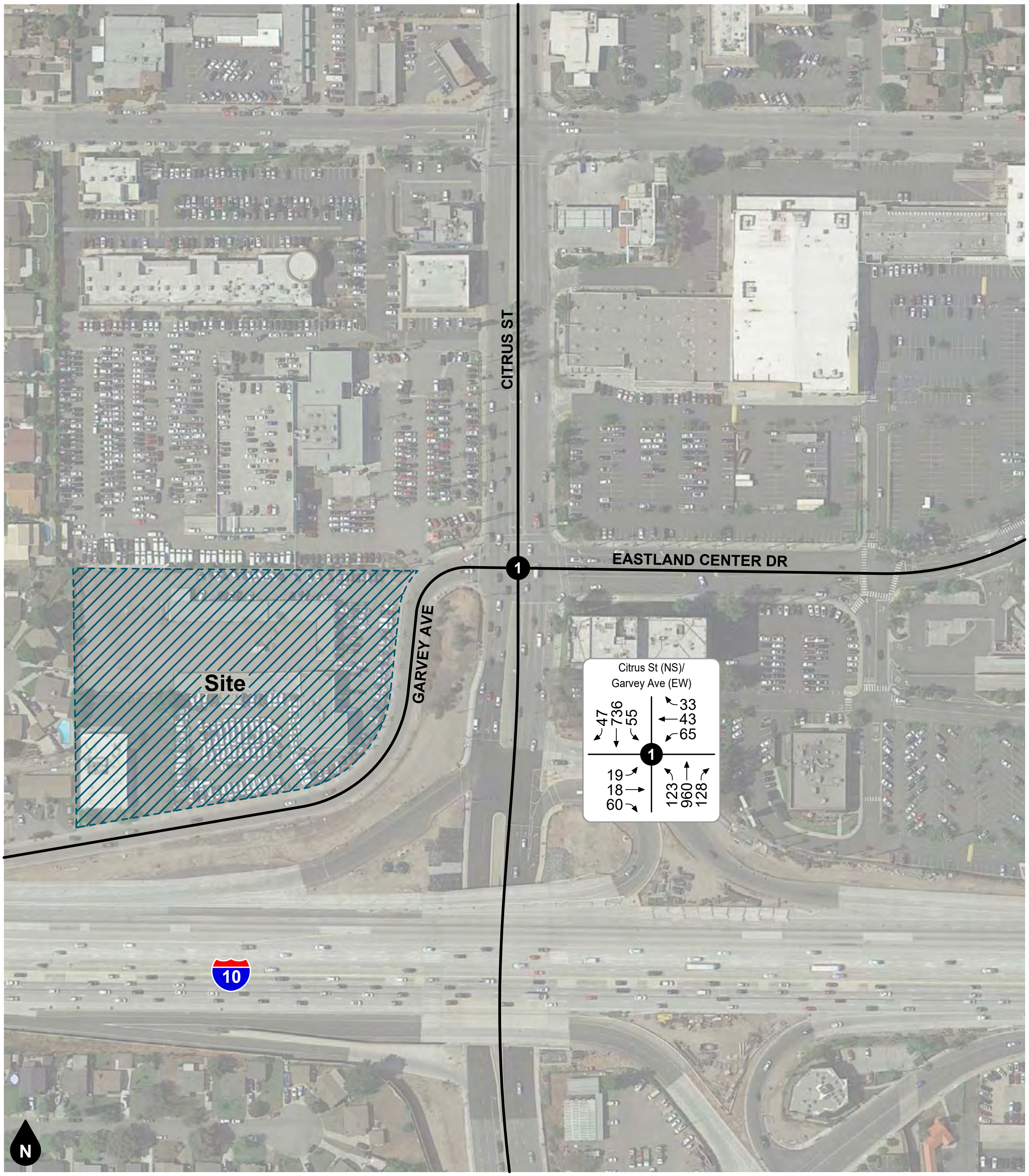


Source: City of West Covina

Figure 8
City of West Covina General Plan Circulation Element

Legend
●## Vehicles Per Day (1,000's)

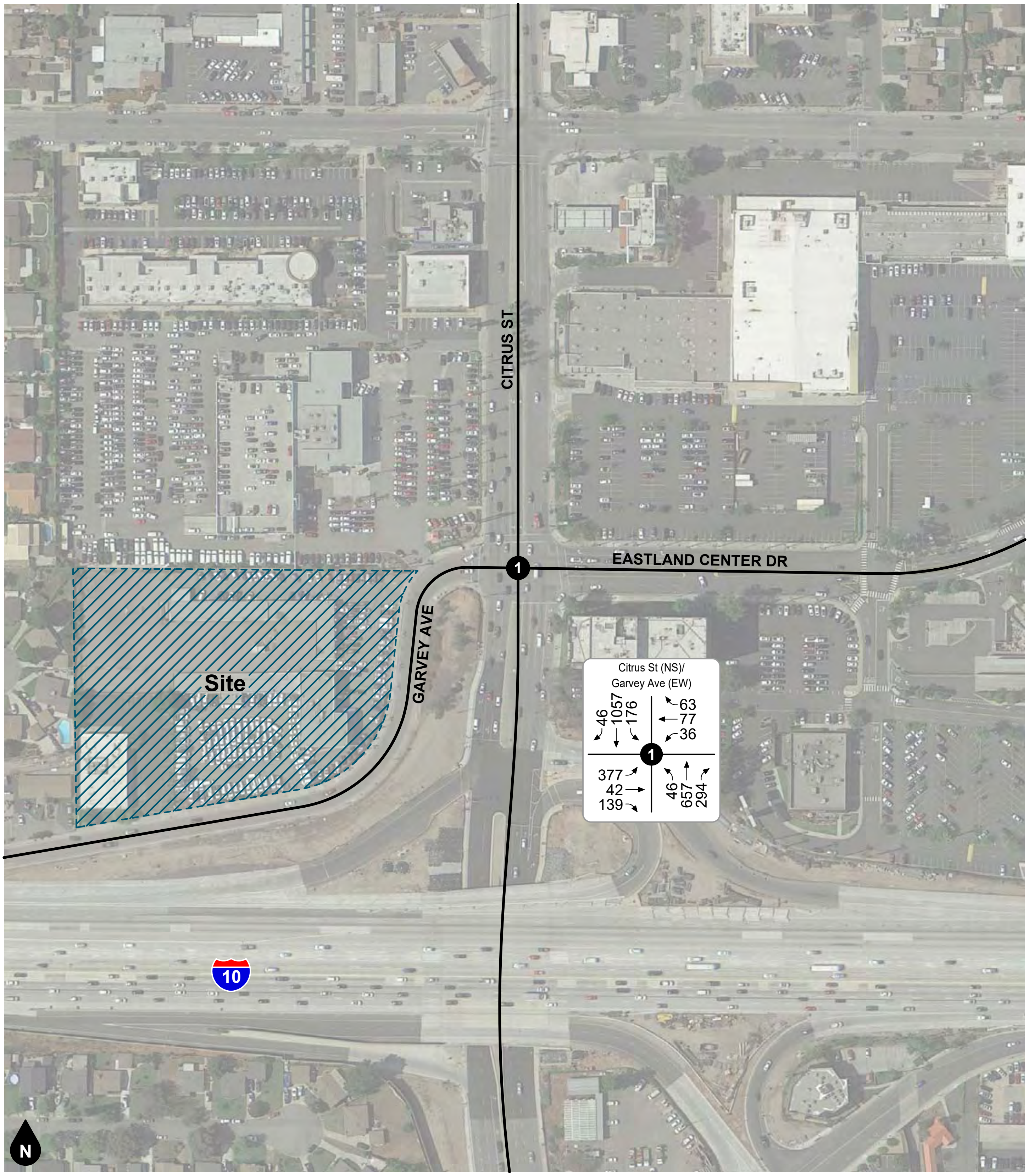
Figure 9
Existing Average Daily Traffic Volumes



Legend

Study Intersection

Figure 10
Existing AM Peak Hour Intersection Turning Movement Volumes



Legend

Study Intersection

Figure 11
Existing PM Peak Hour Intersection Turning Movement Volumes

4. PROJECT TRIP FORECASTS

This section describes how project trip generation, trip distribution, and trip assignment forecasts were developed. The forecast project volumes are illustrated on figures contained in this section.

PROJECT TRIP GENERATION

Table 2 shows the project trip generation based upon trip generation rates obtained from the Institute of Transportation Engineers (ITE) Trip Generation Manual (10th Edition, 2017). The project trip generation forecast is determined by multiplying the trip generation rates by the land use quantity. Trip generation rates for Commercial Retail (ITE Land Use Code 820) and Fast-Food Restaurant with Drive-Thru (ITE Land Use Code 934) were used.

As shown in Table 2, the proposed project is forecast to generate approximately 2,563 daily trips, including 126 trips during the AM peak hour and 121 trips during the PM peak hour.

PROJECT TRIP DISTRIBUTION AND ASSIGNMENT

Figure 12 to Figure 14 show the forecast directional distribution patterns for the project generated trips. The project trip distribution patterns are based on review of existing volume data, surrounding land uses, and the local and regional roadway facilities in the project vicinity.

Based on the identified project trip generation and distributions, project average daily traffic volumes have been calculated and are shown on Figure 15. The project-generated AM and PM peak hour intersection turning movement volumes are shown on Figure 16 and Figure 17.

OTHER FACTORS AFFECTING TRIP GENERATION

Land uses such as shopping centers, restaurants, gasoline stations, and convenience stores will often locate next to busy roadways to attract motorists already on the street. Since the trip generation rates contained in the ITE Trip Generation Manual represent vehicles entering and exiting at the site driveway(s), it is appropriate to reduce the initial trip generation forecast by the applicable pass-by trip rate when calculating the net new trips that will be added to the surrounding street system. This analysis applies a pass-by trip reduction for the commercial retail land use based upon rates from the ITE Trip Generation Handbook (3rd Edition, 2017).

Traffic volumes shown in Table 2 consist of the total trips generated for each project land use. As a commercial retail trip generated by the project may also interact with the restaurant land use within the project, a double counting of those trips occurs. To account for this internal interaction, the trips generated by the project site have been adjusted in accordance with procedures developed by the National Cooperative Highway Research Program 684 Internal Capture Estimation Tool as incorporated into the ITE Trip Generation Handbook (3rd Edition). Detailed internal capture worksheets are provided in the scoping agreement in Appendix B.

Table 2
Project Trip Generation

Trip Generation Rates									
			AM Peak Hour			PM Peak Hour			
Land Use	Source[1]	Units[2]	In	Out	Total	In	Out	Total	Daily
Commercial Retail	ITE 820	TSF	62%	38%	0.94	48%	52%	3.81	37.75
Fast-Food Restaurant w/ Drive-Thru	ITE 934	TSF	51%	49%	40.19	52%	48%	32.67	470.95

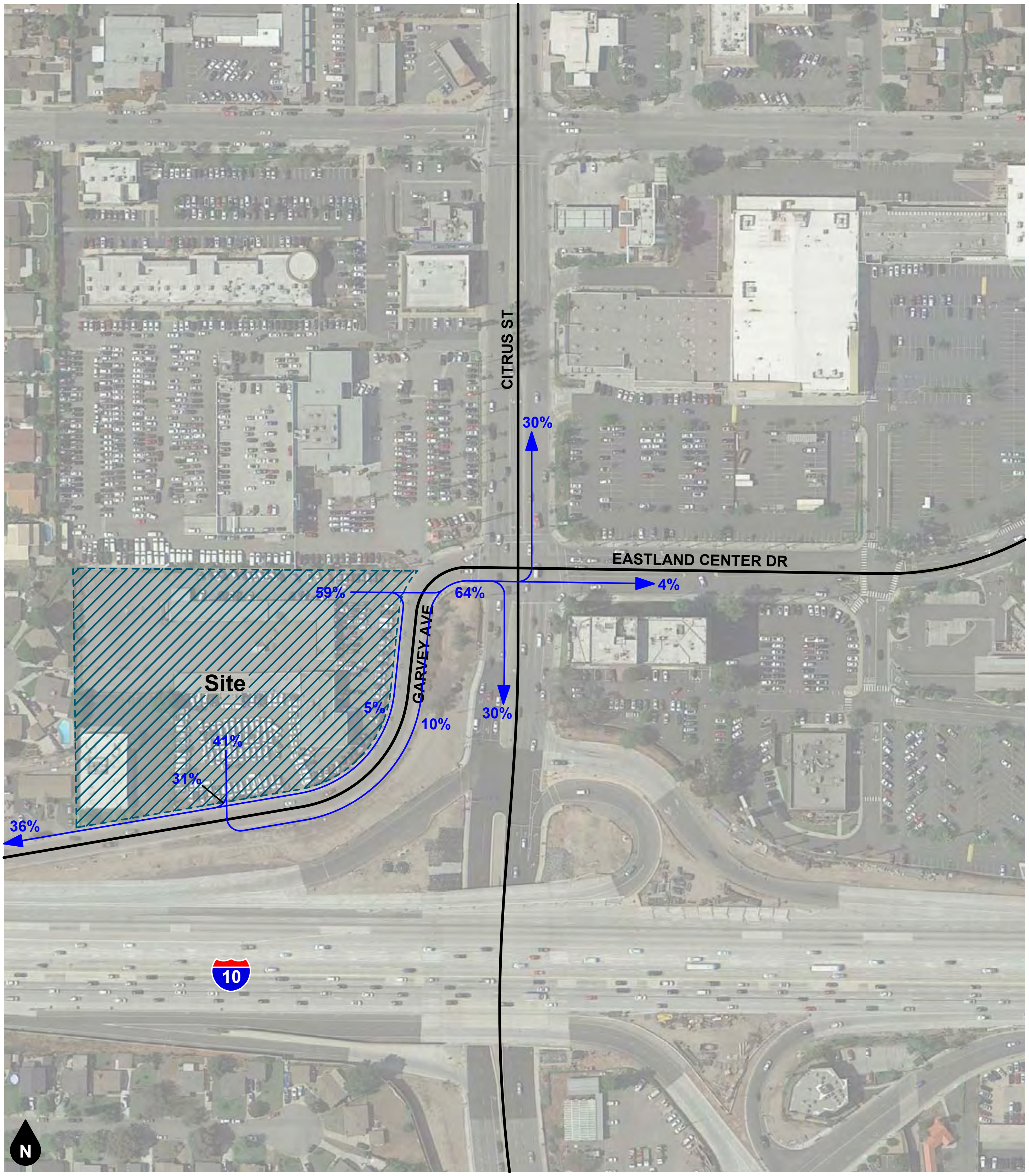
Trips Generated								
		AM Peak Hour			PM Peak Hour			
Land Use	Quantity	In	Out	Total	In	Out	Total	Daily
Commercial Retail	42.455 TSF	25	15	40	78	84	162	1,603
Internal Capture[3]		-2	-2	-4	-29	-22	-51	-55
Pass-By Reduction (34% PM)[3]		--	--	--	-17	-21	-38	-38
Net Subtotal		23	13	36	32	41	73	1,510
Fast-Food Restaurant w/ Drive-Thru	4.500 TSF	92	89	181	76	71	147	2,119
Internal Capture[3]		-2	-2	-4	-22	-29	-51	-55
Pass-By Reduction (49% AM, 50% PM)[3]		-44	-43	-87	-27	-21	-48	-1,011
Net Subtotal		46	44	90	27	21	48	1,053
Total		**69**	**57**	**126**	**59**	**62**	**121**	**2,563**

Notes:

(1) Source: Institute of Transportation Engineers, Trip Generation Manual, 10th Edition, 2017, ### = Land Use Code.

(2) TSF = Thousand Square Feet

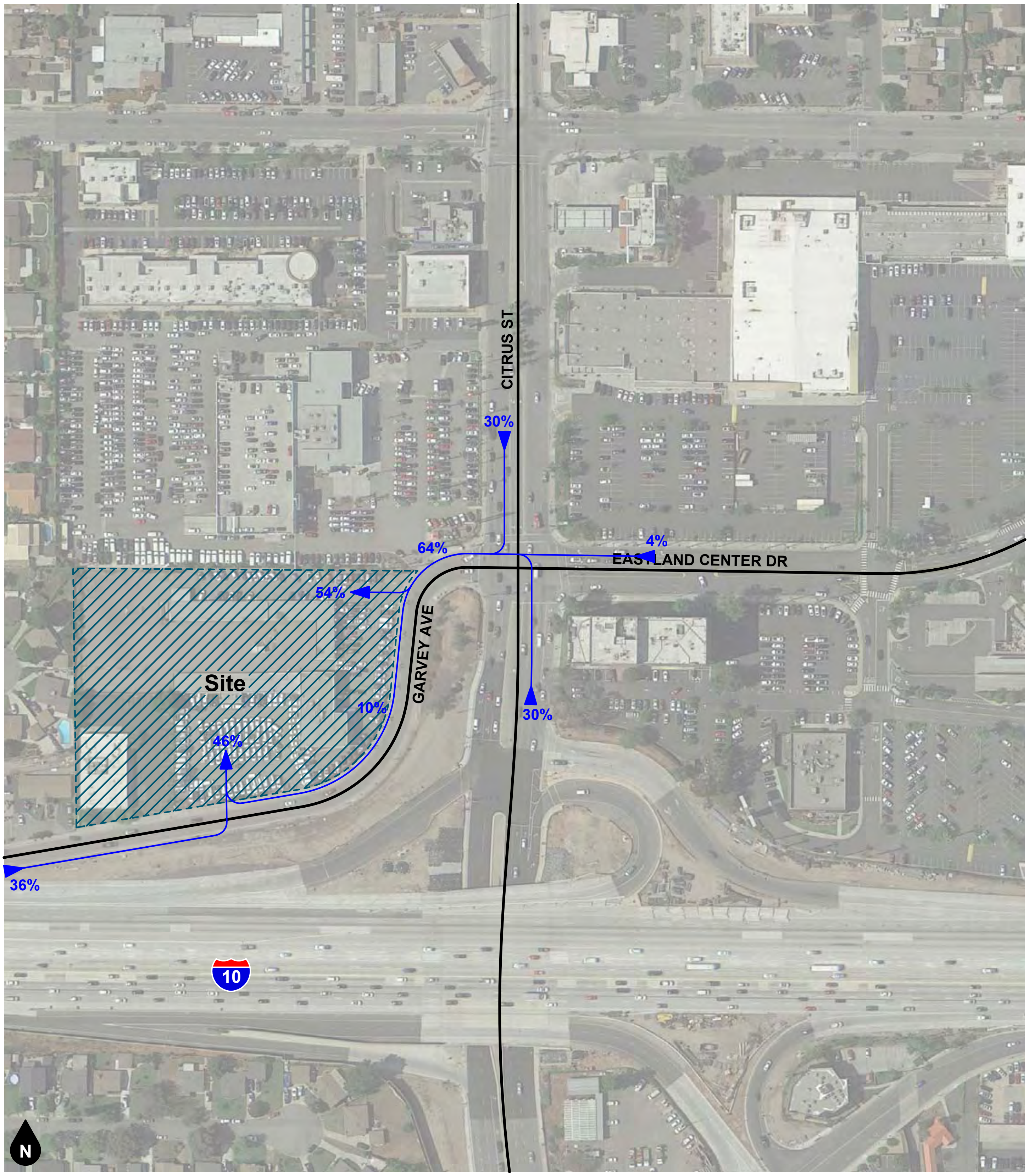
(3) Source: Institute of Transportation Engineers, Trip Generation Handbook, 3rd Edition, 2017. Internal capture calculated using the National Cooperative Highway Research Program 684 Internal Capture Estimation Tool provided by the Institute of Transportation Engineers.



Legend

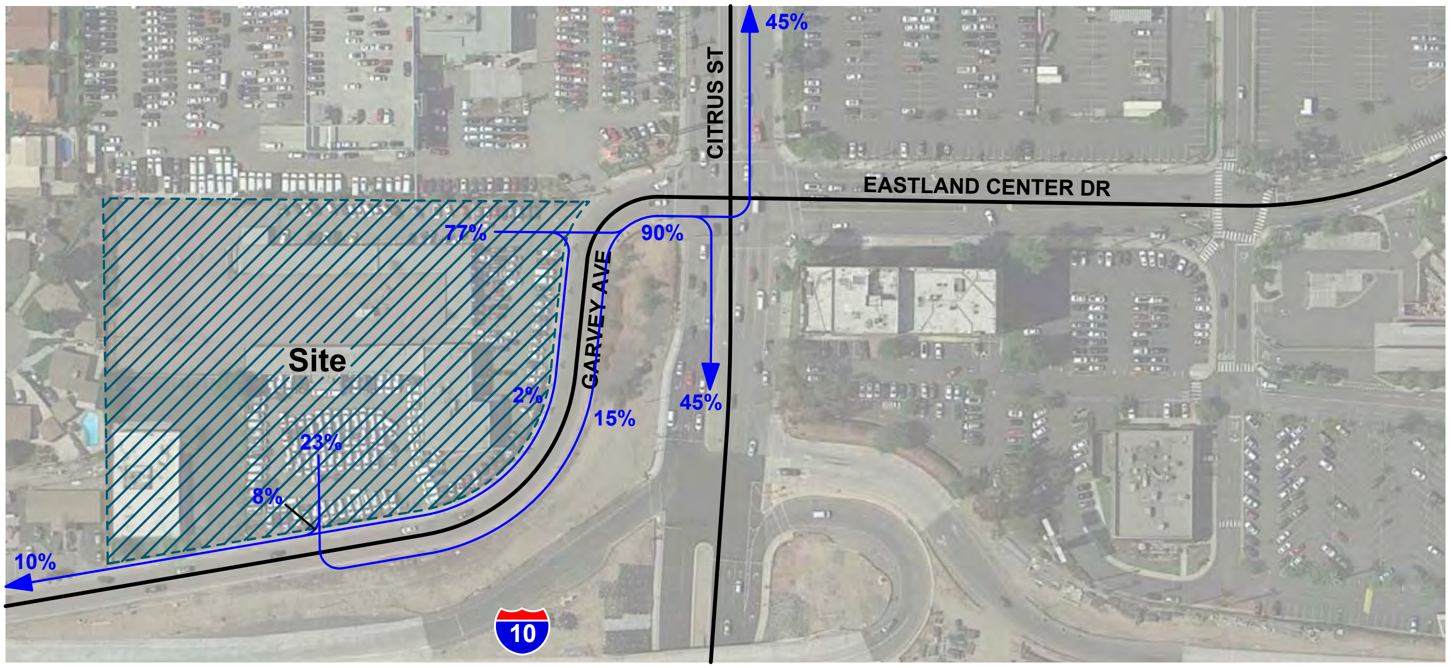
10% Percent From Project

Figure 12
Project Outbound Trip Distribution

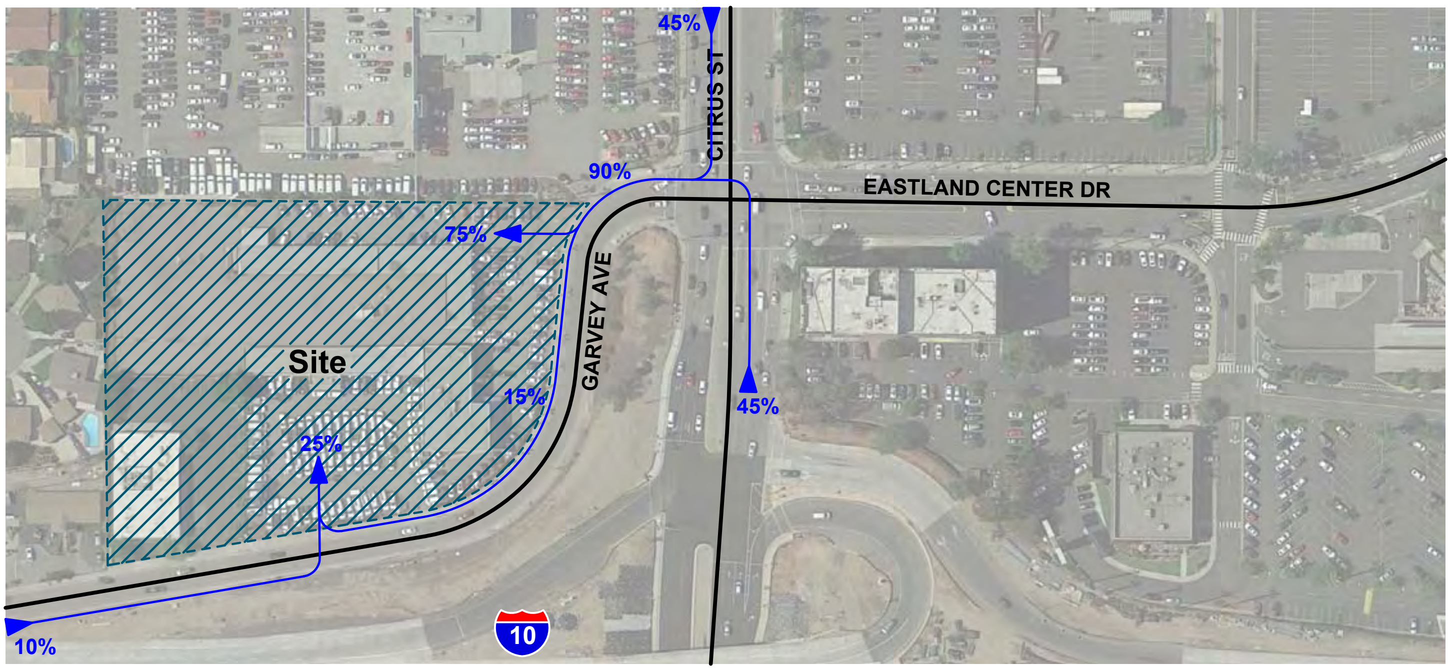


Legend
10% Percent To Project

Figure 13
Project Inbound Trip Distribution



Outbound



Inbound

N

Legend
10% Percent To/From Project

Figure 14
Project Pass-By Trip Distribution

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2539 East Garvey Avenue Project
Traffic Impact Analysis
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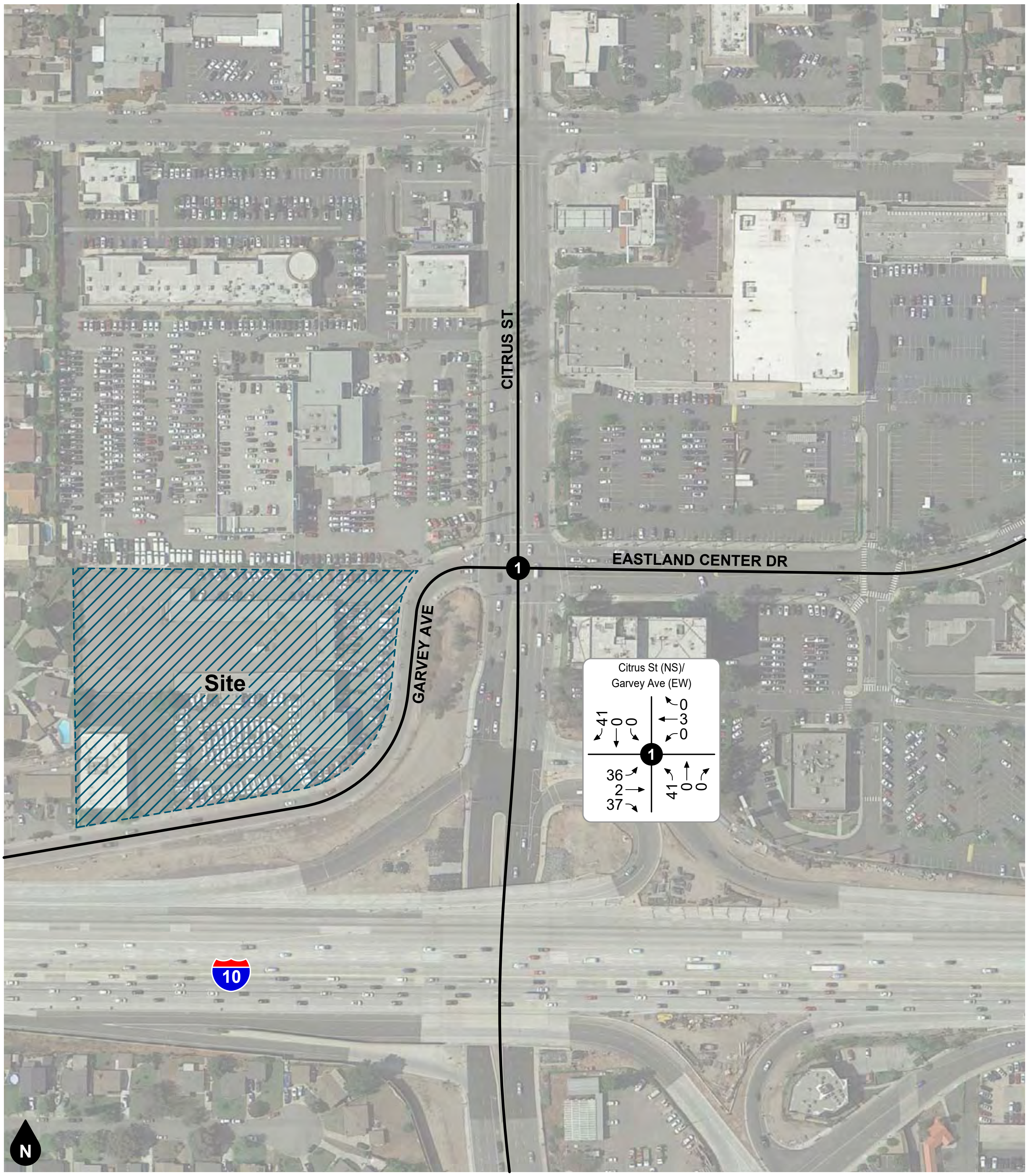
Legend

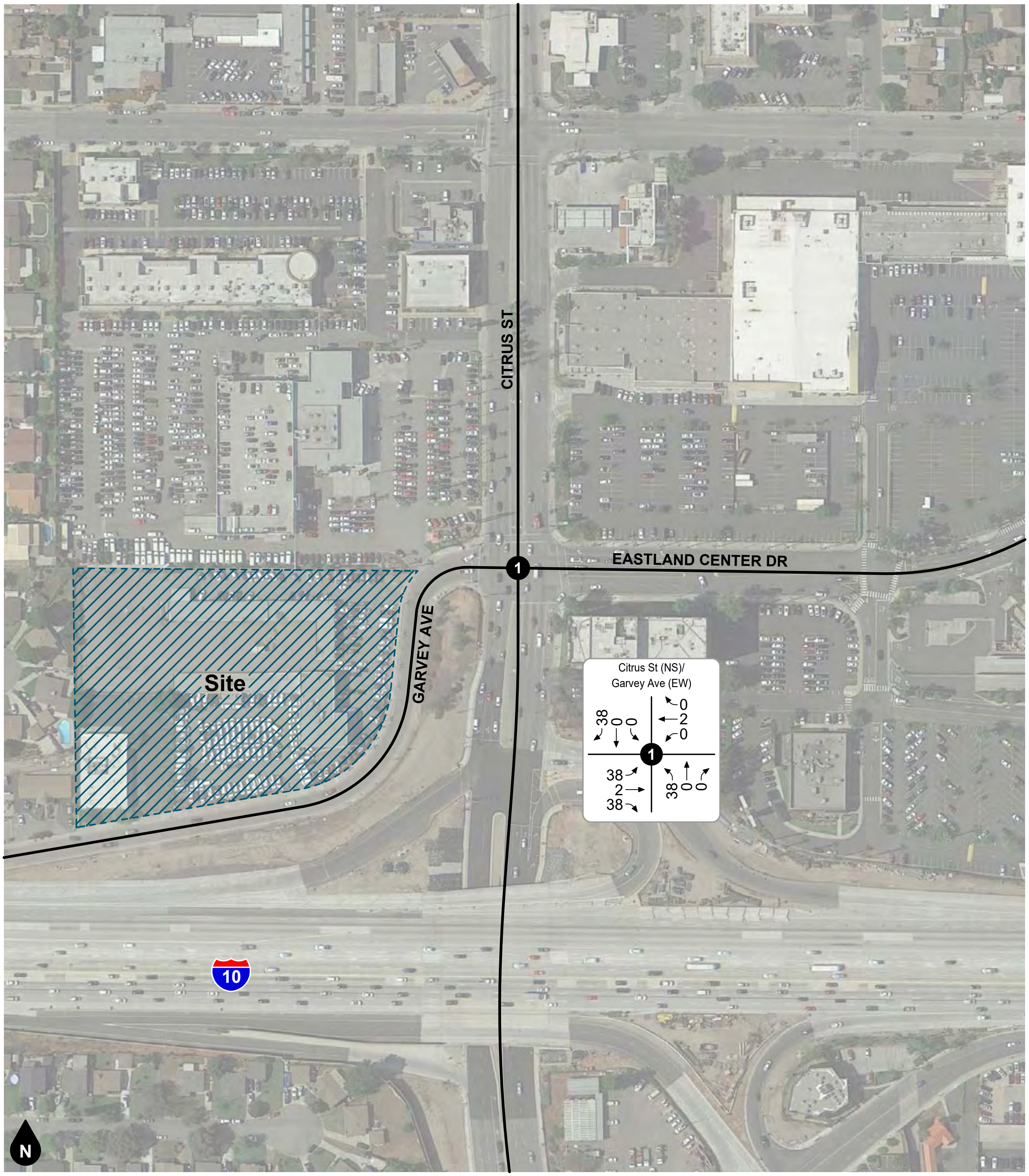
●## Vehicles Per Day (1,000's)

Figure 15
Project Average Daily Traffic Volumes



Legend
Study Intersection

Figure 16
Project AM Peak Hour Intersection Turning Movement Volumes



Legend
Study Intersection

Figure 17
Project PM Peak Hour Intersection Turning Movement Volumes

5. FUTURE VOLUME FORECASTS

This section describes how future volume forecasts for each analysis scenario were developed. Forecast study area volumes are illustrated on figures contained in this section.

CUMULATIVE TRIPS

Ambient Growth Rate

To account for ambient growth on roadways, existing roadway volumes were increased by a growth rate of one percent (1%) per year over one year for Opening Year (2021) conditions. This equates to a total growth factor of approximately 1.01. The ambient growth rate was conservatively applied to all movements at the study intersections.

Other Development

To account for trips generated by future development, trips generated by pending and approved other development projects in the Cities of West Covina and Covina were added to the study area. Table 3 shows the trip generation summary for other development projects. Figure 18 shows the other development location map.

Figure 19 shows the forecast average daily traffic volumes for the other development. Figure 20 and Figure 21 show the forecast AM and PM peak hour intersection turning movement volumes for trips generated by other developments.

ANALYSIS SCENARIO VOLUME FORECASTS

Existing Plus Project

Existing Plus Project volume forecasts were developed by adding the project-generated trips to Existing volumes. Existing Plus Project average daily traffic volumes are shown on Figure 22. Existing Plus Project AM and PM peak hour intersection turning movement volumes are shown on Figure 23 and Figure 24.

Opening Year (2021) Without Project

To develop Opening Year (2021) Without Project volume forecasts, Existing volumes were combined with ambient growth and trips generated by other developments. Opening Year (2021) Without Project average daily traffic volumes are shown on Figure 25. Opening Year (2021) Without Project AM and PM peak hour intersection turning movement volumes are shown Figure 26 and Figure 27.

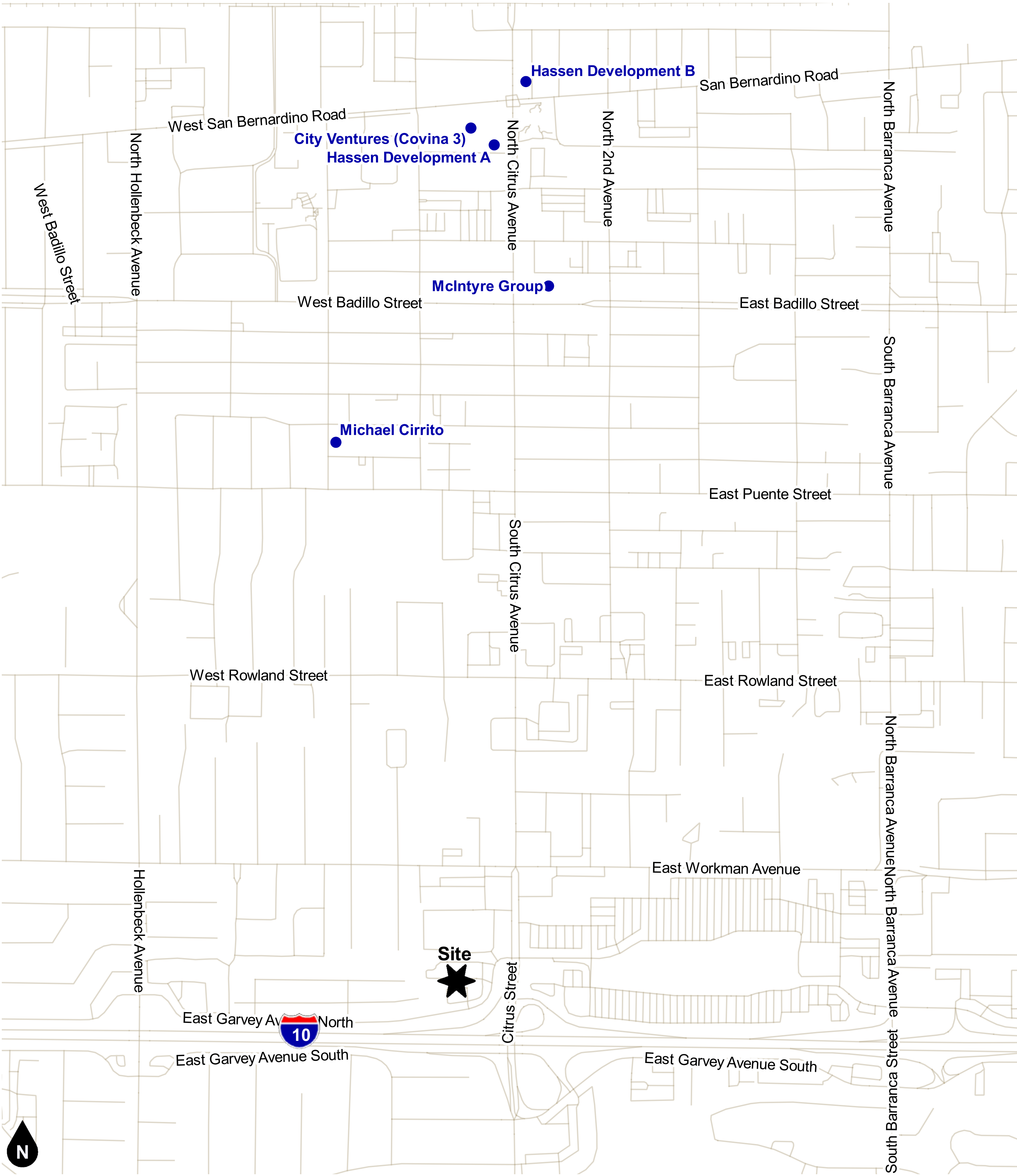
Opening Year (2021) With Project

Opening Year (2021) With Project volume forecasts were developed by adding project-generated trips to the Opening Year (2021) Without Project forecast. Opening Year (2021) With Project average daily traffic volumes are shown on Figure 28. Opening Year (2021) With Project AM and PM peak hour intersection turning movement volumes are shown on Figure 29 and Figure 30.

Table 3
Other Development Trip Generation

Project	Land Use	Source[1]	Quantity	Units[2]	AM Peak Hour			PM Peak Hour			Daily
					In	Out	Total	In	Out	Total	
City Ventures (Covina 3)	Condominiums	ITE 220	68	DU	7	24	31	24	14	38	498
	Retail	ITE 820	5.794	TSF	3	2	5	11	11	22	219
	Subtotal				10	26	36	35	25	60	717
Hassen Development A	Office	ITE 710	1.030	TSF	1	0	1	0	1	1	10
	Retail	ITE 820	3.370	TSF	2	1	3	6	7	13	127
	Townhomes	ITE 220	18	DU	2	6	8	6	4	10	132
	Subtotal				5	7	12	12	12	24	269
Hassen Development B	Multi-Family Housing	ITE 220	161	DU	17	57	74	64	37	101	1,179
	Retail	ITE 820	15.000	TSF	9	5	14	27	30	57	566
	Subtotal				26	62	88	91	67	158	1,745
Michael Cirrito	Condominiums	ITE 220	3	DU	0	1	1	1	1	2	22
McIntyre Group	Multi-Family Housing	ITE 220	10	DU	1	4	5	4	3	7	73
	Retail	ITE 820	3.821	TSF	2	2	4	7	8	15	144
	Subtotal				3	6	9	11	11	22	217
Total					44	102	146	150	116	266	2,970

Notes:
(1) ITE = Institute of Transportation Engineers, Trip Generation Manual (10th Edition, 2017); ### = Land Use Code
(2) DU = Dwelling Units; TSF = Thousand Square Feet

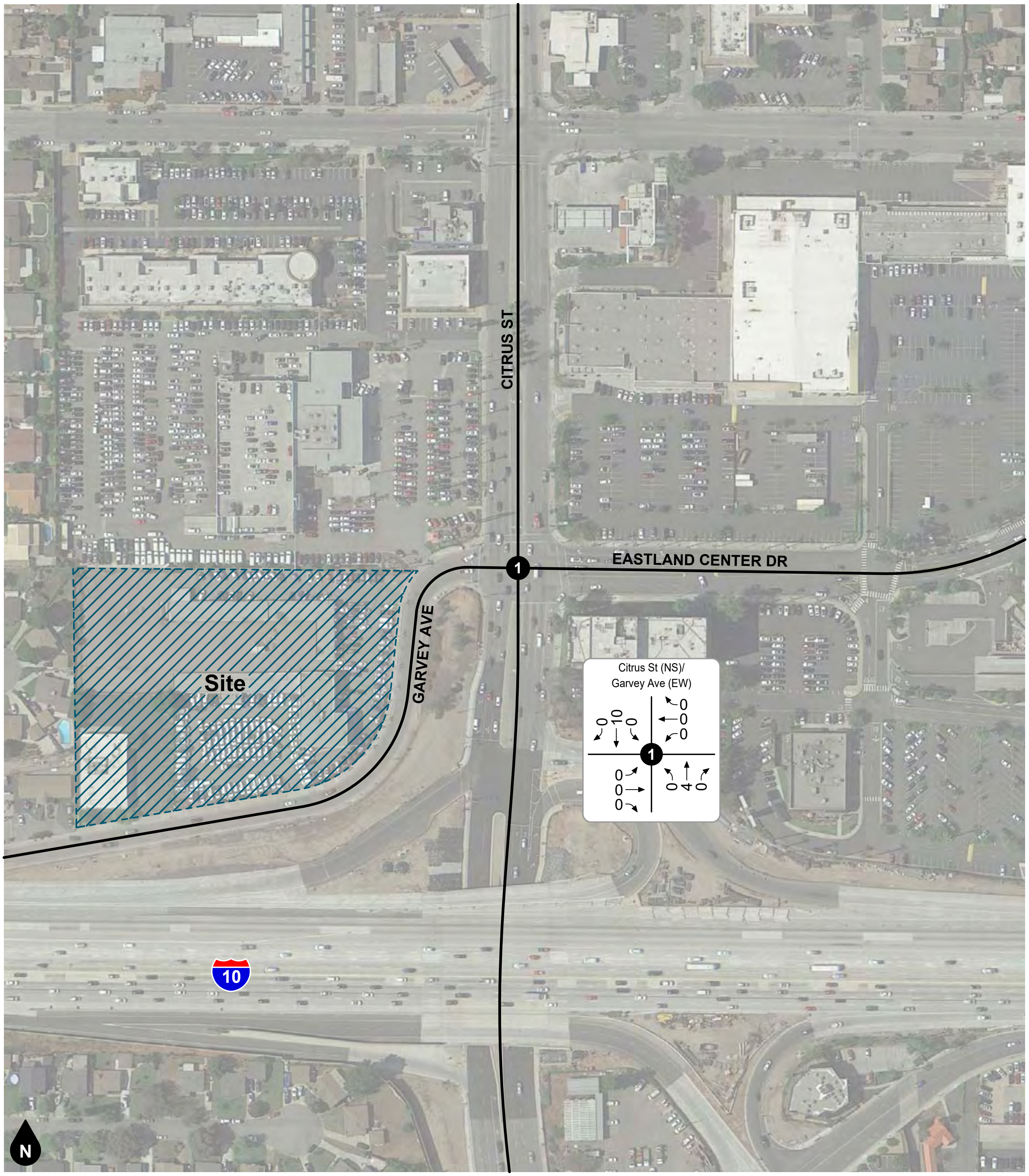


Legend
Other Development ID in:
City of Covina (C)

Figure 18
Other Development Location Map

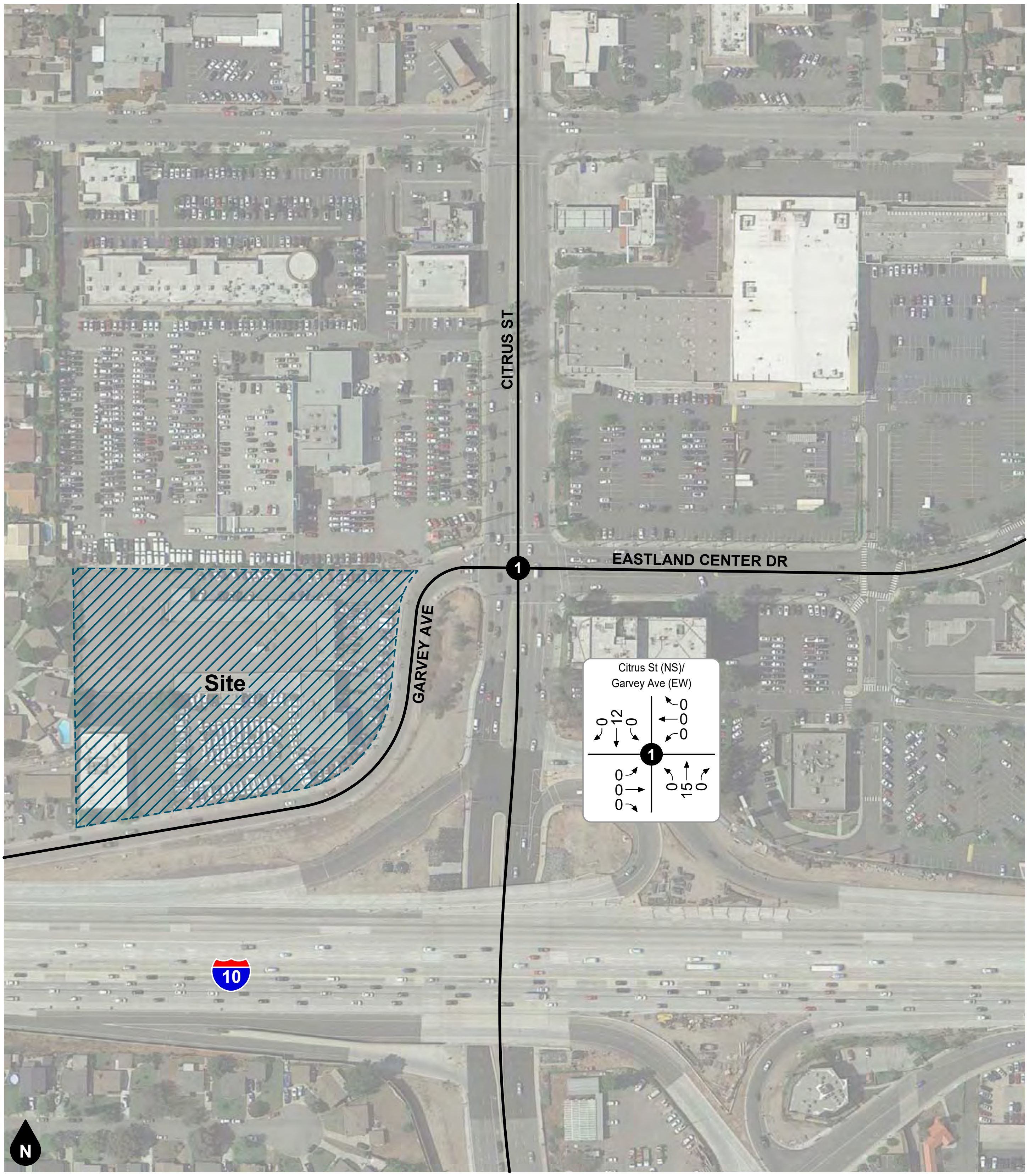
Legend
●## Vehicles Per Day (1,000's)

Figure 19
Other Development Average Daily Traffic Volumes



Legend
Study Intersection

Figure 20
Other Development
AM Peak Hour Intersection Turning Movement Volumes



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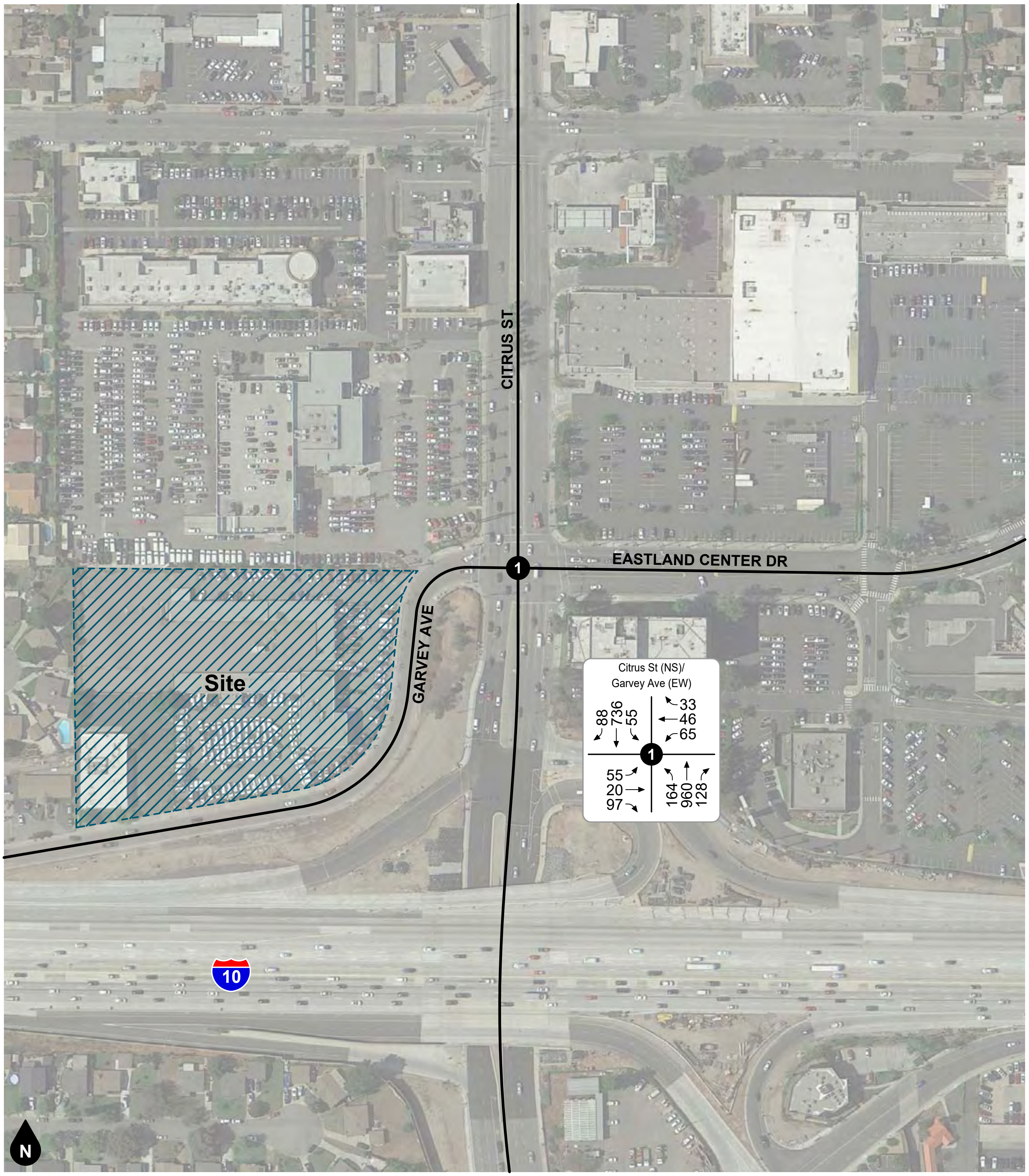
Study Intersection

Figure 21
Other Development
PM Peak Hour Intersection Turning Movement Volumes

Legend

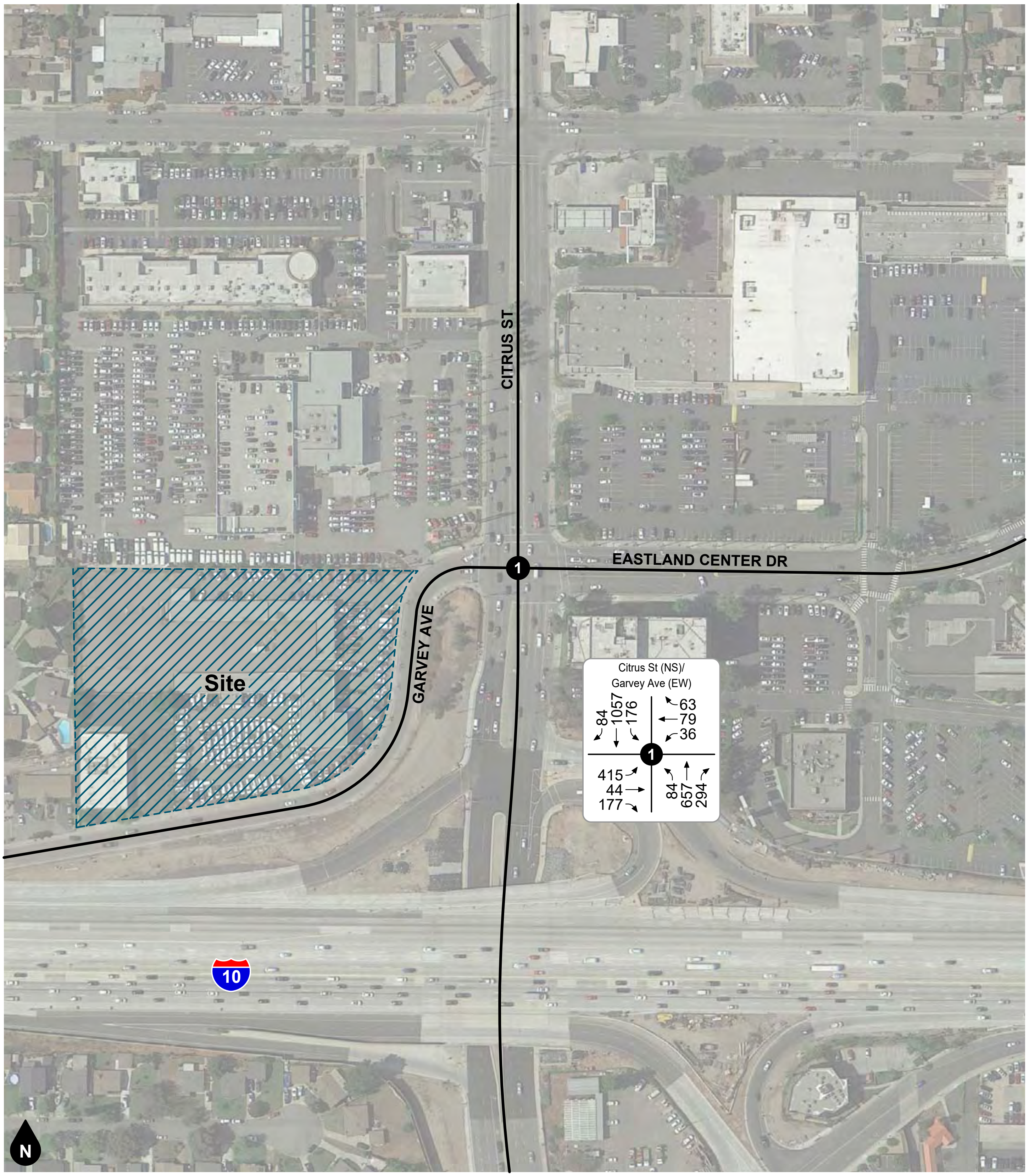
●## Vehicles Per Day (1,000's)

Figure 22
Existing Plus Project Average Daily Traffic Volumes



Legend
Study Intersection

Figure 23
Existing Plus Project
AM Peak Hour Intersection Turning Movement Volumes

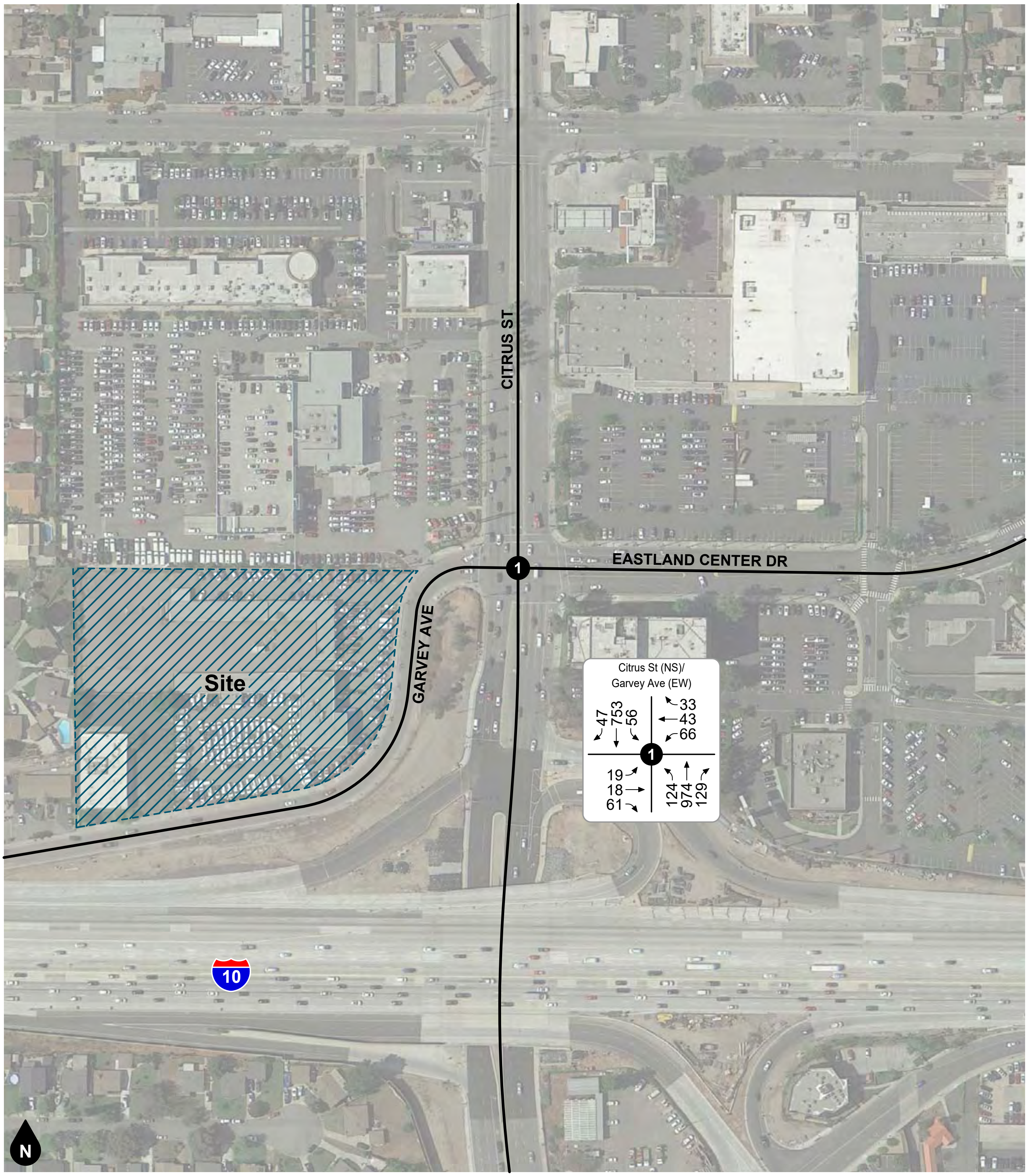


Legend
Study Intersection

Figure 24
Existing Plus Project
PM Peak Hour Intersection Turning Movement Volumes

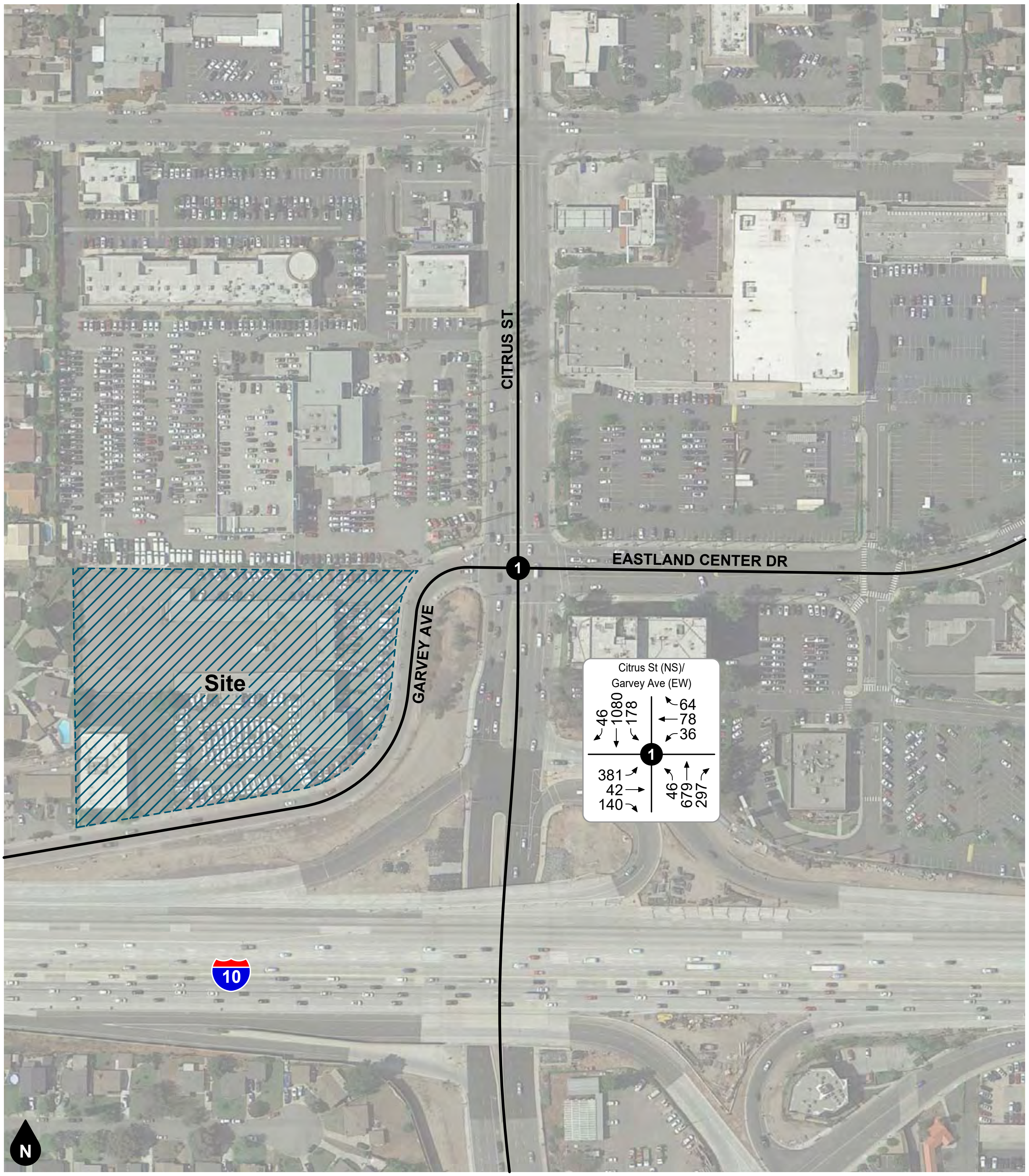
Legend
●## Vehicles Per Day (1,000's)

Figure 25
Opening Year (2021) Without Project Average Daily Traffic Volumes



Legend
Study Intersection

Figure 26
Opening Year (2021) Without Project
AM Peak Hour Intersection Turning Movement Volumes



Legend

Study Intersection

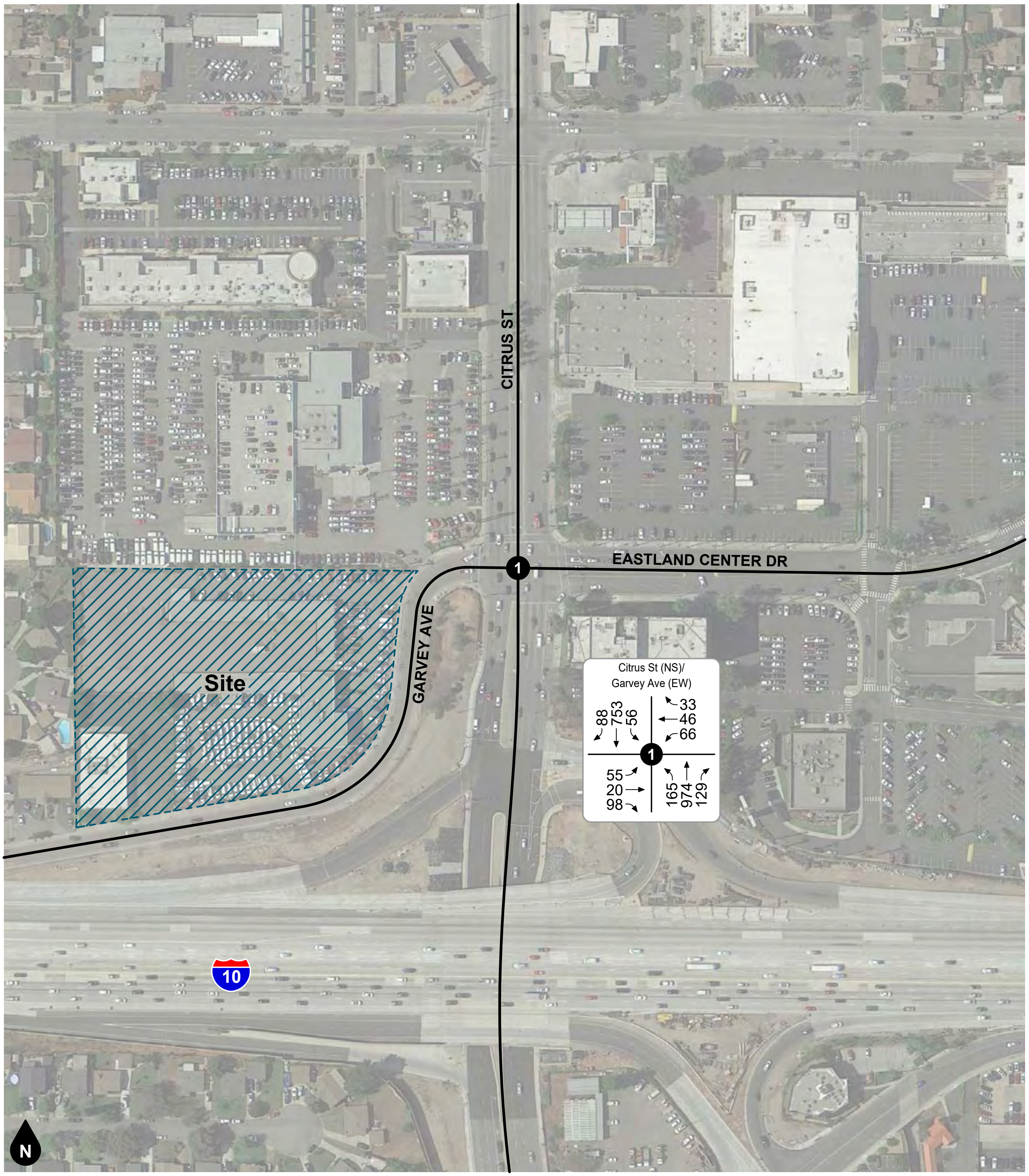
Figure 27

Opening Year (2021) Without Project

PM Peak Hour Intersection Turning Movement Volumes

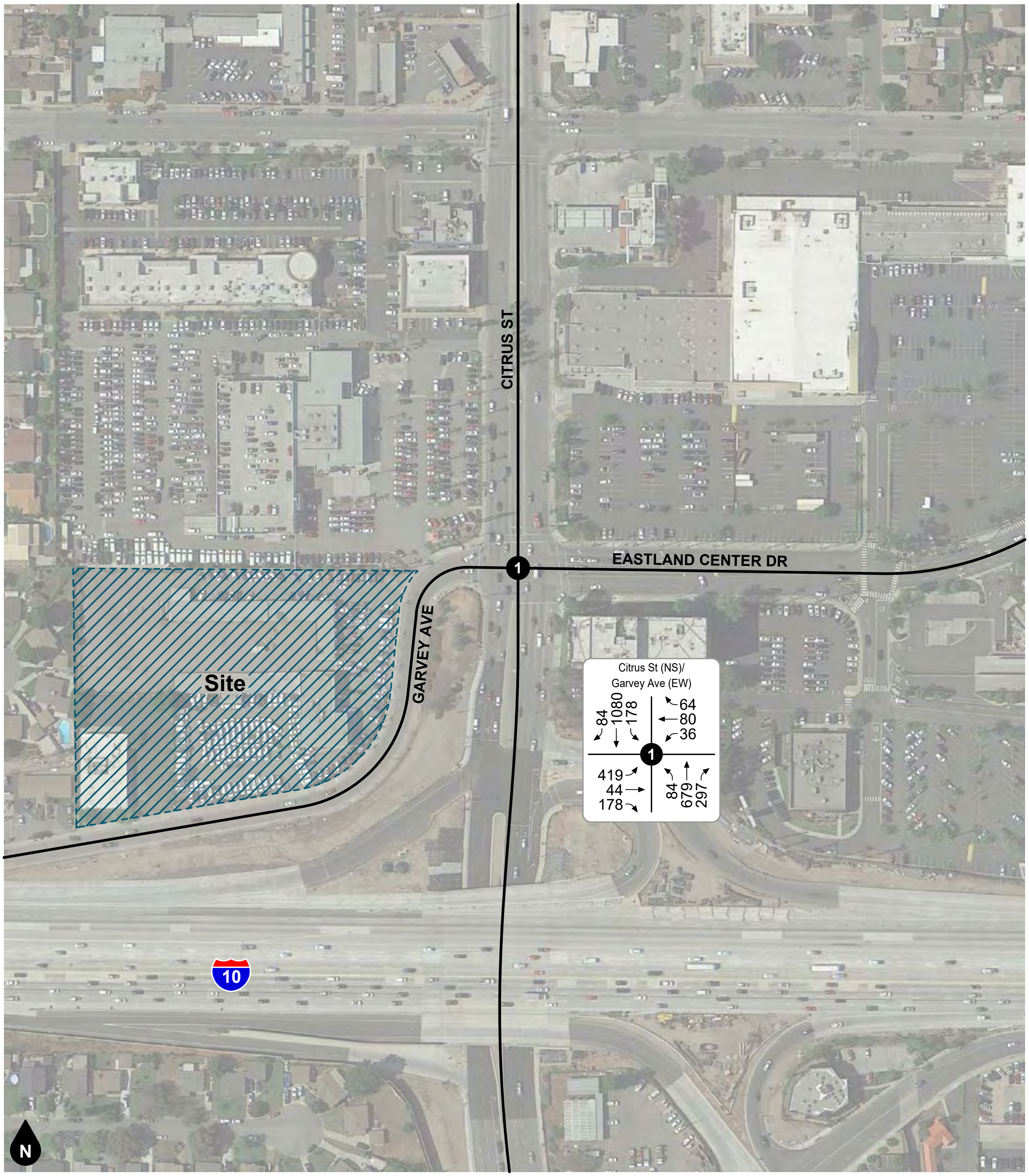
Legend
●## Vehicles Per Day (1,000's)

Figure 28
Opening Year (2021) With Project Average Daily Traffic Volumes



Legend
Study Intersection

Figure 29
Opening Year (2021) With Project
AM Peak Hour Intersection Turning Movement Volumes



Legend
Study Intersection

Figure 30
Opening Year (2021) With Project
PM Peak Hour Intersection Turning Movement Volumes

6. FUTURE LEVEL OF SERVICE ANALYSIS

Detailed intersection Level of Service calculation worksheets for each of the following analysis scenarios are provided in Appendix D.

EXISTING PLUS PROJECT

The study intersection Levels of Service for Existing Plus Project conditions are shown in Table 4. As shown in Table 4, the study intersection is forecast to operate at Levels of Service D or better during the peak hours for Existing Plus Project conditions.

Table 5 evaluates the project impact at the study intersections for Existing Plus Project conditions. As shown in Table 5, the proposed project is not forecast to result in Level of Service operational impacts at the study intersection during the weekday AM and PM peak hours for Existing Plus Project conditions.

No off-site operational improvements were identified since the proposed project is forecast to result in no operational traffic impact at the study intersection for Existing Plus Project conditions.

OPENING YEAR (2021) WITHOUT PROJECT

The study intersection Levels of Service for Opening Year (2021) Without Project conditions are shown in Table 6. As shown in Table 6, the study intersections are forecast to operate at Levels of Service C or better during the peak hours for Opening Year (2021) Without Project conditions.

OPENING YEAR (2021) WITH PROJECT

The study intersection Levels of Service for Opening Year (2021) With Project conditions are shown in Table 7. As shown in Table 7, the study intersections are forecast to operate at Levels of Service D or better during the peak hours for Opening Year (202a) With Project conditions.

Table 8 evaluates the project impact at the study intersections for Opening Year (2022) With Project conditions. As shown in Table 8, the proposed project is not forecast to result in Level of Service operational impacts at the study intersection during the weekday AM and PM peak hours for Opening Year (2021) With Project conditions.

No off-site operational improvements were identified since the proposed project is forecast to result in no operational traffic impact at the study intersection for Opening Year (2021) With Project conditions.

Table 4
Existing Plus Project Intersection Level of Service

ID	Study Intersection	Traffic Control[1]	AM Peak Hour		PM Peak Hour	
			ICU[2]	LOS[3]	ICU[2]	LOS[3]
1.	Citrus St at Garvey Ave	TS	0.516	A	0.837	D

Notes:
(1) TS = Traffic Signal
(2) ICU = Intersection Capacity Utilization
(3) LOS = Level of Service

Table 5
Existing Plus Project Operational Impact Assessment

	AM Peak Hour						PM Peak Hour					
	Existing		Existing Plus Project		Project-Related Change	Operational Impact?[3]	Existing		Existing Plus Project		Project-Related Change	Operational Impact?[3]
ID Study Intersection	ICU[1]	LOS[2]	ICU[1]	LOS[2]			ICU[1]	LOS[2]	ICU[1]	LOS[2]		
1. Citrus St at Garvey Ave	0.434	A	0.516	A	+0.082	No	0.755	C	0.837	D	+0.082	No

Notes:

(1) ICU = Intersection Capacity Utilization

(2) LOS = Level of Service

(3) In the Citiy of West Covina, an operational impact occurs if the project-related increase in ICU equals or exceeds 0.02 when an intersection is operating at Level of Service D, E, or F in the baseline.

Table 6
Opening Year (2021) Without Project Intersection Level of Service

ID Study Intersection	Traffic Control[1]	AM Peak Hour		PM Peak Hour	
		ICU[2]	LOS[3]	ICU[2]	LOS[3]
1. Citrus St at Garvey Ave	TS	0.439	A	0.764	C

Notes:
(1) TS = Traffic Signal
(2) ICU = Intersection Capacity Utilization
(3) LOS = Level of Service

Table 7
Opening Year (2021) With Project Intersection Level of Service

ID Study Intersection	Traffic Control[1]	AM Peak Hour		PM Peak Hour	
		ICU[2]	LOS[3]	ICU[2]	LOS[3]
1. Citrus St at Garvey Ave	TS	0.521	A	0.846	D

Notes:

(1) TS = Traffic Signal

(2) ICU = Intersection Capacity Utilization

(3) LOS = Level of Service

Table 8
Opening Year (2021) With Project Operational Impact Assessment

ID	Study Intersection	AM Peak Hour						PM Peak Hour					
		Without Project		With Project		Project-Related Change	Operational Impact?[3]	Without Project		With Project		Project-Related Change	Operational Impact?[3]
		ICU[1]	LOS[2]	ICU[1]	LOS[2]			ICU[1]	LOS[2]	ICU[1]	LOS[2]		
1.	Citrus St at Garvey Ave	0.439	A	0.521	A	+0.082	No	0.764	C	0.846	D	+0.082	No

Notes:

(1) ICU = Intersection Capacity Utilization

(2) LOS = Level of Service

(3) In the Citiy of West Covina, an operational impact occurs if the project-related increase in ICU equals or exceeds 0.02 when an intersection is operating at Level of Service D, E, or F in the baseline.

7. SITE ACCESS AND CIRCULATION

This section includes a description of project improvements necessary to provide site access and an evaluation of site access and circulation.

PROJECT DESIGN FEATURES

The proposed project shall construct the following improvements as project design features to provide project site access:

- Construct the Project Driveway (NS) at East Garvey Avenue (EW) (located on the southwest portion of the project site) to provide one inbound lane and one outbound lane with southbound stop-control and the following lane configurations:
    - Northbound: not applicable
    - Southbound: one shared left/right turn lane
    - Eastbound: one shared left/through lane
    - Westbound: one shared through/right turn lane.

- Construct the East Garvey Avenue (NS) at Project Driveway (EW) (located on the northeast portion of the project site) to provide one inbound lane and one outbound lane with eastbound stop-control and the following lane configurations:
    - Northbound: one through lane
    - Southbound: one shared through/right turn lane
    - Eastbound: one shared left/right turn lane
    - Westbound: not applicable

This analysis also assumes the project shall comply with the following conditions as part of the City of West Covina standard development review process:

- A construction work site traffic control plan shall comply with State standards set forth in the California Manual of Uniform Traffic Control Devices and shall be submitted to the City for review and approval prior to the issuance of a grading permit or start of construction. The plan shall identify any roadway, sidewalk, bike route, or bus stop closures and detours as well as haul routes and hours of operation. All construction related trips shall be restricted to off-peak hours to the extent possible.

- All on-site and off-site roadway design, traffic signing and striping, and traffic control improvements relating to the proposed project shall be constructed in accordance with applicable State/Federal engineering standards and to the satisfaction of the City of West Covina.

- Site-adjacent roadways shall be constructed or repaired at their ultimate half-section width, including landscaping and parkway improvements in conjunction with development, or as otherwise required by the City of West Covina.

- Adequate off-street parking shall be provided to the satisfaction of City of West Covina.

- Adequate emergency vehicle access shall be provided to the satisfaction of the West Covina Fire Department.

- The final grading, landscaping, and street improvement plans shall demonstrate that sight distance requirements are met in accordance with applicable City of West Covina/California Department of Transportation sight distance standards.

QUEUEING ANALYSIS

A queuing analysis has been performed for Opening Year (2021) With Project conditions for the eastbound left turn movement at the intersection of Citrus Street at Garvey Avenue, which is a key movement for outbound project access. The queuing analysis is based on a Poisson probability distribution for random vehicle arrivals and a uniform Los Angeles County 100 second cycle length. Queue calculation worksheets provided in Appendix E.

Table 9 shows the queuing analysis summary based on the 95th-percentile queue length. The 95th-percentile queue length effectively represents the maximum queue length expected (to a 95 percent confidence level) and is an industry accepted standard for determining turning lane storage and intersection spacing requirements.

Based on the queuing analysis shown in Table 9, the existing storage length for the eastbound left turn movements at the intersection of Citrus Street at Garvey Avenue is forecast to not provide adequate queueing capacity with the addition of project trips. This queuing analysis also incorporates the striping and installment of a dedicated eastbound left turn lane at this intersection.

The recommended improvement to alleviate this operational queuing impact is to stripe “Do Not Block Intersection”, “Keep Clear”, or equivalent striping/signage at the intersection of Garvey Avenue and Project Driveway (located near the northeast portion of the project site), so that the eastbound queue from Garvey Avenue at Citrus Street does not block this intersection, thus allowing for motorists making an eastbound left turn from the project driveway to head east on Garvey Avenue to clear the project driveway.

It should be noted that outbound motorists at this driveway would queue internally and not affect operations on Garvey Avenue. Since the driveway is restricting inbound northbound left turns, there would also not be any conflicts with inbound turning vehicles from Garvey Avenue. Thus, the aforementioned striping combined with internal site queuing and striping of a dedicated eastbound left turn lane should be sufficient to alleviate existing and future eastbound queuing issues at the intersection of Citrus Street at Garvey Avenue.

TRUCK ACCESS POINTS AND TURNING TEMPLATES

Figure 31 shows the truck access points and turning templates. Truck turning templates are provided for both inbound and outbound truck turning movements on Garvey Avenue. As shown on Figure 31, inbound trucks servicing the retail (major pad) will enter the project driveway at the southwest portion of the project site heading westbound on Garvey Avenue. Trucks will then drive northbound through the drive aisle to the northwest portion of the project site. They will then use the east-west drive aisle to back into the loading area. They will then drive eastbound to the project driveway at the northeast portion of the project site and exit the project site to Garvey Avenue, where they will proceed northbound/eastbound to the signalized intersection at Citrus Street. The truck turning templates used a WB-67 truck.

In order for these truck turning templates to function without encroaching across the centerline on Garvey Avenue, the centerline of Garvey Avenue will need to be restriped south approximately 4 feet. It will be the responsibility of the project applicant to provide striping and signing plans for Garvey Avenue to the City of West Covina for review that shows this restriping of the centerline, including centerline striping transitions east-west on Garvey Avenue

TRUCK DELIVERY SCHEDULE

Truck deliveries shall occur only during off-peak hours so that any potential conflict between trucks and customers of the project site land uses will be minimal.

TRASH TRUCK CIRCULATION

Figure 32 shows trash truck circulation for each trash enclosure located on the project site.

PEDESTRIAN ACCESS PLAN

Figure 33 shows pedestrian paths of travel to/from the parking lot to entrances/exits.

RESTAURANT DRIVE-THRU QUEUING ANALYSIS

Drive through queues were measured based on data provided within the Drive-Through Queue Generation (CountingCars.com, February 2012). Queuing data was provided from 14 studies at six fast-food restaurant locations. The 85th percentile maximum number of vehicles queued in the drive through lanes was measured at 12 vehicles. This would require 240 feet of vehicle stacking. This analysis is provided in Appendix F.

The distance from the approximation of the pay window to the entrance of the drive through lane (western boundary of the trash enclosure) is approximately 130 feet. This would provide for stacking of 6 vehicles. The site plan provides an additional 85 feet westbound from the extension of the drive through lane to the western extension of the drive aisle that services the restaurant from the project driveway from Garvey Avenue. This provides queuing for an additional 4 vehicles, which would provide a total queueing capacity for 10 vehicles. Although it is not anticipated to be necessary, the drive through queue could be directed along the north-south drive aisle adjacent to the west façade of the restaurant to provide an additional approximately 60 feet, or approximately 3 vehicles, of queueing capacity. Figure 34 exhibits the location of the trash enclosure and potential vehicle queuing.

The summation of the queuing ability for the drive-thru lane (6 vehicles), east-west drive aisle (4 vehicles), and north-south drive aisle (3 vehicles) equates to a total queuing capacity of 13 vehicles. This queuing capacity of 13 vehicles exceeds the 85^{th} percentile maximum queue of 12 vehicles. Therefore, adequate queuing capacity is forecast to be provided to accommodate the expected 85th percentile queue volume of 12 vehicles.

It should be noted that the fast-food restaurants observed in the aforementioned analysis are fast-food restaurants whose primary business operations revolve around drive-thru sales. The proposed fast-food restaurant for this project, at 4,300 square feet, is anticipate to function primarily as a high-turnover sit-down restaurant, with the drive-thru functioning as a secondary use (similar to how Panera Bread functions).

While this location appears to have adequate queuing available for a fast-food restaurant, the anticipated queuing necessary at this location is anticipated to be less than what has been analyzed.

SIGHT DISTANCE ANALYSIS

The de facto speed limit on East Garvey Avenue North adjacent to the project is 40 miles per hour per City of West Covina staff. The stopping sight distance minimum is 300 feet per Table 201.1 in the Highway Design Manual (see Appendix G). Figure 35 illustrates the stopping sight distance for Garvey Avenue. Stopping sight distance requires 300 feet of unobstructed line of sight for a 40 mile per hour design speed. The driver's eye for a vehicle located at a project driveway intending to head either eastbound or westbound on Garvey Avenue is situated 42 inches above the pavement and 15 feet back from the edge of the travel way. The driver must have a minimum unobstructed sight line of 300 feet looking westbound at an object 42 inches above the pavement situated in the center of the eastbound travel lane, and must have a minimum unobstructed sight line of 300 feet looking eastbound at an object 42 inches above the pavement situated in the center of the westbound travel lane.

While the de facto speed limit of 40 mph for Garvey Avenue between Citrus Street and Hollenbeck was verified via an Engineering and Traffic Study conducted by the City of West Covina on October 5, 2017, this speed survey was most likely conducted mid-block on the roadway segment along the stretch of roadway that is a straightaway. Therefore, the stopping sight distance for 40 miles per hour is realistic for vehicles situated at the project driveway at the southeast portion of the project site looking westbound. However, it is not realistic for vehicles at this driveway looking eastbound, or at the project driveway at the northeast portion of the project site looking either westbound or eastbound. This is because both driveways are located near almost 90 degree horizontal curves on Garvey Avenue, and 40 mile per hour 85th percentile speeds on these curves is unlikely to occur due to the curvature of the roadway. For example, for westbound vehicles turning off Citrus Street onto Garvey Avenue, there is a posted curve advisory speed of 20 miles per hour.

Thus, a stopping sight distance of 25 miles per hour has been used at these locations to reflect more realistic travel speeds along this stretch of roadway. The stopping sight distance minimum is 150 feet per Table 201.1 in the Highway Design Manual for 25 miles per hour. Figure 35 illustrates the stopping sight distance for Garvey Avenue. Stopping sight distance requires 150 feet of unobstructed line of sight for a 25 mile per hour design speed. The driver's eye for a vehicle located at a project driveway intending to head either eastbound or westbound on Garvey Avenue is situated 42 inches above the pavement and 15 feet back from the edge of the travel way. The driver must have a minimum unobstructed sight line of 150 feet looking westbound at an object 42 inches above the pavement situated in the center of the eastbound travel lane, and must have a minimum unobstructed sight line of 150 feet looking eastbound at an object 42 inches above the pavement situated in the center of the westbound travel lane.

As shown on Figure 35, adequate stopping sight distance appears to be provided, however, sight distance should be confirmed in the final grading, landscaping, and street improvement plans.

Garvey Avenue and the surrounding terrain at and adjacent to the project site is relatively flat with minimal changes in gradient. Therefore, vertical sight distance concerns do not appear to be prevalent.

ON-SITE PARKING

The City of West Covina Municipal Code Section 26-582 lists non-residential off-street parking requirements. General retail requires 1 parking spaces per 250 square feet of gross floor area. Thus, the proposed project requires 188 (46,955 square feet / 250 square feet per parking space) marked parking spaces.

The proposed project is proposing 199 parking spaces.

Table 9
Queuing Analysis Summary

ID	Study Intersection	Lane[1]	Existing Storage Length (Feet/Lane)	95th-Percentile Queue Length (Feet/Lane)	
				Opening Year With Project	
				AM Peak Hour	PM Peak Hour
1.	Citrus St at Garvey Ave	EBL	65	100	400

Notes:
(1) EB = Eastbound; L = Left

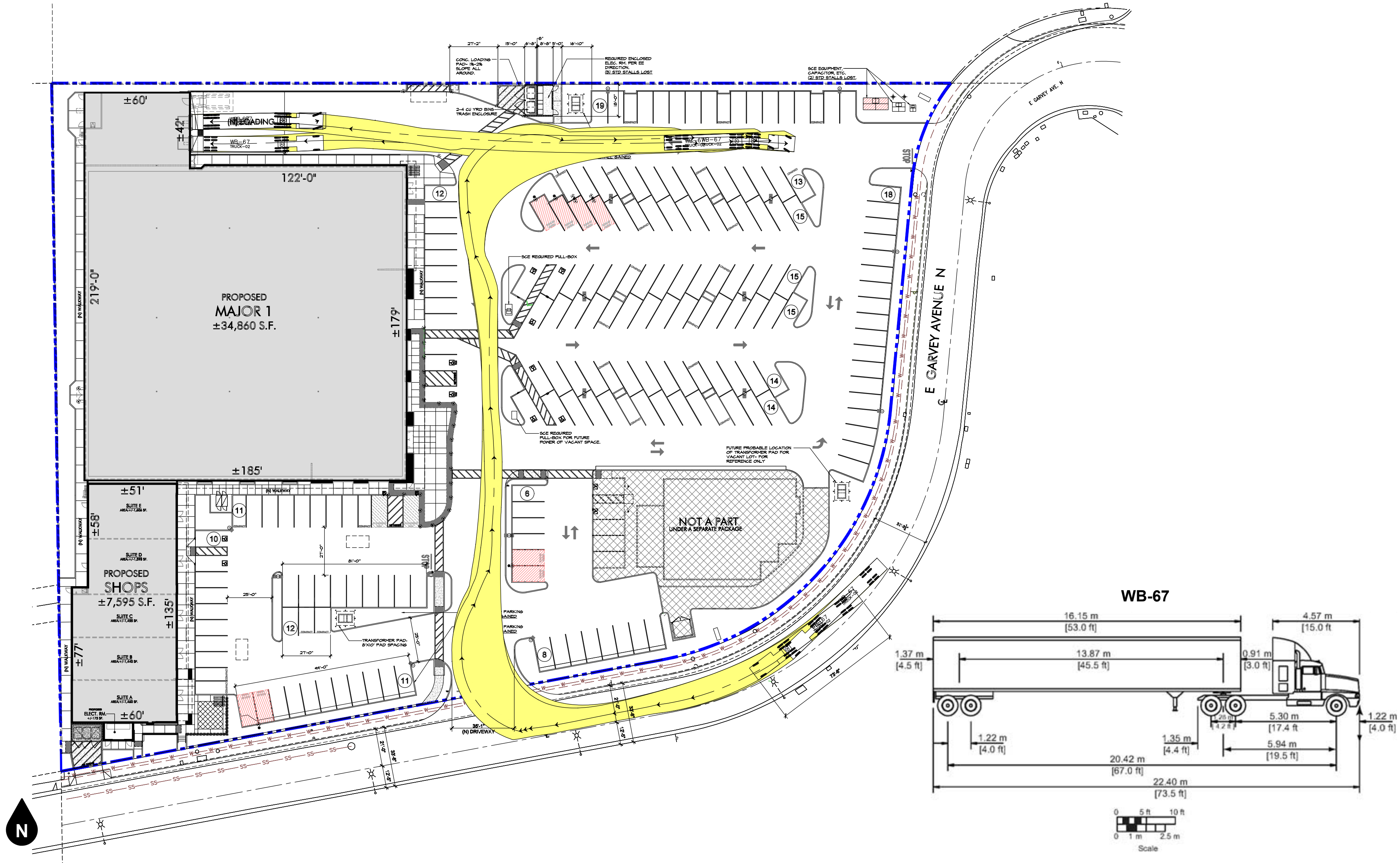
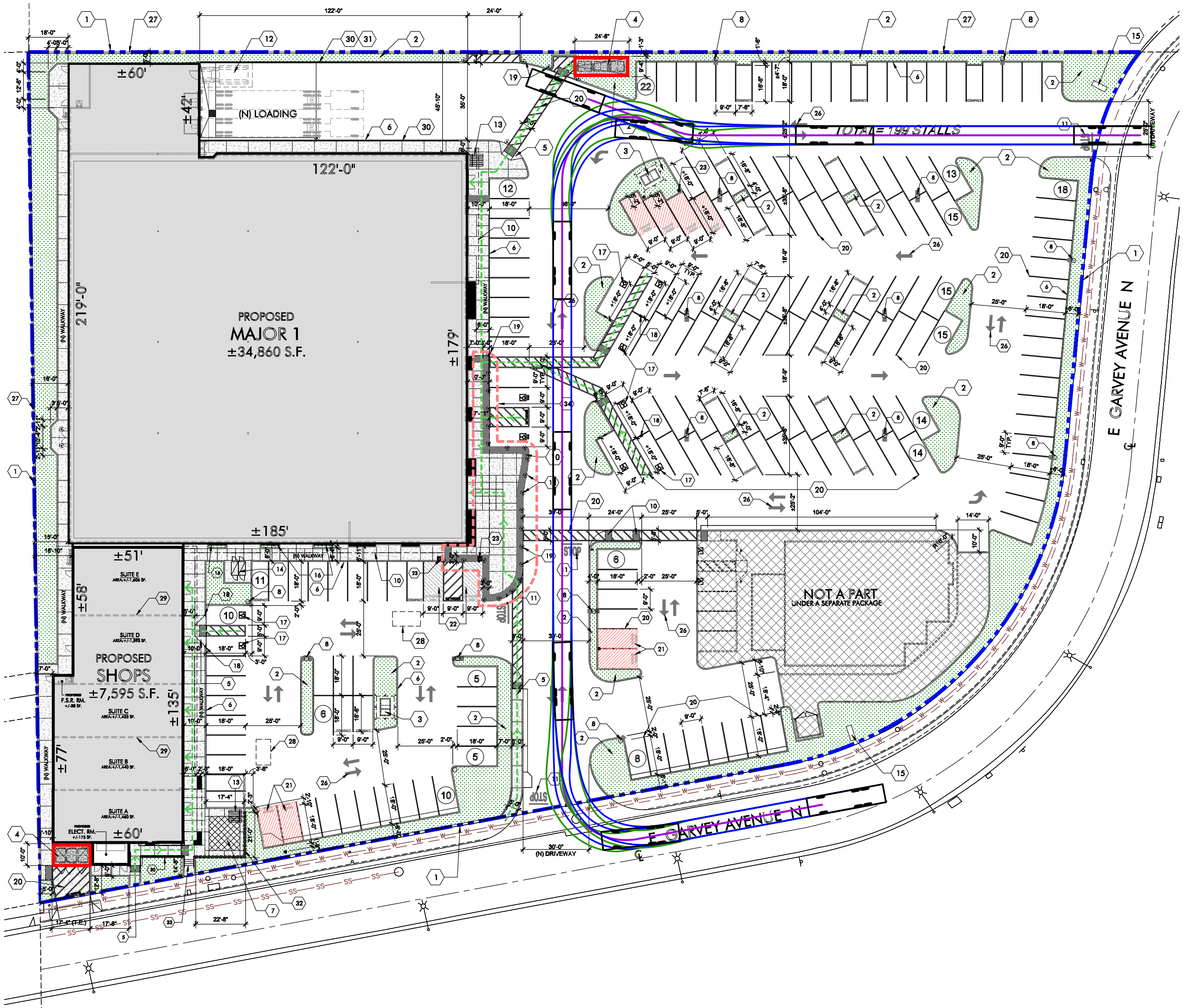


Figure 31
Truck Turning Templates



Legend
- Vehicle Wheel Path
- Vehicle Overhang
- Vehicle Centerline
- Trash Bin Location

Figure 32
Trash Truck Circulation

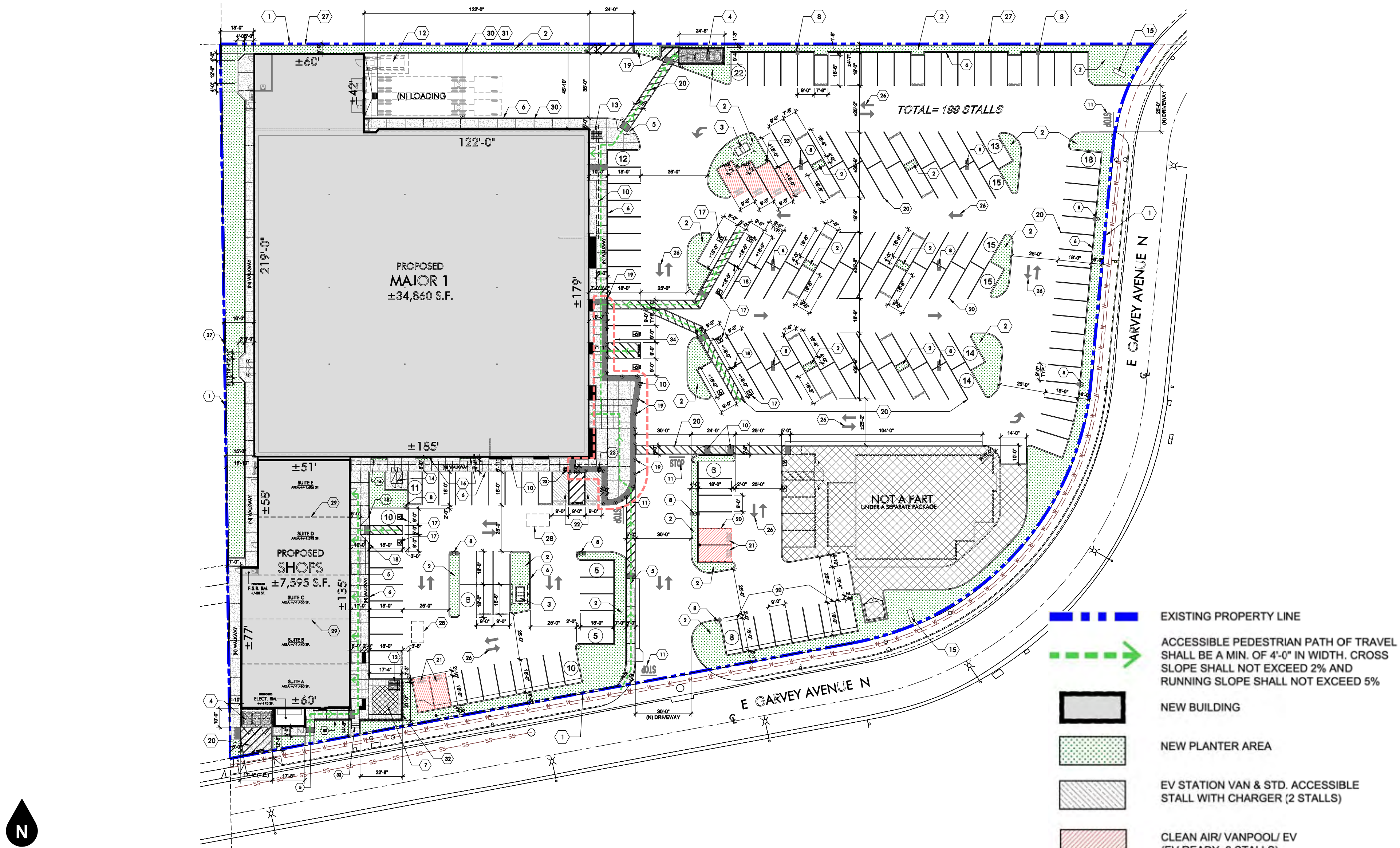


Figure 33
Pedestrian Access

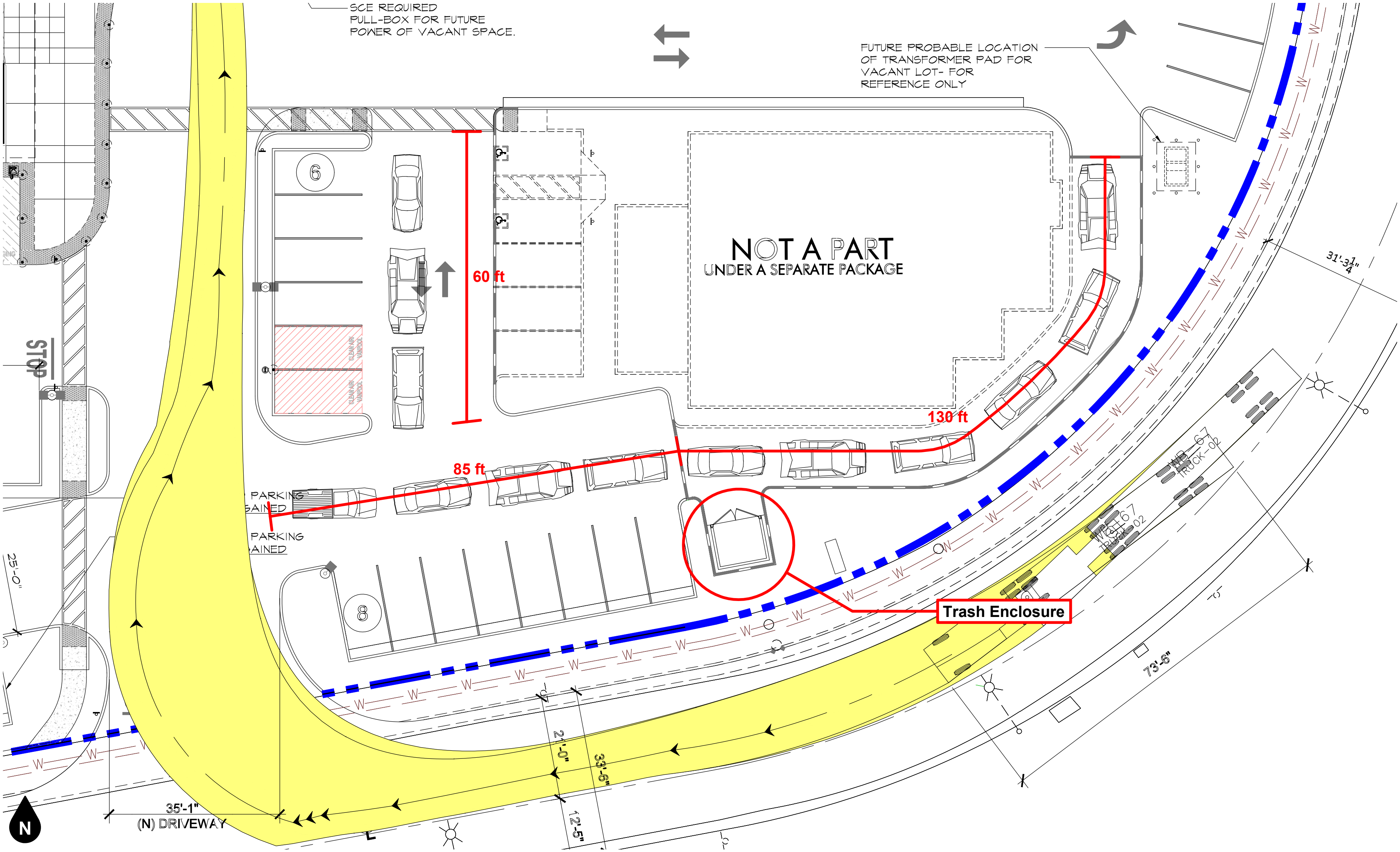
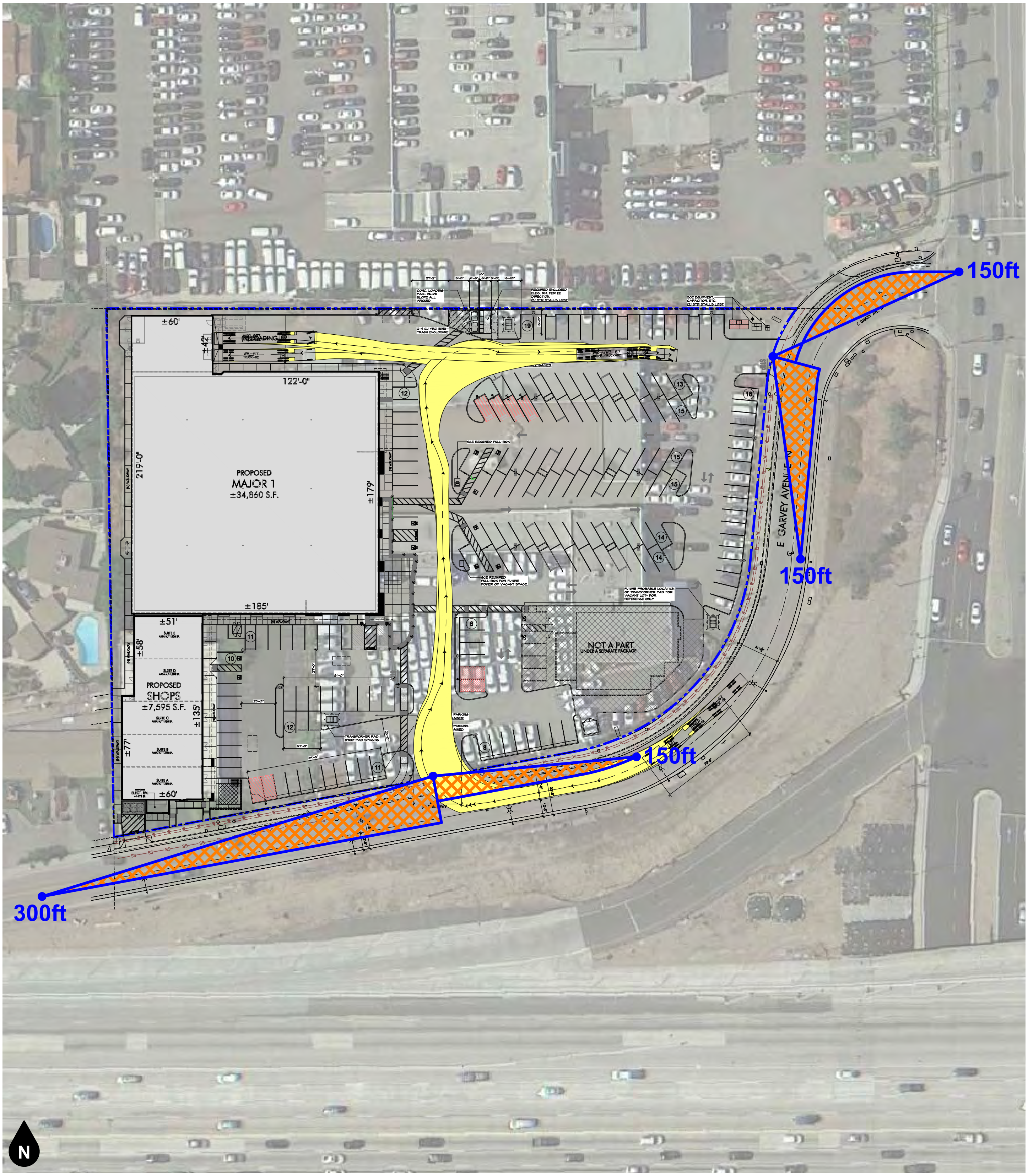


Figure 34
Drive-Thru Assessment

gandini



Legend
Stopping Sight Distance
Restricted Use Area

Figure 35
Sight Distance Analysis

8. CONGESTION MANAGEMENT PROGRAM

This section provides analysis of the project impacts at County facilities in accordance with typical Orange County Congestion Management Program (CMP) requirements.

CRITERIA FOR REQUIRING A TRAFFIC IMPACT ANALYSIS FOR CMP

The Los Angeles County 2010 CMP provides the following thresholds for requiring a CMP-compliant traffic impact analysis:

- All CMP arterial monitoring intersections, including monitored freeway on or off-ramp intersections, where the proposed project will add 50 or more trips during either the AM or PM weekday peak hours (of adjacent street traffic)

- If CMP arterial segments are being analyzed rather than intersections, the study area must include all segments where the proposed project will add 50 or more peak hour trips (total of both directions).

- Mainline freeway monitoring locations were the project will add 150 or more trips, in either direction, during either the AM or PM weekday peak hours.

As previously shown in Table 2, the proposed project is forecast to generate approximately 126 AM peak hour trips and 121 PM peak hour trips, which are distributed from the project site. The intersection of Citrus Street at Garvey Avenue is not a CMP intersection. The project will not add 150 or more peak hour trips to the I-10 Freeway since the project generates less than this threshold in total during each peak hour. Therefore, the proposed project would not result in a CMP impact as it does not meet the thresholds requiring a traffic impact analysis for CMP purposes and no further CMP traffic analysis is warranted.

CMP TRANSIT IMPACT REVIEW

The Los Angeles County Metropolitan Transportation Authority 2010 Congestion Management Program Appendix D - Guidelines for CMP Transportation Impact Analysis 8.4 utilizes a conversion factor based on the daily and AM and PM peak hour trip generation to provide for a transit analysis. The conversion is as follows:

- Multiply the total trips generated by 1.4 to convert vehicle trips to person trips;
- For each time period, multiply the result by one of the following factors:

    3.5% of Total Person Trips Generated for most cases, except:

    10% primarily Residential within 1/4 mile of a CMP transit center
    15% primarily Commercial within 1/4 mile of a CMP transit center
    7% primarily Residential within 1/4 mile of a CMP multi-modal transportation center
    9% primarily Commercial within 1/4 mile of a CMP multi-modal transportation center
    5% primarily Residential within 1/4 mile of a CMP transit corridor
    7% primarily Commercial within 1/4 mile of a CMP transit corridor
    0% if no fixed route transit services operate within one mile of the project

Accordingly, the proposed project-generated transit trips are calculated as follows:

- Daily: ((2,563 trips x 1.4) x 0.035) ≈ 126
- Morning Peak Hour: ((126 trips x 1.4) x 0.035) ≈ 6
- Evening Peak Hour: ((121 trips x 1.4) x 0.035) ≈ 6

The proposed project is forecast to generate approximately six (6) transit trips during the AM and PM peak hours. Based on the existing transit services available in the project vicinity and the relatively low transit trip generation, the proposed project is forecast to have a nominal impact on transit service.

9. VEHICLES MILES TRAVELED (VMT)

BACKGROUND

California Senate Bill 743 (SB 743) directs the State Office of Planning and Research (OPR) to amend the California Environmental Quality Act (CEQA) Guidelines for evaluating transportation impacts to provide alternatives to Level of Service that “promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses.” In December 2018, the California Natural Resources Agency certified and adopted the updated CEQA Guidelines package. The amended CEQA Guidelines, specifically Section 15064.3, recommend the use of Vehicle Miles Travelled (VMT) as the primary metric for the evaluation of transportation impacts associated with land use and transportation projects. In general terms, VMT quantifies the amount and distance of automobile travel attributable to a project or region. All agencies and projects State-wide are required to utilize the updated CEQA guidelines recommending use of VMT for evaluating transportation impacts as of July 1, 2020.

The updated CEQA Guidelines allow for lead agency discretion in establishing methodologies and thresholds provided there is substantial evidence to demonstrate that the established procedures promote the intended goals of the legislation. Where quantitative models or methods are unavailable, Section 15064.3 allows agencies to assess VMT qualitatively using factors such as availability of transit and proximity to other destinations. The Office of Planning and Research (OPR) Technical Advisory on Evaluating Transportation Impacts in CEQA (State of California, December 2018) [“OPR Technical Advisory”] provides technical considerations regarding methodologies and thresholds with a focus on office, residential, and retail developments as these projects tend to have the greatest influence on VMT.

SCREENING CRITERIA

The City of West Covina adopted its VMT guidelines in June 2020 and the City has provided this information for use in this analysis. Therefore, the project VMT impact has been assessed in accordance with the City of West Covina VMT guidelines and guidance from City staff.

Consistent with recommendations in the OPR Technical Advisory, the City of West Covina has established screening criteria for certain projects that may be presumed to have a less than significant VMT impact, including local-serving retail uses less than 50,000 square feet.

The proposed project involves construction of a retail development totaling approximately 46,955 square feet. Therefore, the proposed project satisfies the screening criteria for local-serving retail and may be presumed to result in a less than significant VMT impact in accordance with City of West Covina VMT guidelines.

10. CONCLUSIONS

This section summarizes the findings and mitigation measures (if any) identified in previous sections of this study.

FORECAST LEVELS OF SERVICE

The proposed project is not forecast to result in Level of Service operational impacts at the study intersection during the weekday AM and PM peak hours for the scenarios evaluated.

No off-site operational improvements were identified since the proposed project is forecast to result in no operational traffic impact at the study intersection for Existing Plus Project conditions.

CONGESTION MANAGEMENT PROGRAM

The proposed project would result in no operational CMP impact as it does not meet the thresholds requiring a traffic impact analysis for CMP purposes and no further CMP analysis is warranted. A transit impact review was conducted for compliance with the CMP requirements and found that the proposed project is forecast to have a nominal impact on transit service.

SITE ACCESS AND CIRCULATION

The proposed project shall construct the following improvements as project design features to provide project site access:

- Construct the Project Driveway (NS) at East Garvey Avenue (EW) (located on the southwest portion of the project site) to provide one inbound lane and one outbound lane with southbound stop-control and the following lane configurations:
    - Northbound: not applicable
    - Southbound: one shared left/right turn lane
    - Eastbound: one shared left/through lane
    - Westbound: one shared through/right turn lane.

- Construct the East Garvey Avenue (NS) at Project Driveway (EW) (located on the northeast portion of the project site) to provide one inbound lane and one outbound lane with eastbound stop-control and the following lane configurations:
    - Northbound: one through lane
    - Southbound: one shared through/right turn lane
    - Eastbound: one shared left/right turn lane
    - Westbound: not applicable

Outbound motorists at the East Garvey Avenue at Project Driveway intersection would queue internally and not affect operations on Garvey Avenue. Since the driveway is restricting inbound northbound left turns, there would also not be any conflicts with inbound turning vehicles from Garvey Avenue. Thus, any queuing concerns would be internal to the site and not affect the surrounding roadway network. If extensive queuing occurs at any particular time at this driveway for outbound left turning vehicles, motorists will naturally observe this queue, determine they don't want to wait in line, and naturally gravitate to the other project access. This natural spreading of vehicles at the project accesses will also reduce internal queues at this project driveway.

To provide for truck turning templates to function without encroaching across the centerline on Garvey Avenue, the centerline of Garvey Avenue will need to be restriped south approximately 4 feet. It will be the responsibility of the project applicant to provide striping and signing plans for Garvey Avenue to the City of West Covina for review that shows this restriping of the centerline, including centerline striping transitions east-west on Garvey Avenue

VMT Evaluation

The proposed project satisfies the screening criteria for local-serving retail and may be presumed to result in a less than significant VMT impact in accordance with City of West Covina VMT guidelines. The project can be considered local-serving retail since the project consists of a fast-food restaurant with drive-thru and under 50,000 square feet of commercial retail. Fast-food restaurants with drive-thrus typically attract traffic from other fast-food restaurants with drive-thrus. As such, this land uses primary function is to provide people with quick access to food. Thus, local residents will drive to this establishment instead of driving to a similar yet father away fast-food restaurant. This reduces VMT. Commercial retail less than 50,000 square feet is considered local-serving retail since the tenants constitute the majority of their clientele from the neighboring community, as opposed to a regional commercial center like a mall. Similar to a fast-food restaurant, the availability of this local-serving retail reduces VMT since patrons drive to these closer retail establishments instead of similar retail that is father away in terms of VMT.

APPENDICES

APPENDIX A

GLOSSARY

GLOSSARY OF TERMS

ACRONYMS

AC	Acres
ADT	Average Daily Traffic
Caltrans	California Department of Transportation
DU	Dwelling Unit
ICU	Intersection Capacity Utilization
LOS	Level of Service
TSF	Thousand Square Feet
V/C	Volume/Capacity
VMT	Vehicle Miles Traveled

TERMS

AVERAGE DAILY TRAFFIC: The average 24-hour volume for a stated period divided by the number of days in that period. For example, Annual Average Daily Traffic is the total volume during a year divided by 365 days.

BANDWIDTH: The number of seconds of green time available for through traffic in a signal progression.

BOTTLENECK: A point of constriction along a roadway that limits the amount of traffic that can proceed downstream from its location.

CAPACITY: The maximum number of vehicles that can be reasonably expected to pass over a given section of a lane or a roadway in a given time period.

CHANNELIZATION: The separation or regulation of conflicting traffic movements into definite paths of travel by the use of pavement markings, raised islands, or other suitable means to facilitate the safe and orderly movements of both vehicles and pedestrians.

CLEARANCE INTERVAL: Nearly same as yellow time. If there is an all red interval after the end of a yellow, then that is also added into the clearance interval.

CONTROL DELAY: The component of delay, typically expressed in seconds per vehicle, resulting from the type of traffic control at an intersection. Control delay is measured by comparison with the uncontrolled condition; it includes delay incurred by slowing down, stopping/waiting, and speeding up.

CORDON: An imaginary line around an area across which vehicles, persons, or other items are counted (in and out).

CORNER SIGHT DISTANCE: The minimum sight distance required by the driver of a vehicle to cross or enter the lanes of the major roadway without requiring approaching traffic travelling at a given speed to radically alter their speed or trajectory. Corner sight distance is measured from the driver's eye at 42 inches above the pavement to an object height of 36 inches above the pavement in the center of the nearest approach lane.

CYCLE LENGTH: The time period in seconds required for a traffic signal to complete one full cycle of indications.

CUL-DE-SAC: A local street open at one end only and with special provisions for turning around.

DAILY CAPACITY: A theoretical value representing the daily traffic volume that will typically result in a peak hour volume equal to the capacity of the roadway.

DELAY: The time consumed while traffic is impeded in its movement by some element over which it has no control, usually expressed in seconds per vehicle.

DEMAND RESPONSIVE SIGNAL: Same as traffic-actuated signal.

DENSITY: The number of vehicles occupying in a unit length of the through traffic lanes of a roadway at any given instant. Usually expressed in vehicles per mile.

DETECTOR: A device that responds to a physical stimulus and transmits a resulting impulse to the signal controller.

DESIGN SPEED: A speed selected for purposes of design. Features of a highway, such as curvature, superelevation, and sight distance (upon which the safe operation of vehicles is dependent) are correlated to design speed.

DIRECTIONAL SPLIT: The percent of traffic in the peak direction at any point in time.

DIVERSION: The rerouting of peak hour traffic to avoid congestion.

FORCED FLOW: Opposite of free flow.

FREE FLOW: Volumes are well below capacity. Vehicles can maneuver freely and travel is unimpeded by other traffic.

GAP: Time or distance between successive vehicles in a traffic stream, rear bumper to front bumper.

HEADWAY: Time or distance spacing between successive vehicles in a traffic stream, front bumper to front bumper.

INTERCONNECTED SIGNAL SYSTEM: A number of intersections that are connected to achieve signal progression.

LEVEL OF SERVICE: A qualitative measure of a number of factors, which include speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs.

LOOP DETECTOR: A vehicle detector consisting of a loop of wire embedded in the roadway, energized by alternating current and producing an output circuit closure when passed over by a vehicle.

MINIMUM ACCEPTABLE GAP: Smallest time headway between successive vehicles in a traffic stream into which another vehicle is willing and able to cross or merge.

MULTI-MODAL: More than one mode; such as automobile, bus transit, rail rapid transit, and bicycle transportation modes.

OFFSET: The time interval in seconds between the beginning of green at one intersection and the beginning of green at an adjacent intersection.

PLATOON: A closely grouped component of traffic that is composed of several vehicles moving, or standing ready to move, with clear spaces ahead and behind.

PASSENGER CAR EQUIVALENT (PCE): A metric used to assess the impact of larger vehicles, such as trucks, recreational vehicles, and buses, by converting the traffic volume of larger vehicles to an equivalent number of passenger cars.

PEAK HOUR: The 60 consecutive minutes with the highest number of vehicles.

PRETIMED SIGNAL: A type of traffic signal that directs traffic to stop and go on a predetermined time schedule without regard to traffic conditions. Also, fixed time signal.

PROGRESSION: A term used to describe the progressive movement of traffic through several signalized intersections.

QUEUE: The number of vehicles waiting at a service area such as a traffic signal, stop sign, or access gate.

QUEUE LENGTH: The length of vehicle queue, typically expressed in feet, waiting at a service area such as a traffic signal, stop sign, or access gate.

SCREEN-LINE: An imaginary line or physical feature across which all trips are counted, normally to verify the validity of mathematical traffic models.

SHARED/RECIPROCAL PARKING AGREEMENT: A written binding document executed between property owners to provide a designated number of off-street parking stalls within a designated area to be available for specified businesses or land uses.

SIGHT DISTANCE: The continuous length of roadway visible to a driver or roadway user.

SIGNAL CYCLE: The time period in seconds required for one complete sequence of signal indications.

SIGNAL PHASE: The part of the signal cycle allocated to one or more traffic movements.

STACKING DISTANCE: The length of area available behind a service area, such as a traffic signal or gate, for vehicle queueing to occur.

STARTING DELAY: The delay experienced in initiating the movement of queued traffic from a stop to an average running speed through an intersection.

STOPPING SIGHT DISTANCE: The minimum distance required by the driver of a vehicle on the major roadway travelling at a given speed to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance is measured from the driver's eye at 42 inches above the pavement to an object height of 6 inches above the pavement.

TRAFFIC-ACTUATED SIGNAL: A type of traffic signal that directs traffic to stop and go in accordance with the demands of traffic, as registered by the actuation of detectors.

TRIP: The movement of a person or vehicle from one location (origin) to another (destination). For example, from home to store to home is two trips, not one.

TRIP-END: One end of a trip at either the origin or destination (i.e., each trip has two trip-ends). A trip-end occurs when a person, object, or message is transferred to or from a vehicle.

TRIP GENERATION RATE: The quantity of trips produced and/or attracted by a specific land use stated in terms of units such as per dwelling, per acre, and per 1,000 square feet of floor space.

TRUCK: A vehicle having dual tires on one or more axles, or having more than two axles.

TURNING RADIUS: The circular arc formed by the smallest turning path radius of the front outside tire of a vehicle, such as that performed by a U-turn maneuver. This is based on the length and width of the wheel base as well as the steering mechanism of the vehicle.

UNBALANCED FLOW: Heavier traffic flow in one direction than the other. On a daily basis, most facilities have balanced flow. During the peak hours, flow is seldom balanced in an urban area.

VEHICLE MILES OF TRAVEL: A measure of the amount of usage of a section of highway, obtained by multiplying the average daily traffic by length of facility in miles.

APPENDIX B

SCOPING AGREEMENT

MEMORANDUM OF UNDERSTANDING

TO: Jana Robbins, PTP, RSP | TRANSTECH

FROM: Bryan Crawford | GANDDINI GROUP, INC.

DATE: July 13, 2020

SUBJECT: 2539 East Garvey Avenue Project Traffic Study Scope
19275

INTRODUCTION

The purpose of this scoping document is to outline the proposed traffic analysis parameters and assumptions for review/concurrence by City of West Covina staff. This scoping analysis is based on traffic comments provided by Transtech to the City of West Covina in a document provided on June 4, 2020.

PROJECT DESCRIPTION

Figure 1 shows the project location map. The project site is located at 2539 East Garvey Avenue in the City of West Covina.

The site plan is illustrated on Figure 2. The proposed project consists of redeveloping the project site with 42,516 square feet of commercial retail and 4,300 square feet of fast-food restaurant with drive-thru. The project site has existing structures that are currently vacant and will be demolished.

The project proposes two full access driveways to East Garvey Avenue and has an expected opening year of 2021.

PROJECT TRIP GENERATION & DISTRIBUTION

Table 1 shows the project trip generation based upon rates obtained from the Institute of Transportation Engineers (ITE) Trip Generation Manual (10th Edition, 2017). As shown in Table 1, the proposed project is forecast to generate approximately 2,521 daily trips, including 122 trips during the AM peak hour and 122 trips during the PM peak hour.

Pass-by trip adjustments were calculated in accordance with procedures outlined in the latest ITE Trip Generation Handbook (3rd Edition, 2017), which utilizes the National Cooperative Highway Research Program 684 Internal Capture Estimation Tool. Internal capture worksheets are attached following Table 1.

Figures 3 and 4 illustrate the forecast directional distribution patterns of project-generated trips.

STUDY AREA

Based on the County of Los Angeles Congestion Management Program guidelines, intersections identified for analysis typically include signalized intersections at which a project is forecast to contribute 50 or more trips during the AM or PM peak hours. The study area is proposed to consist of the following two (2) study intersections, even if the project may not contribute 50 or more trips during either the AM or PM peak hours, but are the adjacent or primary intersections impacted by the proposed project. These intersections were identified in the traffic comments provided by Transtech to the City of West Covina in a document provided on June 4, 2020.

Study Intersections

1. Hollenbeck Avenue (NS) at Garvey Avenue (EW)
2. Citrus Street (NS) at Garvey Avenue (EW)

TRAFFIC COUNTS

New intersection turning movement counts will be collected at the study intersections during the AM peak period (7:00 AM – 9:00 AM) and PM peak period (4:00 PM – 6:00 PM) on a typical weekday (Tuesday, Wednesday, or Thursday) when historical traffic counts are not available. Historical traffic counts will be acquired for all study intersections where available. These historical traffic counts will be adjusted with a growth rate for 2020 traffic conditions. Intersections without historical traffic count data will be manually adjusted based on the traffic volumes at nearby intersections with historical data to forecast pre-pandemic traffic conditions.

ANALYSIS SCENARIOS

The traffic study shall evaluate the following analysis scenarios for weekday AM and PM peak hour conditions:

- Existing
- Existing Plus Project
- Opening Year (2021) Without Project
- Opening Year (2021) With Project

ANALYSIS METHODOLOGY

The signalized study intersections shall by analyzed using the Intersection Capacity Utilization methodology in accordance with the capacity parameters prescribed in the Los Angeles County Traffic Impact Analysis Report Guidelines (Public Works Department, January 1997).

The unsignalized study intersections (if any) shall be analyzed using the intersection delay methodology and recommended default factors prescribed in the Transportation Research Board Highway Capacity Manual (6th Edition).

Intersection Level of Service analysis shall be performed using the Vistro software.

PERFORMANCE STANDARDS

The City of West Covina has not established minimum acceptable Level of Service thresholds during peak hour conditions.

THRESHOLDS OF SIGNIFICANCE

Signalized Intersections

For signalized study intersections within City of West Covina jurisdiction, a project traffic impact is considered significant if:

- The addition of project generated trips is forecast to cause an increase in volume-to-capacity of 0.02 or greater when the intersection is operating at Level of Service D, E or F in the baseline condition.

Unsignalized Intersections

Many jurisdictions in the region, including the City of West Covina, have not established significant impact thresholds for unsignalized intersections. For purposes of this traffic impact analysis, a project impact at an unsignalized intersection shall be considered significant if the addition of project-generated trips is forecast to cause or worsen Level of Service E or F and a traffic signal is warranted based on the peak hour volume criteria established in the California Manual on Uniform Traffic Control Devices (2014 Edition).

FORECASTING METHODOLOGY

To account for ambient growth, existing roadway volumes shall be increased by a growth rate of 1 percent (1%) per year over a one-year period for Opening Year (2021) conditions.

In addition, a list of pending and approved other development projects shall be requested from the City of West Covina. Trip forecasts for other development projects within the project study area shall be determined based on the Institute of Transportation Engineers (ITE), Trip Generation Manual, 10th Edition, 2017 and will be added to existing roadway volumes for the applicable analysis scenarios.

GARVEY AVENUE ANALYSIS

Lane striping with roadway widths for Garvey Avenue to be included on the site plan. Analysis will be conducted to determine if there is lane width for a left turn pocket into the site at the southwestern driveway, and to determine if the location of the northeast driveway is too close to the signal at Citrus Street to allow left turns out of the site onto Garvey Avenue.

RESTAURANT DRIVE-THRU QUEUING ANALYSIS

Review the stacking capacity for the proposed drive through restaurant, including stacking distance between the order board and end of queue as well as from the pick-up window. Determine the anticipated drive through queueing demand based on existing literature resources and, if necessary, identify recommendations to ensure any drive through queue overflow does not adversely impact on-site circulation or access to parking.

PEDESTRIAN ACCESS PLAN

Exhibit pedestrian access to/from each building to the parking areas.

TRUCK ACCESS

A truck delivery schedule will be provided that includes the areas where trucks will deliver to the project site. Truck turning templates for trucks (WB-67) will be provided within the parking areas to loading docks for the larger commercial pad. Truck turning templates for inbound/outbound truck traffic on Garvey Avenue will be provided.

A circulation plan for trash trucks with turning templates to each dumpster will also be provided.

CONCLUSION

We appreciate the opportunity to provide this scoping document for your review. Should you have any questions or comments regarding the proposed scope, please contact me at (714) 795-3100 x 104.

Table 1
Project Trip Generation

Trip Generation Rates									
			AM Peak Hour			PM Peak Hour			
Land Use	Source[1]	Units[2]	In	Out	Total	In	Out	Total	Daily
Commercial Retail	ITE 820	TSF	62%	38%	0.94	48%	52%	3.81	37.75
Fast-Food Restaurant w/ Drive-Thru	ITE 934	TSF	51%	49%	40.19	52%	48%	32.67	470.95

Trips Generated									
			AM Peak Hour			PM Peak Hour			
Land Use	Quantity		In	Out	Total	In	Out	Total	Daily
Commercial Retail	42.516	TSF	25	15	40	78	84	162	1,605
Internal Capture[3]			-2	-2	-4	-27	-21	-48	-52
Pass-By Reduction (34% PM)[3]			--	--	--	-17	-21	-38	-38
Subtotal			23	13	36	34	42	76	1,515
Fast-Food Restaurant w/ Drive-Thru	4.300	TSF	88	85	173	73	67	140	2,025
Internal Capture[3]			-2	-2	-4	-21	-27	-48	-52
Pass-By Reduction (49% AM, 50% PM)[3]			-42	-41	-83	-26	-20	-46	-967
Subtotal			44	42	86	26	20	46	1,006
Total			**67**	**55**	**122**	**60**	**62**	**122**	**2,521**

Notes:

(1) Source: Institute of Transportation Engineers, Trip Generation Manual, 10th Edition, 2017, ### = Land Use Code.

(2) TSF = Thousand Square Feet

(3) Source: Institute of Transportation Engineers, Trip Generation Handbook, 3rd Edition, 2017. Internal capture calculated using the National Cooperative Highway Research Program 684 Internal Capture Estimation Tool provided by the Institute of Transportation Engineers.

NCHRP 684 Internal Trip Capture Estimation Tool

Project Name:	2539 East Garvey Avenue Project		**Organization:**	Gandinni Group, Inc.
Project Location:	City of West Covina		**Performed By:**	Bryan Crawford
Scenario Description:	Commercial		**Date:**	13-Jul-20
Analysis Year:	2021		**Checked By:**	
Analysis Period:	**AM Street Peak Hour**		**Date:**	

Table 1-A: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)

Land Use	Development Data (*For Information Only*)				Estimated Vehicle-Trips[3]		
	ITE LUCs[1]	Quantity	Units		Total	Entering	Exiting
Office					0		
Retail					40	25	15
Restaurant					173	88	85
Cinema/Entertainment					0		
Residential					0		
Hotel					0		
All Other Land Uses[2]					0		
					213	113	100

Table 2-A: Mode Split and Vehicle Occupancy Estimates

Land Use	Entering Trips				Exiting Trips		
	Veh. Occ.[4]	% Transit	% Non-Motorized		Veh. Occ.[4]	% Transit	% Non-Motorized
Office							
Retail							
Restaurant							
Cinema/Entertainment							
Residential							
Hotel							
All Other Land Uses[2]							

Table 3-A: Average Land Use Interchange Distances (Feet Walking Distance)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-A: Internal Person-Trip Origin-Destination Matrix*

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		2	0	0	0
Restaurant	0	2		0	0	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	0	0	0	

Table 5-A: Computations Summary

	Total	Entering	Exiting
All Person-Trips	213	113	100
Internal Capture Percentage	4%	4%	4%
External Vehicle-Trips[5]	205	109	96
External Transit-Trips[6]	0	0	0
External Non-Motorized Trips[6]	0	0	0

Table 6-A: Internal Trip Capture Percentages by Land Use

Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	8%	13%
Restaurant	2%	2%
Cinema/Entertainment	N/A	N/A
Residential	N/A	N/A
Hotel	N/A	N/A

[1]Land Use Codes (LUCs) from *Trip Generation Manual*, published by the Institute of Transportation Engineers.

[2]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

[3]Enter trips assuming no transit or non-motorized trips (as assumed in ITE *Trip Generation Manual*).

[4]Enter vehicle occupancy assumed in Table 1-A vehicle trips. If vehicle occupancy changes for proposed mixed-use project, manual adjustments must be made to Tables 5-A, 9-A (O and D). Enter transit, non-motorized percentages that will result with proposed mixed-use project complete.

[5]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A.

[6]Person-Trips

*Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by the Texas A&M Transportation Institute - Version 2013.1

Project Name:	2539 East Garvey Avenue Project
Analysis Period:	**AM Street Peak Hour**

Table 7-A: Conversion of Vehicle-Trip Ends to Person-Trip Ends

Land Use	Table 7-A (D): Entering Trips				Table 7-A (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*		Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	0	0		1.00	0	0
Retail	1.00	25	25		1.00	15	15
Restaurant	1.00	88	88		1.00	85	85
Cinema/Entertainment	1.00	0	0		1.00	0	0
Residential	1.00	0	0		1.00	0	0
Hotel	1.00	0	0		1.00	0	0

Table 8-A (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	4		2	0	2	0
Restaurant	26	12		0	3	3
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	0	0	0	

Table 8-A (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		8	20	0	0	0
Retail	0		44	0	0	0
Restaurant	0	2		0	0	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	4	18	0		0
Hotel	0	1	5	0	0	

Table 9-A (D): Internal and External Trips Summary (Entering Trips)

Destination Land Use	Person-Trip Estimates				External Trips by Mode*		
	Internal	External	Total		Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0		0	0	0
Retail	2	23	25		23	0	0
Restaurant	2	86	88		86	0	0
Cinema/Entertainment	0	0	0		0	0	0
Residential	0	0	0		0	0	0
Hotel	0	0	0		0	0	0
All Other Land Uses[3]	0	0	0		0	0	0

Table 9-A (O): Internal and External Trips Summary (Exiting Trips)

Origin Land Use	Person-Trip Estimates				External Trips by Mode*		
	Internal	External	Total		Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0		0	0	0
Retail	2	13	15		13	0	0
Restaurant	2	83	85		83	0	0
Cinema/Entertainment	0	0	0		0	0	0
Residential	0	0	0		0	0	0
Hotel	0	0	0		0	0	0
All Other Land Uses[3]	0	0	0		0	0	0

[1]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A
[2]Person-Trips
[3]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator
*Indicates computation that has been rounded to the nearest whole number.

NCHRP 684 Internal Trip Capture Estimation Tool			
Project Name:	2539 East Garvey Avenue Project	**Organization:**	Gandinni Group, Inc.
Project Location:	City of West Covina	**Performed By:**	Bryan Crawford
Scenario Description:	Commercial	**Date:**	44025
Analysis Year:	2021	**Checked By:**	
Analysis Period:	**PM Street Peak Hour**	**Date:**	

Table 1-P: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)

Land Use	Development Data (*For Information Only*)			Estimated Vehicle-Trips[3]		
	ITE LUCs[1]	Quantity	Units	Total	Entering	Exiting
Office				0		
Retail				162	78	84
Restaurant				140	73	67
Cinema/Entertainment				0		
Residential				0		
Hotel				0		
All Other Land Uses[2]				0		
				302	151	151

Table 2-P: Mode Split and Vehicle Occupancy Estimates

Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.[4]	% Transit	% Non-Motorized	Veh. Occ.[4]	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses[2]						

Table 3-P: Average Land Use Interchange Distances (Feet Walking Distance)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-P: Internal Person-Trip Origin-Destination Matrix*

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		21	0	0	0
Restaurant	0	27		0	0	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	0	0	0	

Table 5-P: Computations Summary

	Total	Entering	Exiting
All Person-Trips	302	151	151
Internal Capture Percentage	32%	32%	32%
External Vehicle-Trips[5]	206	103	103
External Transit-Trips[6]	0	0	0
External Non-Motorized Trips[6]	0	0	0

Table 6-P: Internal Trip Capture Percentages by Land Use

Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	35%	25%
Restaurant	29%	40%
Cinema/Entertainment	N/A	N/A
Residential	N/A	N/A
Hotel	N/A	N/A

[1]Land Use Codes (LUCs) from *Trip Generation Manual*, published by the Institute of Transportation Engineers.

[2]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

[3]Enter trips assuming no transit or non-motorized trips (as assumed in ITE *Trip Generation Manual*).

[4]Enter vehicle occupancy assumed in Table 1-P vehicle trips. If vehicle occupancy changes for proposed mixed-use project, manual adjustments must be

[5]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P.

[6]Person-Trips

*Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by the Texas A&M Transportation Institute - Version 2013.1

Project Name:	2539 East Garvey Avenue Project
Analysis Period:	**PM Street Peak Hour**

Table 7-P: Conversion of Vehicle-Trip Ends to Person-Trip Ends

Land Use	Table 7-P (D): Entering Trips				Table 7-P (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*		Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	0	0		1.00	0	0
Retail	1.00	78	78		1.00	84	84
Restaurant	1.00	73	73		1.00	67	67
Cinema/Entertainment	1.00	0	0		1.00	0	0
Residential	1.00	0	0		1.00	0	0
Hotel	1.00	0	0		1.00	0	0

Table 8-P (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	2		24	3	22	4
Restaurant	2	27		5	12	5
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	0	0	0	

Table 8-P (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		6	1	0	0	0
Retail	0		21	0	0	0
Restaurant	0	39		0	0	0
Cinema/Entertainment	0	3	2		0	0
Residential	0	8	10	0		0
Hotel	0	2	4	0	0	

Table 9-P (D): Internal and External Trips Summary (Entering Trips)

Destination Land Use	Person-Trip Estimates				External Trips by Mode*		
	Internal	External	Total		Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0		0	0	0
Retail	27	51	78		51	0	0
Restaurant	21	52	73		52	0	0
Cinema/Entertainment	0	0	0		0	0	0
Residential	0	0	0		0	0	0
Hotel	0	0	0		0	0	0
All Other Land Uses[3]	0	0	0		0	0	0

Table 9-P (O): Internal and External Trips Summary (Exiting Trips)

Origin Land Use	Person-Trip Estimates				External Trips by Mode*		
	Internal	External	Total		Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0		0	0	0
Retail	21	63	84		63	0	0
Restaurant	27	40	67		40	0	0
Cinema/Entertainment	0	0	0		0	0	0
Residential	0	0	0		0	0	0
Hotel	0	0	0		0	0	0
All Other Land Uses[3]	0	0	0		0	0	0

[1]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

[2]Person-Trips

[3]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator

*Indicates computation that has been rounded to the nearest whole number.

Table 7.1a Adjusted Internal Trip Capture Rates for Trip Origins within a Multi-Use Development			
Land Use Pairs		Weekday	
		AM Peak Hour	PM Peak Hour
From OFFICE	To Office	0.0%	0.0%
	To Retail	28.0%	20.0%
	To Restaurant	63.0%	4.0%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	1.0%	2.0%
	To Hotel	0.0%	0.0%
From RETAIL	To Office	29.0%	2.0%
	To Retail	0.0%	0.0%
	To Restaurant	13.0%	29.0%
	To Cinema/Entertainment	0.0%	4.0%
	To Residential	14.0%	26.0%
	To Hotel	0.0%	5.0%
From RESTAURANT	To Office	31.0%	3.0%
	To Retail	14.0%	41.0%
	To Restaurant	0.0%	0.0%
	To Cinema/Entertainment	0.0%	8.0%
	To Residential	4.0%	18.0%
	To Hotel	3.0%	7.0%
From CINEMA/ENTERTAINMENT	To Office	0.0%	2.0%
	To Retail	0.0%	21.0%
	To Restaurant	0.0%	31.0%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	0.0%	8.0%
	To Hotel	0.0%	2.0%
From RESIDENTIAL	To Office	2.0%	4.0%
	To Retail	1.0%	42.0%
	To Restaurant	20.0%	21.0%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	0.0%	0.0%
	To Hotel	0.0%	3.0%
From HOTEL	To Office	75.0%	0.0%
	To Retail	14.0%	16.0%
	To Restaurant	9.0%	68.0%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	0.0%	2.0%
	To Hotel	0.0%	0.0%

Table 7.2a Adjusted Internal Trip Capture Rates for Trip Destinations within a Multi-Use Development			
Land Use Pairs		Weekday	
		AM Peak Hour	PM Peak Hour
To OFFICE	From Office	0.0%	0.0%
	From Retail	4.0%	31.0%
	From Restaurant	14.0%	30.0%
	From Cinema/Entertainment	0.0%	6.0%
	From Residential	3.0%	57.0%
	From Hotel	3.0%	0.0%
To RETAIL	From Office	32.0%	8.0%
	From Retail	0.0%	0.0%
	From Restaurant	8.0%	50.0%
	From Cinema/Entertainment	0.0%	4.0%
	From Residential	17.0%	10.0%
	From Hotel	4.0%	2.0%
To RESTAURANT	From Office	23.0%	2.0%
	From Retail	50.0%	29.0%
	From Restaurant	0.0%	0.0%
	From Cinema/Entertainment	0.0%	3.0%
	From Residential	20.0%	14.0%
	From Hotel	6.0%	5.0%
To CINEMA/ENTERTAINMENT	From Office	0.0%	1.0%
	From Retail	0.0%	26.0%
	From Restaurant	0.0%	32.0%
	From Cinema/Entertainment	0.0%	0.0%
	From Residential	0.0%	0.0%
	From Hotel	0.0%	0.0%
To RESIDENTIAL	From Office	0.0%	4.0%
	From Retail	2.0%	46.0%
	From Restaurant	5.0%	16.0%
	From Cinema/Entertainment	0.0%	4.0%
	From Residential	0.0%	0.0%
	From Hotel	0.0%	0.0%
To HOTEL	From Office	0.0%	0.0%
	From Retail	0.0%	17.0%
	From Restaurant	4.0%	71.0%
	From Cinema/Entertainment	0.0%	1.0%
	From Residential	0.0%	12.0%
	From Hotel	0.0%	0.0%

Legend
Study Intersection

Figure 1
Project Location Map

gandini

2539 East Garvey Avenue Project
Traffic Impact Analysis
19275

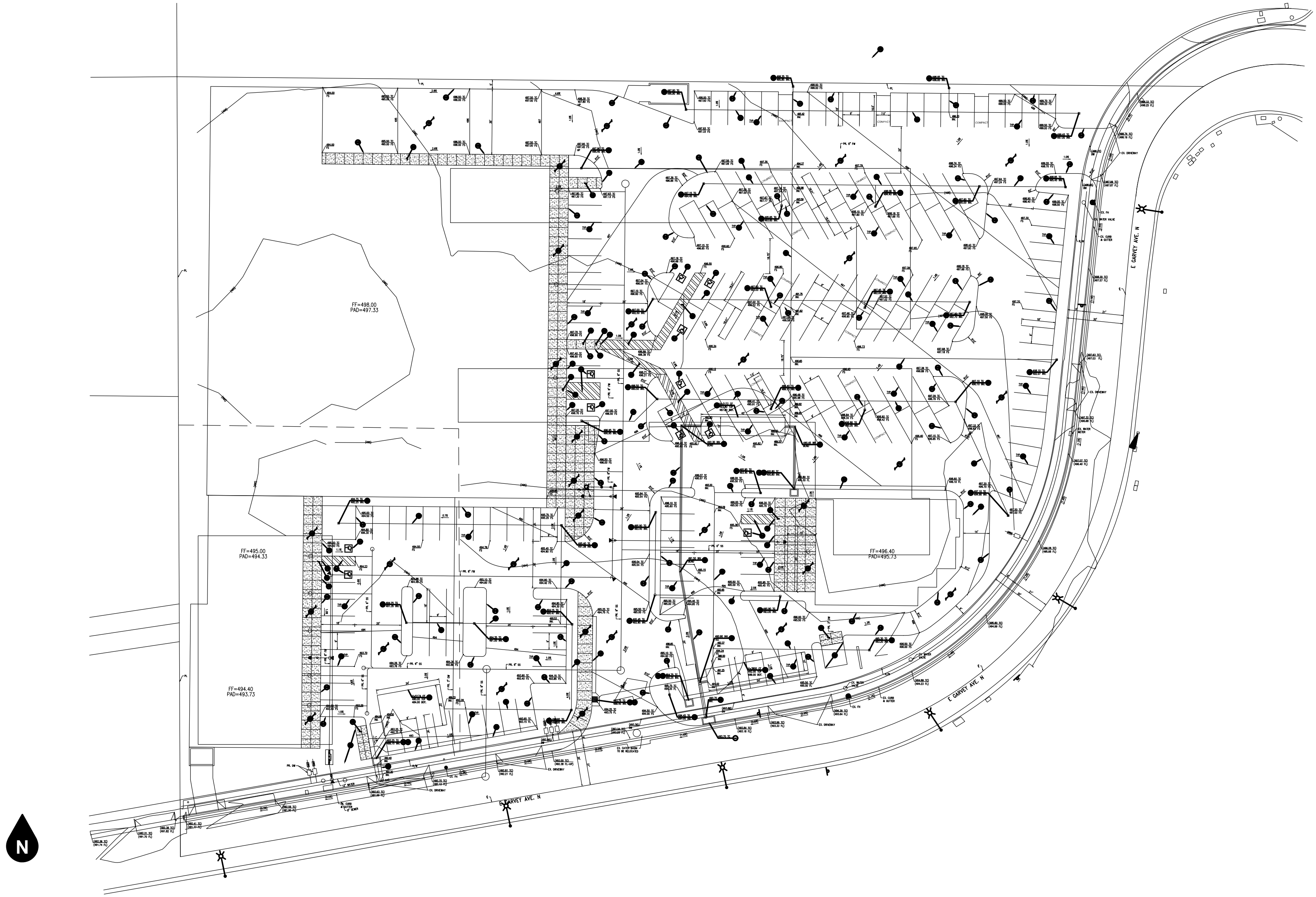


Figure 2
Site Plan

gandini

2539 East Garvey Avenue Project
Traffic Impact Analysis
19275

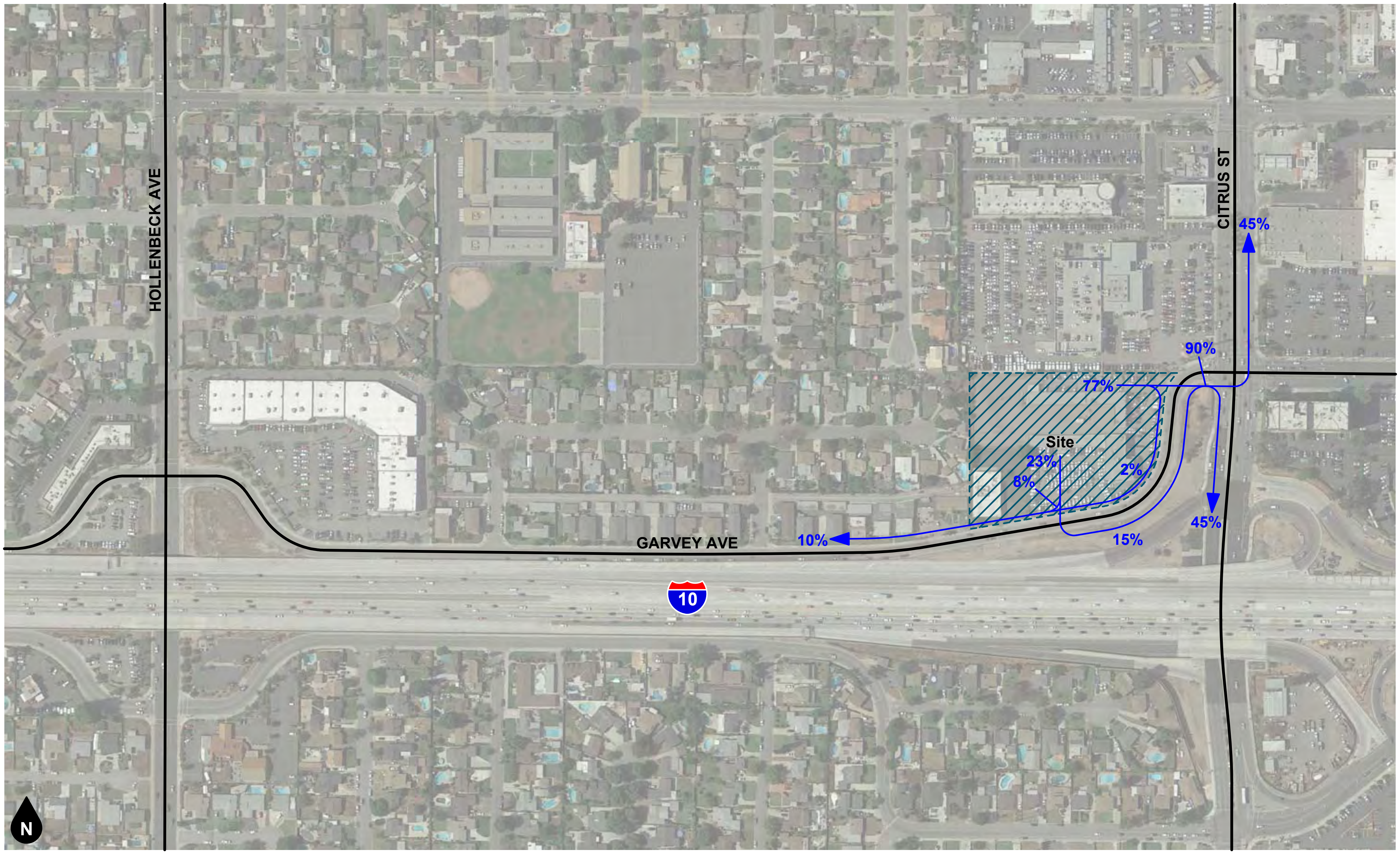
Legend

10% Percent To/From Project

Figure 3
Project Trip Distribution

ganddini

2539 East Garvey Avenue Project
Traffic Impact Analysis
19275



Legend
10% Percent To/From Project

Figure 4
Project Pass-By Trip Distribution

Date: June 4, 2020

To:	Jo-Anne Burns, West Covina Planning Director Jburns@westcovina.org	Pages:	2 Pages
From:	Jana Robbins, PTP, RSP jana.robbins@transtech.org; T: 909-595-8599, 133	Job #:	TT 19571
Re:	Review of Preliminary Plans Submitted for the Construction of a Shopping Center with Drive Thru Restaurant at 2539 N Garvey Avenue in the City of West Covina	Cc:	Michael Ackerman, City Engineer

TRAFFIC COMMENTS TO THE PRELIMINARY SITE PLAN SUBMITTED FOR A SHOPPING CENTER WITH DRIVE-THRU RESTAURANT AT THE NW CORNER OF N GARVEY AVENUE AND CITRUS STREET

Transtech has reviewed the preliminary site plan submitted for the above referenced project. The developer is proposing to add a shopping center at the 2539 Garvey Avenue N site. The site includes a 34,854 sqf commercial building, a 7,660 sqf retail pad and a 4,300 sqf fast food with drive-thru with 525 sqf for outside seating. The total commercial space is around 47,339 sqf. Currently the site is comprised of a used car lot and a "Lotus of West Covina" vacant car dealer space. These buildings will be demolished to make room for the new proposed shopping center. Access to the parking area will be from two full service driveways with access onto Garvey Avenue North. The closest intersection is at Citrus Street opposite the entrance to the Eastland Center.

The City is currently in the process of adopting and approving VMT thresholds and screening criteria for development projects. It is likely that this project would be a candidate for screening from the need to prepare a full traffic impact analysis for CEQA. However, the City is retaining the requirement for projects to look at local traffic impacts which would include the following:

1. Provide a comparison table of future New project trips that will be Generated by the site minus any trips generated by existing use (if active and in operation).
2. Provide an estimated trip distribution of project traffic into and out of the site.
3. Show lane striping with roadway widths for Garvey North on the site plan and determine if there is lane width for a left turn pocket into the site at the southwestern driveway and to determine if the location of the northeast driveway is too close to the signal at Citrus St to allow left turns out of the site onto Garvey Ave N.
4. The following intersections will need to be analyzed in the traffic analysis:
    a. Citrus Street at Garvey Ave N
    b. Hollenbeck Ave at Garvey Ave N
5. Provide a queuing study looking at the restaurants drive thru. How many cars will be able to stack between the order board and end of queue as well as from the pick up window. Visually the available drive thru queue does not look long enough to provide for stacking before blocking adjacent parking spaces.
6. Please provide a pedestrian plan to and from the entry of each building to the parking.
7. Please provide a truck delivery schedule and area that trucks will deliver to the site. This should include a turning template for trucks maneuvering within the parking area to the loading dock for the larger commercial pad. A truck turning template will also need to be shown entering from Garvey N and how they anticipate to enter and exit the site and back into the loading dock.
8. Site plan needs to also include a circulation plan of trash trucks with turning templates to each dumpster.
9. Number of parking spaces will need to be per City Code and shown on the plan.

TRANSTECH

Date: July 17, 2020

To:	Jo-Anne Burns, West Covina Planning Director Jburns@westcovina.org	Pages:	3 Pages
From:	Jana Robbins, PTP, RSP jana.robbins@transtech.org; T: 909-595-8599, 133	Job #:	TT 19571
Re:	Review of Traffic Scoping Memorandum for the Construction of a Shopping Center with Drive Thru Restaurant at 2539 N Garvey Avenue in the City of West Covina	Cc:	Michael Ackerman, City Engineer

TRAFFIC COMMENTS TO THE TRAFFIC SCOPING MEMORANDUM OF UNDERSTANDING PREPARED BY THE APPLICANTS TRAFFIC CONSULTANT GANDDINI GROUP INC AND DATED JULY 13, 2020.

We have reviewed the Traffic Scoping MOU prepared by Bryan Crawford with the Ganddini Group and generally agree and accept the MOU as submitted.

However, there are a few comments and items that will need to also be added to the traffic analysis when submitted. These items include the following:

1. Full project trips without pass-by reductions will need to be shown at each project driveway.
2. Will need to include a look at the EB queueing of traffic on Garvey Avenue as it approaches Citrus Street to determine if there is adequate gaps in traffic to allow left turns out of the northeastern driveway.
3. The consultant will need to determine based on road geometrics, distance to Citrus Street, line of sight and street width if the northeast driveway should also restrict EB left turns <u>into</u> the driveway.
4. Perform a line of sight analysis at each driveway to determine if any red curb is required on either side of each driveway.
5. VMT Screening – it has been determined that this project can be screened from performing a VMT analysis since it can be considered as a local serving “Project Type”. Any project that uses the designation of “local-serving” needs to provide adequate justification for this designation and should be able to demonstrate that its users (employees, customers, visitors) would be existing within the community. The project would not generate new “demand” for the project land uses but would meet the existing demand that would shorten the distance existing residents, employees, customers, or visitors would need to travel.

Recently, the City adopted in June the use of the VMT Analysis Methodology for projects when evaluating Traffic Impacts within CEQA to be in line with State Mandates. CEQA Guidelines identified that all lead agencies must use VMT as the new transportation metric for identifying impacts for land use projects beginning July 1, 2020. While CEQA requirements have changed and LOS no longer constitutes CEQA impacts, the City elected to still use LOS for planning and analysis purposes.

VMT Screening –There are three types of screening that may be applied to effectively screen projects from a detailed, project-level VMT assessment. These screening types are summarized below:

Transit Priority Area (TPA) Screening
Projects located within a TPA[1] may be presumed to have a less than significant impact absent substantial evidence to the contrary. Additionally, the analyst should confirm with all local transit providers that no recent changes in transit service have occurred in the project area (e.g. addition or removal of transit lines, addition or removal of transit stops, or changes to service frequency).

Low VMT Area Screening
Residential and office projects located within a low VMT-generating area may be presumed to have a less than significant impact absent substantial evidence to the contrary. In addition, other employment-related and mixed-use land use projects may qualify for the use of screening if the project can reasonably be expected to generate VMT per resident, per employee, or per service population that is similar to the existing land uses in the low VMT area.

Project Type Screening
Some project types have been identified as having the presumption of a less than significant impact. The following uses can be presumed to have a less than significant impact absent substantial evidence to the contrary as their uses are local serving in nature:

- Local-serving retail uses less than 50,000 square feet, including:
    - Gas stations
    - Banks
    - Restaurants
    - Shopping Center
- Other local-serving uses as approved by the City Staff
- Projects generating less than 110 daily vehicle trips[2,3]

---

[1] A TPA is defined as a half mile area around an existing major transit stop or an existing stop along a high-quality transit corridor per the definitions below. Public Resources Code § 21099(a)(7)

Pub. Resources Code, § 21064.3 - 'Major transit stop' means a site containing an existing rail transit station, a ferry terminal served by either a bus or rail transit service, or the intersection of two or more major bus routes with a frequency of service interval of 15 minutes or less during the morning and afternoon peak commute periods.

Pub. Resources Code, § 21155 - For purposes of this section, a 'high-quality transit corridor' means a corridor with fixed route bus service with service intervals no longer than 15 minutes during peak commute hours.

[2] Note that a redevelopment project replacing an existing use would estimate the net increase in trips above trips what already exists.

[3] This threshold ties directly to the OPR technical advisory and notes that CEQA provides a categorical exemption for existing facilities, including additions to existing structures of up to 10,000 square feet, so long as the project is in an area where public infrastructure is available to allow for maximum planned development and the project is not in an environmentally sensitive area. (CEQA Guidelines, § 15301, subd. (e)(2).) Typical project types for which trip generation increases relatively linearly with building footprint (i.e., general office building, single tenant office

- This generally corresponds to the following “typical” development potentials:
  - 11 single family housing units
  - 16 multi-family, condominiums, or townhouse housing units
  - 10,000 sq. ft. of office
  - 15,000 sq. ft. of light industrial[4]
  - 63,000 sq. ft. of warehousing[3]
  - 79,000 sq. ft. of high cube transload and short-term storage warehouse[3]

Local serving retail projects with a total square footage less than 50,000 square feet may be presumed to have a less than significant impact absent substantial evidence to the contrary. Local serving retail generally improves the convenience of shopping close to home and has the effect of reducing vehicle travel.

building, office park, and business park) generate or attract an additional 110-124 trips per 10,000 square feet. Therefore, absent substantial evidence otherwise, it is reasonable to conclude that the addition of 110 or fewer trips could be considered not to lead to a significant impact.

[4] This number was estimated using rates from ITE’s Trip Generation Manual. Some industrial and warehousing tenants may generate traffic differently than what is documented in ITE. In these cases, documentation of the project generating less than 110 daily trips will be required for review and approval by the City Traffic Engineer.

APPENDIX C

VOLUME COUNT WORKSHEETS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Volume (vph)	18	17	58	62	41	32	118	923	123	1	52	707
Pedestrians	4					4			7		7	
Ped Button					Yes			No				
Pedestrian Timing (s)					16.0			16.0				
Free Right			No			No			No			
Ideal Flow	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600
Lost Time (s)	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.5	5.5	4.5	4.5	4.5
Minimum Green (s)	6.0	6.0	4.0	10.0	10.0	10.0	4.0	10.0	10.0	4.0	4.0	4.0
Refr Cycle Length (s)	120	120	120	120	120	120	120	120	120	120	120	120
Volume Combined (vph)	0	93	0	0	103	32	118	923	123	0	53	752
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.91	1.00	1.00	1.00	0.91
Turning Factor (vph)	0.95	0.90	0.85	0.95	0.97	0.85	0.95	1.00	0.85	0.95	0.95	0.99
Saturated Flow (vph)	0	1436	0	0	3104	1360	1520	4358	1360	0	1520	4319
Ped Intf Time (s)	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.9	0.0	0.0	0.0
Pedestrian Frequency (%)		0.00			0.12			1.00				0.00
Protected Option Allowed		No			No			Yes				Yes
Reference Time (s)			0.0			3.3	9.3	25.4	11.7	0.0	4.2	20.9
Adj Reference Time (s)			0.0			15.0	14.3	30.9	17.2	0.0	8.7	25.4
Permitted Option												
Adj Saturation A (vph)	0	365		0	1229		101	1453		0	101	1440
Reference Time A (s)	0.0	30.6		0.0	10.1		139.7	25.4		0.0	62.8	20.9
Adj Saturation B (vph	0	0		0	0		NA	NA		NA	NA	NA
Reference Time B (s)	9.4	15.8		10.4	12.0		NA	NA		NA	NA	NA
Reference Time (s)		15.8			10.1			139.7				62.8
Adj Reference Time (s)		20.8			15.1			145.2				67.3
Split Option												
Ref Time Combined (s)	0.0	7.8		0.0	4.0		9.3	25.4		0.0	4.2	20.9
Ref Time Seperate (s)	1.4	1.4		2.4	3.1		9.3	25.4		0.1	4.1	19.6
Reference Time (s)	7.8	7.8		4.0	4.0		25.4	25.4		20.9	20.9	20.9
Adj Reference Time (s)	12.8	12.8		15.0	15.0		30.9	30.9		25.4	25.4	25.4

Summary	EB WB	NB SB	Combined
Protected Option (s)	NA	39.7	
Permitted Option (s)	20.8	145.2	
Split Option (s)	27.8	56.3	
Minimum (s)	20.8	39.7	60.5

Right Turns	WBR	NBR
Adj Reference Time (s)	15.0	17.2
Cross Thru Ref Time (s)	39.6	12.8
Oncoming Left Ref Time (s)	12.8	8.7
Combined (s)	67.4	38.7

Intersection Summary			
Intersection Capacity Utilization	56.1%	ICU Level of Service	B

Reference Times and Phasing Options do not represent an optimized timing plan.

Movement	SBR
Lane Configurations	
Volume (vph)	45
Pedestrians	
Ped Button	
Pedestrian Timing (s)	
Free Right	No
Ideal Flow	1600
Lost Time (s)	4.0
Minimum Green (s)	4.0
Refr Cycle Length (s)	120
Volume Combined (vph)	0
Lane Utilization Factor	1.00
Turning Factor (vph)	0.85
Saturated Flow (vph)	0
Ped Intf Time (s)	0.0
Pedestrian Frequency (%)	
Protected Option Allowed	
Reference Time (s)	0.0
Adj Reference Time (s)	0.0
Permitted Option	
Adj Saturation A (vph)	
Reference Time A (s)	
Adj Saturation B (vph	
Reference Time B (s)	
Reference Time (s)	
Adj Reference Time (s)	
Split Option	
Ref Time Combined (s)	
Ref Time Seperate (s)	
Reference Time (s)	
Adj Reference Time (s)	
Summary	

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	362	40	134	35	74	61	44	631	283	169	1016	44
Pedestrians						6			15			1
Ped Button					Yes			No			No	
Pedestrian Timing (s)					16.0			16.0			16.0	
Free Right			No			No			No			No
Ideal Flow	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600
Lost Time (s)	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.5	5.5	4.5	4.5	4.0
Minimum Green (s)	6.0	6.0	4.0	10.0	10.0	10.0	4.0	10.0	10.0	4.0	4.0	4.0
Refr Cycle Length (s)	120	120	120	120	120	120	120	120	120	120	120	120
Volume Combined (vph)	0	536	0	0	109	61	44	631	283	169	1060	0
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Turning Factor (vph)	0.95	0.93	0.85	0.95	0.98	0.85	0.95	1.00	0.85	0.95	0.99	0.85
Saturated Flow (vph)	0	1488	0	0	3149	1360	1520	4358	1360	1520	4331	0
Ped Intf Time (s)	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	1.8	0.0	0.0	0.1
Pedestrian Frequency (%)		0.00			0.18			1.00			1.00	
Protected Option Allowed		No			No			Yes			Yes	
Reference Time (s)			0.0			6.1	3.5	17.4	26.8	13.3	29.4	0.0
Adj Reference Time (s)			0.0			15.0	9.0	22.9	32.3	17.8	33.9	0.0
Permitted Option												
Adj Saturation A (vph)	0	132		0	3139		101	1453		101	1444	
Reference Time A (s)	0.0	486.3		0.0	4.2		52.1	17.4		200.1	29.4	
Adj Saturation B (vph	0	0		NA	NA		NA	NA		NA	NA	
Reference Time B (s)	36.6	51.2		NA	NA		NA	NA		NA	NA	
Reference Time (s)		51.2			4.2			52.1			200.1	
Adj Reference Time (s)		56.2			15.0			57.6			204.6	
Split Option												
Ref Time Combined (s)	0.0	43.2		0.0	4.2		3.5	17.4		13.3	29.4	
Ref Time Seperate (s)	28.6	3.4		1.4	5.5		3.5	17.4		13.3	28.2	
Reference Time (s)	43.2	43.2		5.5	5.5		17.4	17.4		29.4	29.4	
Adj Reference Time (s)	48.2	48.2		15.0	15.0		22.9	22.9		33.9	33.9	

Summary	EB WB	NB SB	Combined
Protected Option (s)	NA	42.9	
Permitted Option (s)	56.2	204.6	
Split Option (s)	63.2	56.7	
Minimum (s)	56.2	42.9	99.1

Right Turns	WBR	NBR
Adj Reference Time (s)	15.0	32.3
Cross Thru Ref Time (s)	40.7	48.2
Oncoming Left Ref Time (s)	48.2	17.8
Combined (s)	103.9	98.3

Intersection Summary			
Intersection Capacity Utilization	86.6%	ICU Level of Service	E

Reference Times and Phasing Options do not represent an optimized timing plan.

Citrus Street (NS) at Garvey Avenue (EW)

Modified Traffic Count

Historical Traffic Count[1]												
2016												
AM Peak Hour												
Northbound			Southbound			Eastbound			Westbound			
Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	Total
118	923	123	53	707	45	18	17	58	62	41	32	2,197
PM Peak Hour												
Northbound			Southbound			Eastbound			Westbound			
Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	Total
44	631	283	169	1,016	44	362	40	134	35	74	61	2,893

Annual Ambient Growth Rate:	1.00%

Modified Traffic Count												
2020												
AM Peak Hour												
Northbound			Southbound			Eastbound			Westbound			
Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	Total
123	960	128	55	736	47	19	18	60	65	43	33	2,287
PM Peak Hour												
Northbound			Southbound			Eastbound			Westbound			
Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	Total
46	657	294	176	1,057	46	377	42	139	36	77	63	3,010

Notes:
(1) Source: West Covina General Plan Update: Revised Draft Traffic Study (Nelson NyGaard Consulting Associates, Inc., August 29, 2016)

APPENDIX D

LEVEL OF SERVICE WORKSHEETS

EXISTING

2539 East Garvey Avenue Project

Vistro File: C:\...\AME.vistro
Report File: C:\...\AME.pdf

Scenario 1 Existing AM Peak Hour
8/16/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	NB Thru	0.434	-	A

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	A
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.434

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	31	240	32	14	184	12	5	5	15	16	11	8
Total Analysis Volume [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.08	0.20	0.06	0.02	0.16	0.16	0.01	0.06	0.06	0.02	0.03	0.02
Intersection LOS	A											
Intersection V/C	0.434											

2539 East Garvey Avenue Project

Vistro File: C:\...\PME.vistro
Report File: C:\...\PME.pdf

Scenario 1 Existing PM Peak Hour
8/16/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	EB Thru	0.755	-	C

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized		Delay (sec / veh):	-
Analysis Method:	ICU 1		Level Of Service:	C
Analysis Period:	15 minutes		Volume to Capacity (v/c):	0.755

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	12	164	74	44	264	12	94	11	35	9	19	16
Total Analysis Volume [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.03	0.14	0.16	0.06	0.23	0.23	0.24	0.35	0.35	0.02	0.05	0.04
Intersection LOS	C											
Intersection V/C	0.755											

EXISTING PLUS PROJECT

2539 East Garvey Avenue Project

Vistro File: C:\...\AME.vistro
Scenario 2 Existing Plus Project AM Peak Hour

Report File: C:\...\AMEP.pdf
8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	NB Thru	0.516	-	A

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	A
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.516

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	41	0	0	0	0	41	36	2	37	0	3	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	164	960	128	55	736	88	55	20	97	65	46	33
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	41	240	32	14	184	22	14	5	24	16	12	8
Total Analysis Volume [veh/h]	164	960	128	55	736	88	55	20	97	65	46	33
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.10	0.20	0.06	0.02	0.17	0.17	0.03	0.11	0.11	0.02	0.03	0.02
Intersection LOS	A											
Intersection V/C	0.516											

2539 East Garvey Avenue Project

Vistro File: C:\...\PME.vistro
Scenario 2 Existing Plus Project PM Peak Hour

Report File: C:\...\PMEP.pdf
8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	EB Right	0.837	-	D

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	D
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.837

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	38	0	0	0	0	38	38	2	38	0	2	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	84	657	294	176	1057	84	415	44	177	36	79	63
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	21	164	74	44	264	21	104	11	44	9	20	16
Total Analysis Volume [veh/h]	84	657	294	176	1057	84	415	44	177	36	79	63
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.05	0.14	0.16	0.06	0.24	0.24	0.26	0.40	0.40	0.02	0.05	0.04
Intersection LOS	D											
Intersection V/C	0.837											

2539 East Garvey Avenue Project

Vistro File: C:\...\AME.vistro

Scenario 5 Existing Plus Project AM Peak Hour - With Improvements

Report File: C:\...\AMEPI.pdf

8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	NB Thru	0.482	-	A

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	A
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.482

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	41	0	0	0	0	41	36	2	37	0	3	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	164	960	128	55	736	88	55	20	97	65	46	33
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	41	240	32	14	184	22	14	5	24	16	12	8
Total Analysis Volume [veh/h]	164	960	128	55	736	88	55	20	97	65	46	33
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.10	0.20	0.06	0.02	0.17	0.17	0.03	0.07	0.07	0.02	0.03	0.02
Intersection LOS	A											
Intersection V/C	0.482											

2539 East Garvey Avenue Project

Vistro File: C:\...\PME.vistro

Scenario 5 Existing Plus Project PM Peak Hour - With Improvements

Report File: C:\...\PMEPI.pdf

8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	EB Left	0.699	-	B

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	B
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.699

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	38	0	0	0	0	38	38	2	38	0	2	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	84	657	294	176	1057	84	415	44	177	36	79	63
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	21	164	74	44	264	21	104	11	44	9	20	16
Total Analysis Volume [veh/h]	84	657	294	176	1057	84	415	44	177	36	79	63
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.05	0.14	0.16	0.06	0.24	0.24	0.26	0.14	0.14	0.02	0.05	0.04
Intersection LOS	B											
Intersection V/C	0.699											

OPENING YEAR (2021) WITHOUT PROJECT

2539 East Garvey Avenue Project

Vistro File: C:\...\AME.vistro

Scenario 3 Opening Year (2021) Without Project AM Peak Hour

Report File: C:\...\AMOYWO.pdf

8/16/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	NB Thru	0.439	-	A

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	A
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.439

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	4	0	0	10	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	124	974	129	56	753	47	19	18	61	66	43	33
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	31	244	32	14	188	12	5	5	15	17	11	8
Total Analysis Volume [veh/h]	124	974	129	56	753	47	19	18	61	66	43	33
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.08	0.20	0.06	0.02	0.17	0.17	0.01	0.06	0.06	0.02	0.03	0.02
Intersection LOS	A											
Intersection V/C	0.439											

2539 East Garvey Avenue Project

Vistro File: C:\...\PME.vistro

Scenario 3 Opening Year (2021) Without Project PM Peak Hour

Report File: C:\...\PMOYWO.pdf

8/16/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	EB Thru	0.764	-	C

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	C
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.764

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	15	0	0	12	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	46	679	297	178	1080	46	381	42	140	36	78	64
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	12	170	74	45	270	12	95	11	35	9	20	16
Total Analysis Volume [veh/h]	46	679	297	178	1080	46	381	42	140	36	78	64
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.03	0.14	0.16	0.06	0.23	0.23	0.24	0.35	0.35	0.02	0.05	0.04
Intersection LOS	C											
Intersection V/C	0.764											

OPENING YEAR (2021) WITH PROJECT

2539 East Garvey Avenue Project

Vistro File: C:\...\AME.vistro

Scenario 4 Opening Year (2021) With Project AM Peak Hour

Report File: C:\...\AMOYW.pdf

8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	NB Thru	0.521	-	A

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	A
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.521

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	41	4	0	0	10	41	36	2	37	0	3	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	165	974	129	56	753	88	55	20	98	66	46	33
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	41	244	32	14	188	22	14	5	25	17	12	8
Total Analysis Volume [veh/h]	165	974	129	56	753	88	55	20	98	66	46	33
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.10	0.20	0.06	0.02	0.18	0.18	0.03	0.11	0.11	0.02	0.04	0.02
Intersection LOS	A											
Intersection V/C	0.521											

2539 East Garvey Avenue Project

Vistro File: C:\...\PME.vistro
Scenario 4 Opening Year (2021) With Project PM Peak Hour
Report File: C:\...\PMOYW.pdf
8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	EB Right	0.846	-	D

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	D
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.846

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	38	15	0	0	12	38	38	2	38	0	2	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	84	679	297	178	1080	84	419	44	178	36	80	64
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	21	170	74	45	270	21	105	11	45	9	20	16
Total Analysis Volume [veh/h]	84	679	297	178	1080	84	419	44	178	36	80	64
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.05	0.14	0.16	0.06	0.24	0.24	0.26	0.40	0.40	0.02	0.05	0.04
Intersection LOS	D											
Intersection V/C	0.846											

2539 East Garvey Avenue Project

Vistro File: C:\...\AME.vistro

Scenario 6 Opening Year (2021) With Project AM Peak Hour - With Improvements

Report File: C:\...\AMOYWI.pdf

8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	NB Thru	0.487	-	A

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	A
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.487

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	123	960	128	55	736	47	19	18	60	65	43	33
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	41	4	0	0	10	41	36	2	37	0	3	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	165	974	129	56	753	88	55	20	98	66	46	33
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	41	244	32	14	188	22	14	5	25	17	12	8
Total Analysis Volume [veh/h]	165	974	129	56	753	88	55	20	98	66	46	33
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.10	0.20	0.06	0.02	0.18	0.18	0.03	0.07	0.07	0.02	0.04	0.02
Intersection LOS	A											
Intersection V/C	0.487											

2539 East Garvey Avenue Project

Vistro File: C:\...\PME.vistro

Scenario 6 Opening Year (2021) With Project PM Peak Hour - With Improvements

Report File: C:\...\PMOYWI.pdf

8/17/2020

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Citrus St (NS) at Garvey Ave (EW)	Signalized	ICU 1	EB Left	0.707	-	C

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Citrus St (NS) at Garvey Ave (EW)

Control Type:	Signalized	Delay (sec / veh):	-
Analysis Method:	ICU 1	Level Of Service:	C
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.707

Intersection Setup

Name												
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Pocket Length [ft]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Speed [mph]	40.00			40.00			30.00			30.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name												
Base Volume Input [veh/h]	46	657	294	176	1057	46	377	42	139	36	77	63
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Growth Factor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	38	15	0	0	12	38	38	2	38	0	2	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	84	679	297	178	1080	84	419	44	178	36	80	64
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	21	170	74	45	270	21	105	11	45	9	20	16
Total Analysis Volume [veh/h]	84	679	297	178	1080	84	419	44	178	36	80	64
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Cycle Length [s]	100
Lost time [s]	10.00

Phasing & Timing

Control Type	Protecte	Permiss	Overlap	Protecte	Permiss	Permiss	Split	Split	Split	Split	Split	Overlap
Signal group	5	2	2	1	6	0	0	8	0	0	4	4
Auxiliary Signal Groups			2,4									4,6
Lead / Lag	Lead	-	-	Lead	-	-	-	-	-	-	-	-

Movement, Approach, & Intersection Results

V/C, Movement V/C Ratio	0.05	0.14	0.16	0.06	0.24	0.24	0.26	0.14	0.14	0.02	0.05	0.04
Intersection LOS	C											
Intersection V/C	0.707											

APPENDIX E

QUEUE WORKSHEETS

Queue Length Calculation
Based on Poisson Probability Distribution

Project Name:	2539 East Garvey Avenue Project
Project Number:	19275
Study Intersection:	Citrus Street at Garvey Avenue
Scenario:	Opening Year With Project - AM

	Major Street	Minor Street
Street Name:	Citrus Street	Garvey Avenue
Direction:	N-S	E-W
Movement:	EB	

Input

Cycle Length	100	sec
Volume	55	veh/ln/hr
Probability	0.95	
Queue length / car	25	feet

Output

Avg. Veh/Sec, λ =	0.0153	veh/ln/sec
Avg. Veh/Cycle, λ * T =	1.5278	veh/ln/cycle
Vehicles/Cycle at 0.95 probability	4	vehicle(s)
95th-Percentile Queue =	**100**	**feet**

Poisson Distribution Formula:

$$P(x) = \frac{(\lambda T)^x * e^{-\lambda T}}{x!}$$

Queue Length Calculation
Based on Poisson Probability Distribution

Project Name:	2539 East Garvey Avenue Project
Project Number:	19275
Study Intersection:	Citrus Street at Garvey Avenue
Scenario:	Opening Year With Project - AM

	Major Street	Minor Street
Street Name:	Citrus Street	Garvey Avenue
Direction:	N-S	E-W
Movement:	EB	

Input

Cycle Length	100	sec
Volume	419	veh/ln/hr
Probability	0.95	
Queue length / car	25	feet

Output

Avg. Veh/Sec, λ =	0.1164	veh/ln/sec
Avg. Veh/Cycle, λ * T =	11.6389	veh/ln/cycle
Vehicles/Cycle at 0.95 probability	16	vehicle(s)
95th-Percentile Queue =	**400**	**feet**

Poisson Distribution Formula:

$$P(x) = \frac{(\lambda T)^x * e^{-\lambda T}}{x!}$$

APPENDIX F

DRIVE-THRU QUEUE ANALYSIS

COUNTINGcars.com

Drive-Through Queue Generation

Mike Spack, PE, PTOE, Max Moreland, EIT, Lindsay de Leeuw, Nate Hood

1.0 Introduction

This report provides queuing data for businesses with drive-through services. It is intended to be an aid for site designers and reviewers, similar to the Institute of Transportation Engineers' *Trip Generation* and *Parking Generation* reports. The data presentation is modeled on the *Parking Generation* report and data is provided based on at least six sites, similar to data sets marked as statistically significant in *Trip Generation*.

Businesses with drive-through lanes are very common in the United States and having data that gives usage information for drive-through lanes will assist designers as well as cities in determining the appropriate amount of storage needed for proposed drive-through businesses. Data for drive-through queues was published by the ITE Technical Council Committee 5D-10 in 1995 based on information collected between the late 1960's and the 1990's. A paper was also published in 2009 by Mark Stuecheli, PTP giving updated information for bank and coffee shop drive-through lanes. The results from the 2009 study are incorporated into this paper (thank you Mark for your assistance).

2.0 Data Collection

Data was collected using COUNTcam video recording systems at a total of 30 drive-through locations in Minneapolis, MN and several surrounding suburbs between 2010 and 2012 (26 of the 30 videos were recorded in February of 2012, which should represent peak usage in the cold Minnesota winter). Videos of drive-through lanes were collected at banks, car washes, coffee shops, fast food restaurants and pharmacies. A total of six locations were selected for each of the five different land uses. Each location was recorded for between one and five days where the majority of locations were recorded for two consecutive days. The days of the week that each video was recorded on varies.

The 24-hour videos were watched at high speeds with the PC-TAS counting software and maximum queues throughout the day were noted. Most of the COUNTcams were set up such that the entire queue lane could be seen, but at a few locations the drive-through lanes wrapped around the building in a way that the entire queue length would not be able to be seen. For these situations, the COUNTcams were set up so that the ordering window and back of the queue could be seen and it was noted how many vehicles could fit between the ordering window and the front of the queue. For drive-through locations with multiple lanes, the number of lanes was noted but the maximum queue is defined as the sum of the queues at each lane for any given point in time, not the queue per lane. This approach provides overall demand, which may assist designers in determining how many drive through lanes are appropriate in addition to determining how long they should be.

Once the maximum queue for each day at each location was determined, the data was compiled and statistics for each land use were calculated. The average maximum queue, standard deviation, coefficient of variation, range, 85th percentile and 33rd percentile were calculated for each land use.

Data for drive-through coffee shops and banks from the Kansas City, Kansas metropolitan area was published in the 2009 paper New Drive-Through Stacking Information for Banks and Coffee Shops by Mark Stuecheli. This data is included in the analysis.

3.0 Data Analysis

Based on the peak queue lengths, it is apparent that each land use will require a different minimum drive through stacking distance. The results for each land use can be found below. The peak queue lengths for each location, broken down by land use and day of the week, can be found in the Appendix.

3.1 Banks

Data collection was done at six banks with drive-through services (including one credit union) in August 2011 and February 2012. Twelve days of data were collected. The banks were located in the cities of Minneapolis, Robbinsdale and St. Louis Park, MN.

All of the locations had a lane with a drive-through ATM and at least two other lanes. Though service times may differ for ATM lanes compared to the regular lanes, the maximum queues were counted together. This is because based upon what was observed, vehicles would occasionally switch the lane they were in. For example, a vehicle waiting in the ATM line with a queue of three vehicles may move over to a regular line with a queue of only one vehicle. Much of what can be done at the bank's drive-through lane can also be accomplished at that bank's ATM and vice versa. Vehicles being served were counted as being in the queue.

Nine days of data from the Kansas City, Kansas area is also included. This data does not factor in vehicles in ATM lanes.

Table 3.1 – Drive-Through Bank Maximum Queue Statistics

	Minnesota Data	Minnesota + Kansas Data
Number of Data Points	12	21
Average Maximum Queue (Vehicles)	5.83	5.76
Standard Deviation (Vehicles)	1.85	2.21
Coefficient of Variation	32%	38%
Range (Vehicles)	3 to 8	1 to 10
85th Percentile (Vehicles)	8.00	8.00
33rd Percentile (Vehicles)	5.00	5.00

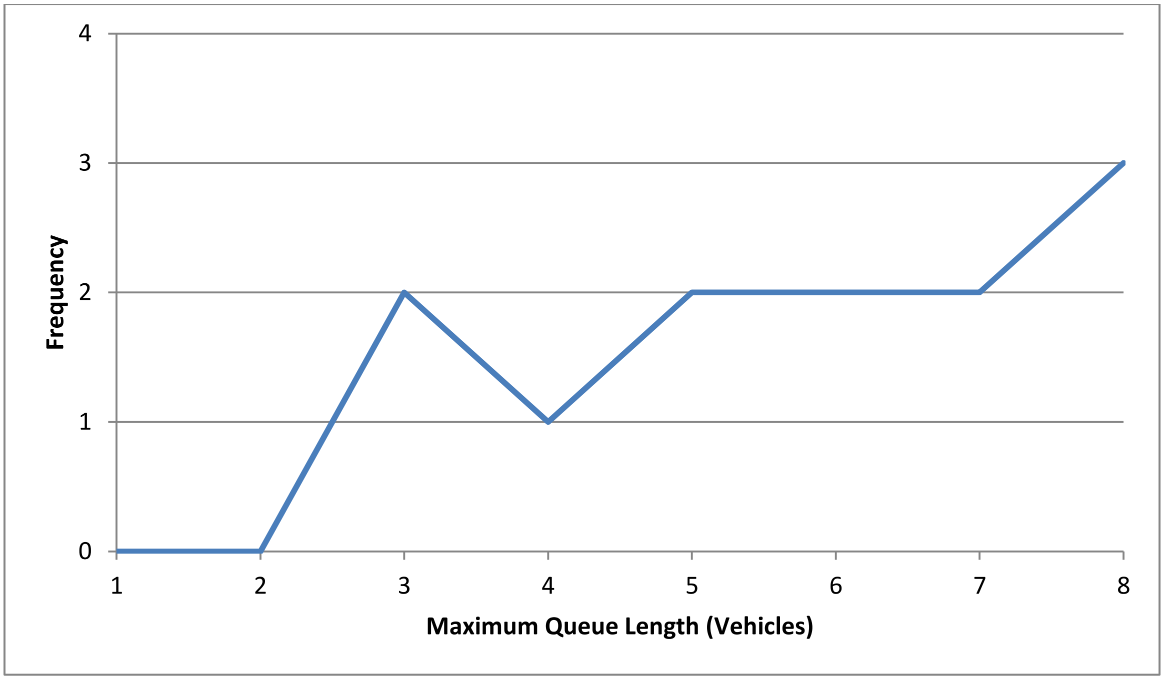


Figure 3.1.1 – Drive-Through Bank Maximum Queue Frequency – Minnesota Data

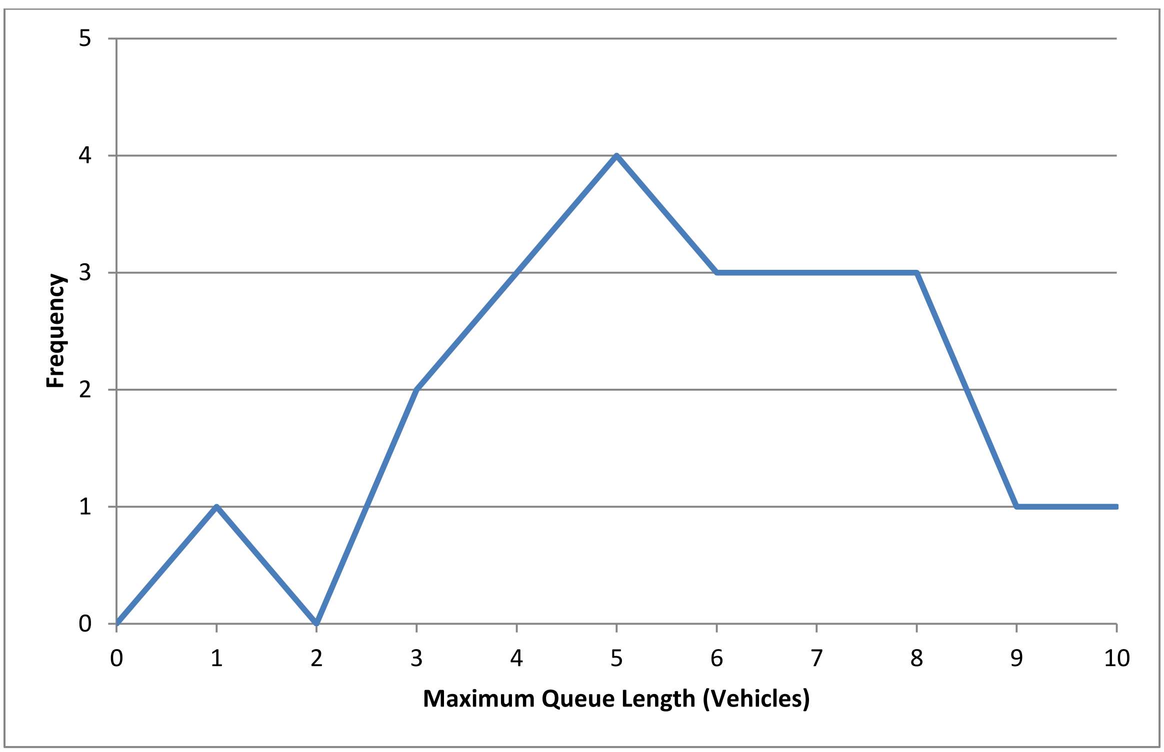


Figure 3.1.2 – Drive-Through Bank Maximum Queue Frequency – Minnesota + Kansas Data

The data for Kansas banks was collected between 4:30pm and 6:00pm. While many of the maximum queues for the data collected in Minnesota were between these times, maximum queues occurred between 8:30am and 5:30pm so it is possible that some of the Kansas data does not capture the actual maximum queues for the day.

The number of available lanes at banks, not including the ATM lane, ranged from two to seven lanes (though the most open at one time was five lanes). Even though plenty of lanes were available, cars often stacked at the lane closest to the building, thus additional lanes may not result in shorter queues. With an 85th percentile maximum queue of eight vehicles, the data suggests that banks with drive-through lanes should be able to accommodate 160 feet of vehicle stacking.

3.2 Car Washes

Data collection was done at six car washes with drive-through services (including one full-service car wash) in February 2012. Twelve days of data were collected. The car washes were located in the cities of Falcon Heights, Hopkins, Minneapolis, Roseville and St. Louis Park, MN. Five of the six car washes (excluding the full-service car wash) were located at gas stations. Only the vehicles waiting in line were counted; vehicles being washed were not added to the queue.

Table 3.2 – Drive-Through Car Wash Maximum Queue Statistics

Number of Data Points	**12**
Average Maximum Queue (Vehicles)	**4.42**
Standard Deviation (Vehicles)	**2.31**
Coefficient of Variation	**52%**
Range (Vehicles)	**1 to 10**
85th Percentile (Vehicles)	**6.20**
33rd Percentile (Vehicles)	**3.00**

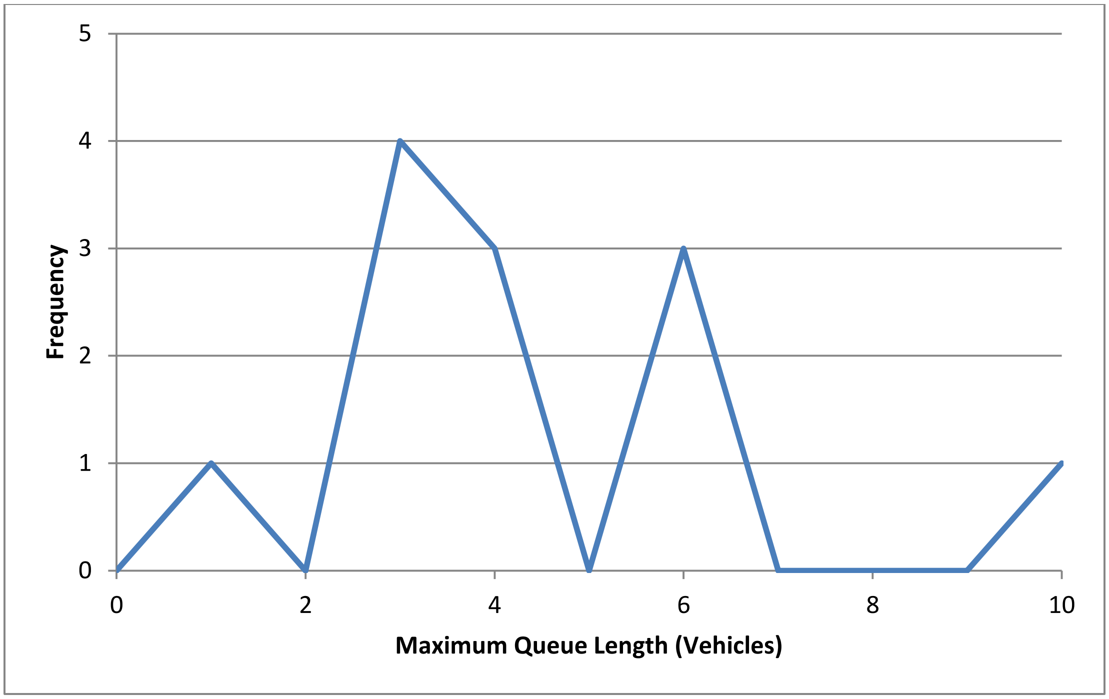


Figure 3.2 – Drive-Through Car Wash Maximum Queue Frequency

Two of the car washes had two lanes while the other four were one lane car washes. The full-service car wash had two lanes and also produced the highest maximum queue of 10 vehicles. The maximum queues for car washes were spread throughout the afternoon from 12:30pm to 8:30pm. With an 85th percentile maximum queue of more than six vehicles, the data suggests that car washes with drive-through lanes should be able to accommodate 140 feet of vehicle stacking throughout the day.

3.3 Coffee Shops

Data collection was done at six coffee shops with drive-through services in November 2010, August 2011 and February 2012. Fourteen days of data were collected. The coffee shops were located in the cities of Edina, Hopkins, Minneapolis, Roseville and St. Louis Park, MN. Vehicles being served were counted as being in the queue. Twelve days of data from the Kansas City, Kansas area is also included.

Table 3.3 – Drive-Through Coffee Shop Maximum Queue Statistics

	Minnesota Data	Minnesota + Kansas Data
Number of Data Points	14	26
Average Maximum Queue (Vehicles)	11.00	10.23
Standard Deviation (Vehicles)	2.25	2.76
Coefficient of Variation	20%	27%
Range (Vehicles)	7 to 16	3 to 16
85th Percentile (Vehicles)	13.50	13.00
33rd Percentile (Vehicles)	10.00	9.91

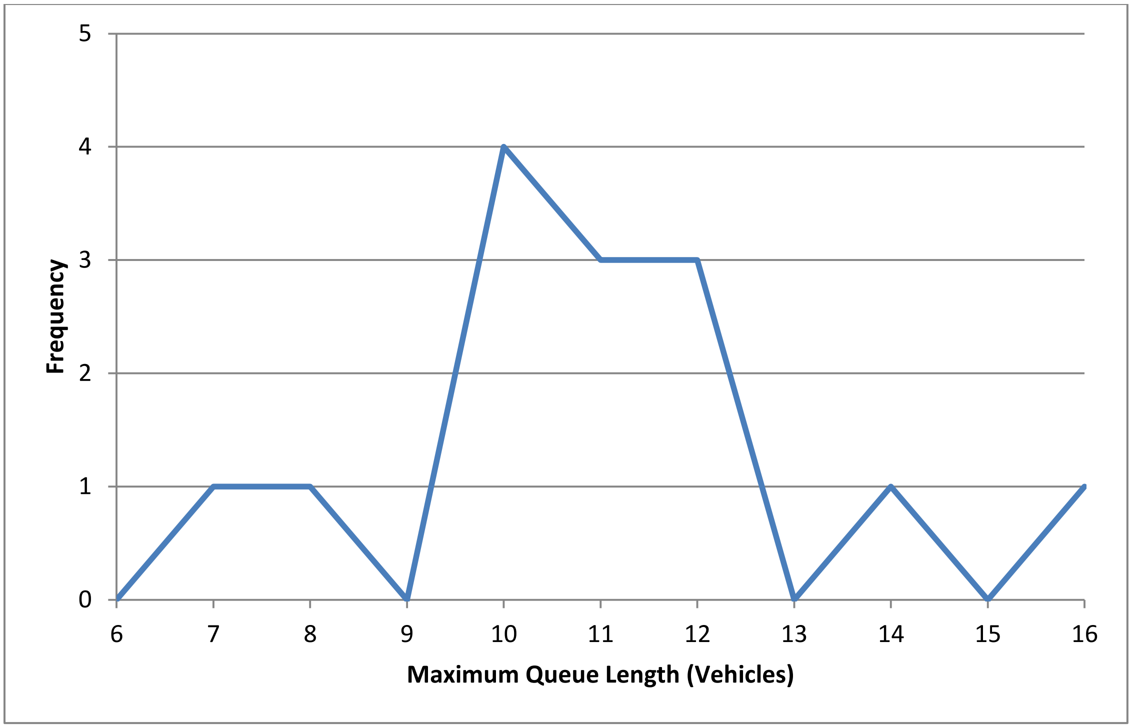


Figure 3.3.1 – Drive-Through Coffee Shop Maximum Queue Frequency – Minnesota Data

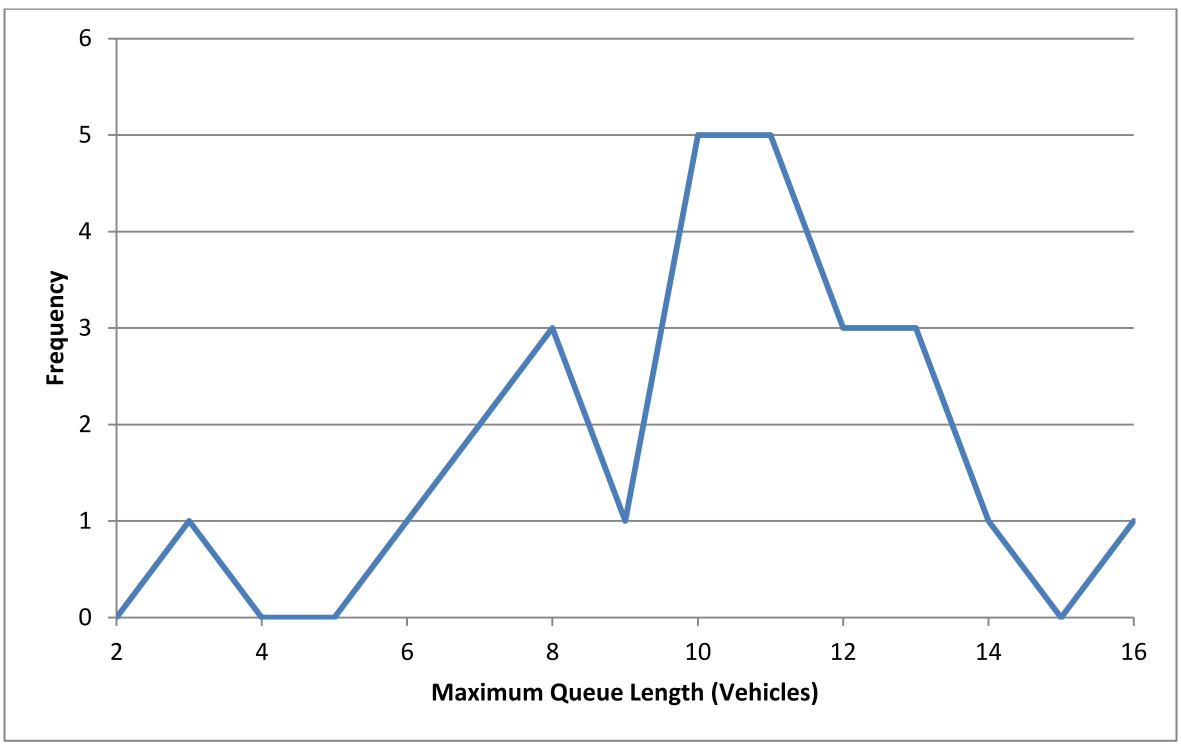


Figure 3.3.2 – Drive-Through Coffee Shop Maximum Queue Frequency – MN + KS Data

Coffee shops produced the longest maximum queues of any of the land uses in this study with all of the maximum queues occurring in the morning. In four of the six cases, the queues spilled out of the parking lot and into the street. These spillovers would typically only happen once or twice a day and last only a few minutes, however, one location had stacking into the street for about 15 minutes in addition to multiple periods of several minutes where cars would queue in the street.

With an 85th percentile maximum queue of 13 vehicles, the data suggests that coffee shops with drive-through lanes should be able to accommodate at least 260 feet of vehicle stacking during morning hours.

3.4 Fast Food Restaurants

Data collection was done at six fast food restaurants with drive-through services in August 2011 and February 2012. Fourteen days of data were collected. The restaurants were located in the cities of Golden Valley, Hopkins, Minneapolis and St. Louis Park, MN. Vehicles being served were counted as being in the queue.

Table 3.4 – Drive-Through Fast Food Restaurant Maximum Queue Statistics

Number of Data Points	**14**
Average Maximum Queue (Vehicles)	**8.50**
Standard Deviation (Vehicles)	**2.68**
Coefficient of Variation	**32%**
Range (Vehicles)	**5-13**
85th Percentile (Vehicles)	**12.00**
33rd Percentile (Vehicles)	**7.90**

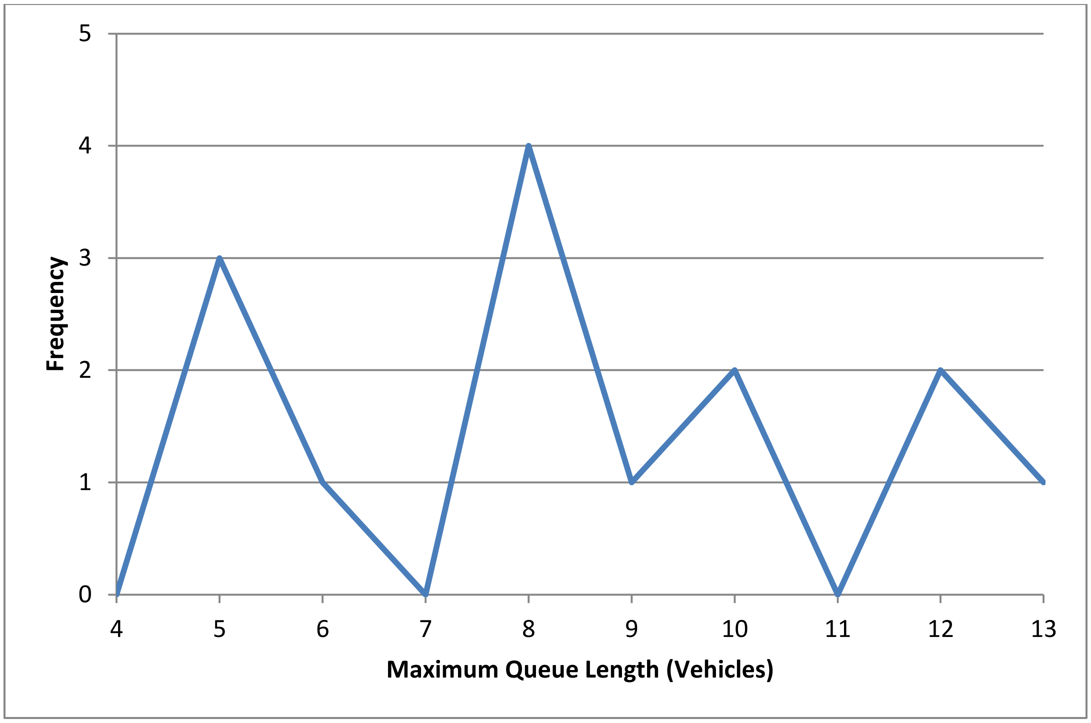


Figure 3.4 – Drive-Through Fast Food Restaurant Maximum Queue Frequency

The maximum queues for fast food restaurants were spread throughout the day from 8:00am to 10:00pm. With an 85th percentile maximum queue of 12 vehicles, the data suggests that fast food restaurants with drive-through lanes should be able to accommodate 240 feet of vehicle stacking throughout the day.

3.5 Pharmacies

Data collection was done at six pharmacies with drive-through services in February 2012. Twelve days of data were collected. The pharmacies were located in the cities of Hopkins, Minneapolis, New Hope and Robbinsdale, MN. Vehicles being served were counted as being in the queue.

Table 3.5 – Drive-Through Pharmacy Maximum Queue Statistics

Number of Data Points	**12**
Average Maximum Queue (Vehicles)	**2.92**
Standard Deviation (Vehicles)	**1.16**
Coefficient of Variation	**40%**
Range (Vehicles)	**1-5**
85th Percentile (Vehicles)	**4.05**
33rd Percentile (Vehicles)	**2.00**

Figure 3.5 – Drive-Through Pharmacy Maximum Queue Frequency

The maximum queues for pharmacies were spread throughout the day from 8:00am to 10:00pm. With an 85th percentile maximum queue of more than 4 vehicles, the data suggests that pharmacies with drive-through lanes should be able to accommodate 100 feet of vehicle stacking throughout the day.

4.0 Conclusions

The 85th percentile maximum queue lengths for each land use are: 160 feet for banks (eight vehicles), 140 feet for car washes (seven vehicles), 260 feet for coffee shops (13 vehicles), 240 feet for fast food restaurants (12 vehicles) and 100 feet for pharmacies (five vehicles).

While some of the locations observed have an excess of space dedicated to drive-through lanes (i.e. some banks and pharmacies), others could occasionally use additional space for drive-through lanes (i.e. coffee shops in the morning).

Fast food restaurants and coffee shops have the longest maximum queues of the five land uses observed. Coffee shops have a tendency for the morning queues to build so long that they spill out onto the street, though, as is expected, their afternoon and evening queues are minimal. Fast food restaurants also have large queues, but they tended to have enough dedicated space that stacking did not go beyond the designated queuing area.

The data collected for this paper along with the data from the papers by Mark Stuecheli and the ITE Technical Committee 5D-10 (see Appendix for both of these) will hopefully provide useful data for traffic engineers and others trying to analyze drive-through queuing storage areas.

5.0 Labor Savings of the COUNTkit

Deploying people in the field to perform this data collection would not have been feasible. Using the COUNTcam video system made it possible to observe the drive through lanes 24 hours a day and the PC-TAS software made the data reduction practical. One location was recorded in November 2010 for 6 hours, three locations were recorded in August 2011 for a total of 202 hours and 26 locations were recorded in February 2012 for a total of 1012 hours. These 1220 hours of video were counted with a total of 120 hours of labor, meaning the videos were watched at approximately 10x speed. Installation of a COUNTcam takes approximately 10 minutes and retrieval takes approximately 5 minutes. This whole project was completed in approximately 3 weeks.

6.0 References

1. Stuecheli, M. (2009). New Drive-Through Stacking Information for Banks and Coffee Shops. *ITE 2009 Annual Meeting and Exhibit.* Print.
2. ITE Technical Committee 5D-10. "Queuing Areas for Drive-Thru Facilities." *ITE Journal* (May 1995): 38-42. Print.
3. Institute of Transportation Engineers. *Parking Generation.* 4th ed. Washington, DC: Institute of Transportation Engineers, 2010. Print.
4. Institute of Transportation Engineers. *Trip Generation.* 8th ed. Washington, DC: Institute of Transportation Engineers, 2008. Print.

7.0 Appendix

A – Day of Week Maximum Queues
B – New Drive-Through Stacking Information for Banks and Coffee Shops
C – ITE Technical Committee 5D-10: Queuing Areas for Drive-Thru Facilities
D – Drive-Through Data Forms

Appendix A

Day of Week Maximum Queues

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Fast Food	Arby's				5	5		
	Burger King	6	12				10	8
	McDonald's				12	13		
	McDonald's				9	8		
	Taco Bell				10	8		
	White Castle				8	5		
Car Wash	BP				6	6		
	BP			1	3			
	BP			4	3			
	Holiday				3	4		
	Mister Car Wash				10	6		
	Mobil				4	3		
Coffee	Caribou				11	10		
	Caribou	7	10	12			12	8
	Starbucks				14	16		
	Starbucks				10	11		
	Starbucks			10	12			
	Starbucks				11			
Bank	Citizens Independent Bank			5	5			
	SharePoint Credit Union				3	3		
	TCF	4					8	8
	US Bank				7	7		
	Wells Fargo			8	6			
	Wells Fargo			6				
Pharmacy	CVS			1	2			
	CVS			4	4			
	CVS			2	2			
	Walgreens				4	5		
	Walgreens			3	3			
	Walgreens			3	2			

Appendix B

New Drive-Through Stacking Information for Banks and Coffee Shops

Mark Stuecheli, PTP

Abstract

This paper provides updated queuing information for drive-in banks and new queuing data for coffee shops with drive-through lanes. The data is presented in a format similar to that used in the report for **ITE Technical Council Committee 5D-10**, originally published in 1995.

Significant changes have occurred in the way that bank patrons conduct business with their banks. In recognition of those changes, ITE has adjusted the trip generation information included in the Eighth Edition of **Trip Generation, an ITE Informational Report** to include only data collected since 2000, and the revised trip generation totals are significantly lower than in previous editions. Clearly, the reduced trip generation figures indicate a reduction in bank drive-through business. This report summarizes queuing information included in counts taken in the Kansas City metropolitan area.

In the last few years coffee shops with drive-through lanes have become prevalent throughout the country. Because those businesses were uncommon when the 1995 report was prepared, no data was gathered for those operations. This paper contains information on counts taken at those establishments, once again in the Kansas City metropolitan area.

Based on the count data, recommendations are included for the minimum amount of stacking distance to require for the two types of drive-through businesses that were studied.

Background

ITE Technical Council Committee 5D-10 was formed in 1987 to produce a database of queuing information for various types of drive-through lanes. The report of the findings of the Committee, published in the May 1995 **ITE Journal**, included information on the characteristics of drive-through lane stacking for fast-food restaurants, drive-in banks, car washes, day care centers and dry cleaners. The counts that were included in the Committee report were conducted from the late 1960s through the late 1980s in a limited number of mid-western, southern and eastern states.

As a former member of that Committee, and having submitted drive-through counts for the effort, I am in a position to make some observations about the change in drive-through usage.

Appendix B

This paper analyzes two types of drive-through operations – one that is greatly modified and another that is new since the original report was published. First, significant changes have occurred in the ways that bank patrons conduct business with their financial institutions. On-line banking, direct deposit and the wide usage of ATMs have resulted in greatly reduced trip generation totals for drive-in banks. In recognition of that fact, ITE adjusted the trip generation information for drive-in banks in the Eighth Edition of **Trip Generation, an ITE Informational Report,** to include only data collected since 2000. The trip generation rates during the p.m. peak hour for the newer data are about 44% lower than rates in the Seventh Edition.

The amount of stacking provided for bank drive-through lanes often has a critical impact on the potential site design alternatives for proposed bank properties. If the information included in the 1995 Report were to be used as the basis for establishing stacking requirements, a large area would need to be allocated to the drive-through lanes. On tight sites, that limitation could preclude developing an acceptable layout.

Clearly, the major drop in trip generation rates indicates that fewer customers are using drive-through lanes. That reduction in drive-through usage has an impact on queue lengths and other operational characteristics observed at those facilities. This paper includes updated information on queuing in bank drive-through lanes based on counts taken in the City of Overland Park, Kansas, a suburban community of 171,000 residents in the Kansas City metropolitan area.

The second area of analysis in this paper pertains to observed queuing characteristics for coffee shops with drive-through lanes. In the last few years, drive-through coffee shops have become common throughout the country. Because those businesses were an insignificant factor when the report for **ITE Technical Council Committee 5D-10** was completed, no counts were conducted for that land use category. This paper contains data on queuing for coffee shops with drive-through lanes, based on counts conducted predominantly in the Kansas suburbs of the Kansas City metropolitan area.

As is the case for drive-in banks, the length of stacking required for a site has a major impact on potential site layouts. If a relatively short stacking distance is permitted, the lanes can be fit into very restricted sites or be more easily retrofitted to work with existing buildings. But if more queuing occurs than is provided for in a dedicated lane, the flow of traffic within a parking lot can be seriously restricted by that excess queue. In the worst case, if the drive-through stacking is located close to a public street and the excess queue extends into or near the street, the operation of the adjoining public street may be negatively impacted.

Appendix B

Drive-In Banks

Counts were conducted at ten suburban drive-in banks located throughout Overland Park in the fall of 2008 and the spring of 2009. Both established locations and sites that were relatively new were counted, although all banks had been open for business for at least one year. All but one location had drive-through ATMs. Based on the results of counts taken at a single bank location during a mid-week lunch hour, a mid-week p.m. peak hour, a Friday lunch hour, and a Friday p.m. peak hour; the maximum queue lengths occurred during the Friday p.m. peak hour. Therefore, all counts used in the study were conducted during the Friday p.m. peak hour time period.

The counting process involved noting the maximum per lane and total queues for the drive-through lanes at each location in fifteen minute increments, along with collecting information on the stacking of any drive-through ATM. In all cases the vehicles in the service positions were included in the counts. Where possible, the volumes of vehicles entering and exiting the parking lot also were tabulated. As a way to evaluate the frequency of various maximum queue lengths, the total queue lengths were noted at five minute intervals.

The queuing data was analyzed in ways similar to the methods used in the 1995 Report. Table 1 lists the observed frequency of maximum queue lengths per lane. Figure 1 plots the per lane maximum queue lengths using both the 2009 data and the data that was presented in 1995 (please note that the 1995 data involved fifteen counts, compared to the ten counts in the 2009 data). Figure 2 plots the probability that the queue lengths per lane will not exceed a given maximum queue length, once again presenting both 2009 and 1995 data.

Table 1 – Drive-In Bank 2009 Maximum Queue Length Per Lane

Queue Length	Frequency	Cumulative Frequency	P(q≤N)
0	0	0	0.00
1	1	1	.10
2	4	5	.50
3	4	9	.90
4	1	10	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length of “q” not exceeding length “N”

Appendix B

Figure 1 – Drive-In Bank 1995 And 2009 Maximum Queue Length Per Lane Data Plot

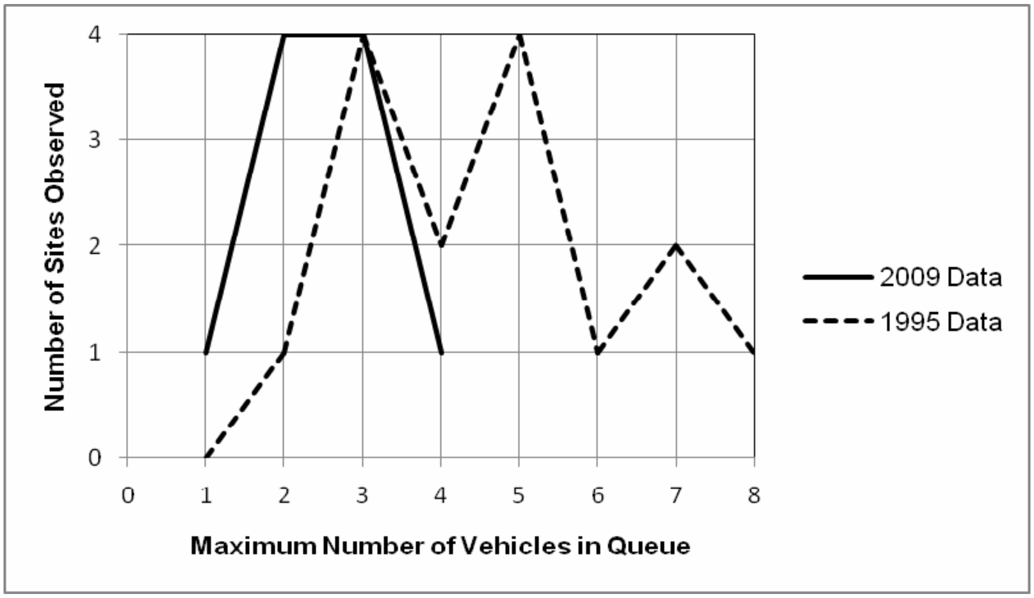
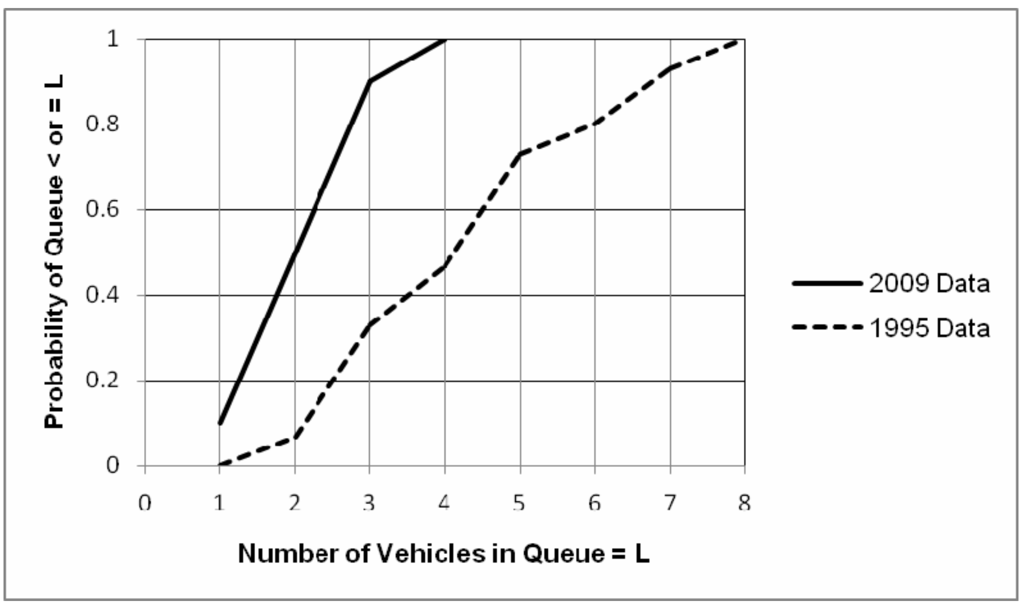


Figure 2 – Drive-In Bank 1995 And 2009 Cumulative Maximum Queue Length Per Lane Data Plot



The differences between the 1995 Report data (as noted earlier, actually based on counts conducted from the late 1960s to the late 1980s) and the 2009 counts are dramatic. The maximum per-lane queue lengths in the current counts were half what they were in the 1995 data.

An attempt was made to determine if such factors as adjoining major street traffic volumes or the size of the building could predict the queuing results, but no correlation was found.

Observations

Some banks, especially those that have been in operation for several years, have a surplus of drive-through lanes and stacking area. That is because those sites were designed to accommodate the much higher demands that existed many years ago. Consequently, they often open only a portion of the available lanes.

In one case, for a main office bank location where it was possible to make a direct comparison between a count conducted in 1988 and a new count in 2008 (actually taken almost precisely 20 years apart), the difference was dramatic. The p.m. peak hour drive-through volumes for the 2008 count were 65% lower than the 1988 count, a much greater drop than would have been indicated by the reduced ITE trip generation figures discussed earlier. The maximum total number of vehicles queued and the maximum queue lengths per lane were correspondingly lower, dropping from 29 to 8 and 7 to 3, respectively. The demographics and development characteristics of the surrounding area have changed little since 1988 and the bank has continued as a stable operation. Considering all of those factors, it is reasonable to assume that the differences are associated with changes in customers' banking habits.

The one incidence of a four car per lane maximum stack was a single occurrence that lasted for only a few minutes. Based on that information, it is reasonable to consider the practical maximum required queue length to be three vehicles.

The maximum queue lengths for ATMS ranged from two to five vehicles. Only one location experienced the longer queue lengths and only for a short time period. All other locations had maximum queue lengths of three vehicles or less.

Coffee Shops With Drive-Through Lanes

Counts were conducted in the fall of 2008 and the spring of 2009 at twelve coffee shops located in the Kansas suburbs of Merriam, Olathe and Overland Park in the Kansas City metropolitan area and also in suburban Kansas City, Missouri. All but two of the establishments were situated in free-standing buildings, and several were located within shopping centers. Three were drive-through-only operations and the remaining nine were full-service locations that included both drive-through lanes and inside seating facilities. Because this type of use is busiest in the morning peak hour, all counts were completed during that time period.

Similar to the process used for drive-in banks, the counting process involved noting the maximum number of vehicles queued in the drive-through lane at each location for fifteen minute increments. As was done for the drive-in bank counts, the vehicle in the service position was included in the counts. Information on the number of vehicles entering and leaving the parking lot was collected for full-service operations (drive-through-only locations did not have any parking activity). The queuing information was tabulated for both the total length of queue and for the number of vehicles behind the menu board. The observed queue length was noted at five minute intervals as a way to evaluate the frequency of various queue lengths.

Once again, the queuing data was analyzed in ways similar to the methods used in the 1995 Report. Table 2 lists the observed frequency of maximum queue lengths. Figure 3 plots the per-lane maximum queue lengths and Figure 4 plots the probability that the queue will not exceed a given maximum queue length.

Table 2 – Coffee Shop With Drive-Through Maximum Queue Length

Queue Length	Frequency	Cumulative Frequency	P(q≤N)
0	0	0	0.00
1	0	0	0.00
2	0	0	0.00
3	1	1	.08
4	0	1	.08
5	0	1	.08
6	1	2	.17
7	1	3	.25
8	2	5	.42
9	1	6	.50
10	1	7	.58
11	2	9	.75
12	0	9	.75
13	3	12	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length of "q" not exceeding length "N"

Appendix B

Figure 3 – Coffee Shop With Drive-Through Maximum Queue Length Data Plot

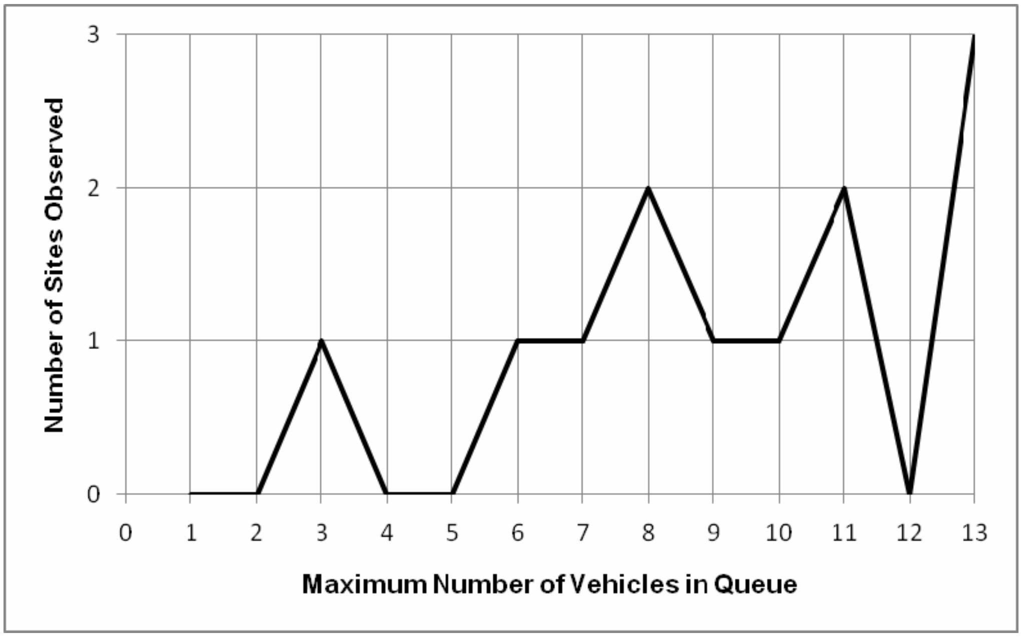
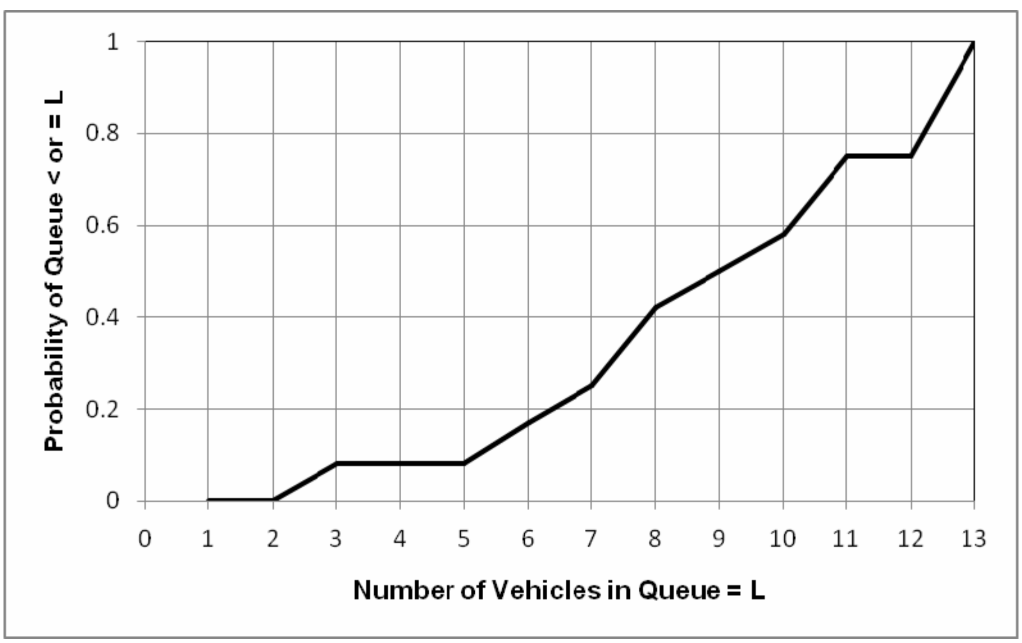


Figure 4 – Coffee Shop With Drive-Through Cumulative Maximum Queue Length Data Plot



Appendix B

The total trip generation figures were compared to the a.m. peak hour ITE rates for Land Use Code 937, Coffee/Donut Shop with Drive-Through Window, and Land Use Code 938, Coffee/Donut Shop with Drive-Through Window and No Indoor Seating. The observed counts generally fell within the range of counts included in those categories, although two of the rates for the No Indoor Seating category exceeded the published range. No correlation was found between the adjoining major street traffic volumes or the size of the building and either the queuing or the trip generation results.

Observations

Several of the drive-through lanes were under-designed for the usage that was observed and queues spilled-out into parking lot circulation areas. In most cases the excess stacking did not result in disruptions of the operations of surrounding uses, since most other businesses were not open in the early morning. But for those sites where the end of the drive-through lane extended into the coffee shop parking lot, the excess queue often disrupted the movements of drivers who were trying to enter or exit parking spaces or the site itself.

One interesting facet of the data is that the three lowest observed maximum queue lengths were for the drive-through-only locations. The highest observed queue length for those operations was seven vehicles, which occurred only once at one location and only for a very short period of time. A six vehicle maximum stack was a more common occurrence.

The data shows that the volume of drive-through traffic and, therefore, the required stacking distance, is higher for full-service coffee shops than for drive-through-only operations. When total trip generation (both drive-through business and customers who park and walk in) is factored in, the full-service coffee shops did, on average, about two and one-half times the business of drive-through-only facilities. Since all of the full-service operations were Starbucks locations, it may be possible to apply the results of those counts to other proposed suburban Starbucks locations elsewhere in the country.

Total vehicular stacking available for a drive-through lane is an important consideration, but the location of the menu board relative to the pick-up window also impacts the efficiency of a drive-through lane operation. If the spacing is too short, stacking behind the pick-up window will extend into the menu board area, delaying ordering for those farther back in the line. In the counts conducted for this study, the pick-up window to menu board available stacking distances ranged from two to five vehicles.

The operation with the two car stack between the pick-up window and menu board regularly resulted in delays for drivers waiting to order at the menu board. The location with a five car stack rarely experienced delays for those ordering. Based on field observations, if an unlimited amount of stacking were available at a proposed site, the five car spacing would be ideal. Realizing that space for stacking nearly always is limited, an acceptable alternative would be the four car spacing.

Conclusions

Drive-in bank usage has dropped dramatically, as illustrated in the data provided in this report. Consequently, a reduced amount of stacking is required. That reduced area for drive-through stacking can provide more flexibility in the design of bank sites, allowing for development on smaller sites or the provision of increased landscaped areas.

Based on the data that was gathered, the City of Overland Park has reduced its previous requirement for a minimum five car stack per lane to a three car stack (a distance of 60 feet per lane, assuming average vehicle spacing to be 20 feet). That design should be sufficient to accommodate virtually all situations. Vehicular stacking requirements for ATMs have been established, also at a minimum of three car lengths.

Coffee shop drive-through lanes are most heavily used during the morning peak period, and therefore it is important to design sites to accommodate that peak demand. The following recommended minimum stacking lengths should be appropriate in most cases. The only exceptions would be situations in which excess queuing could impact a nearby street or major drive, in which case a more conservative approach should be taken.

Based on the data that was gathered for drive-through-only operations, it appears reasonable to require that a dedicated drive-through lane be provided with a stack of 120 feet – enough to handle six vehicles. That should be sufficient to accommodate nearly all vehicles that are likely to arrive during the morning peak hour time period.

For full service establishments, a 220-foot long drive-through lane, providing eleven cars of total storage, should be adequate to handle the vast majority of the drive-through lane volumes that might be encountered. In those cases where more than eleven vehicles were counted, the duration of the extreme queue lasted for only a few minutes. For the most efficient operation, the distance between the pick-up window and menu board should be at least 80 feet to accommodate four vehicles.

References

1. Gattis, J. L., Chair of ITE Technical Council Committee 5D-10. “Queuing Areas for Drive-Thru Facilities, by ITE Technical Council Committee 5D-10.” *ITE Journal* (May 1995): 38-42.

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Queuing Areas For Drive-Thru Facilities

BY ITE TECHNICAL COUNCIL COMMITTEE 5D-10

ITE Technical Council Committee 5D-10 was formed to collect and analyze basic information that may be used to estimate and evaluate lengths of automobile queues at drive-thru facilities. In addition to fulfilling this objective, this Informational Report constitutes a starting point for compiling a database for drive-thru facility queue length information.

Introduction

When faced with the need to evaluate the future impacts of a planned development, the transportation engineer often employs some form of analogy, estimating the future impacts of as-yet unbuilt development by using the attributes of existing land uses having a similar nature. For instance, the engineer may refer to published trip generation rates, derived from observations made at existing developments, to obtain a figure by which to estimate volumes that will occur at the proposed development.

J. L. Gattis, P.E., was Chair of Technical Council Committee 5D-10. He is an Assistant Professor in the Department of Civil Engineering at the University of Arkansas in Fayetteville, Ark. He is a Member of ITE.

Many types of businesses (such as fast-food restaurants, banks and cleaners) utilize drive-thru systems. A similar form of drive-thru operation can be found at sites where passenger pick-up operations occur (such as parents picking up schoolchildren). These drive-thru systems are comprised of a server position (often at a service "window"), and vehicle queuing space in advance

QUEUING DATA SHEET

1.	Type of Service Provided	______			
2.	Day(s) of Week	Sun Mon Tue Wed Thu Fri Sat			
3.	Time(s) of Day	______			
4.	Type of Area	CBD ☐	Surburban ☐	Rural ☐	
5.	Competition in Area (For Same Services)	High ☐	Medium ☐	Low ☐	
6.	Service Rate Measured (Per Window or Aisle or Lane)	______	Vehicles/Time		
7.	Arrival Rate Measured (Per Window or Aisle or Lane)	Avg ____	Max ____	Vehicles/Time	
8.	Uniformity Rating	______	(1 - 10)		
9.	Capacity of Queue Storage Area	______	(Vehicles)		
10.	Measured Average Queue	______	(Vehicles)		
11.	Measured Maximum Queue	______	(Vehicles)		
12.	Excess Demand Volume	______	(Vehicles)		
13.	Excess Demand Frequency	______			
14.	Size Sample or Length of Count Data	______			
15.	Narrative Description of Service	______			

Figure 1. Data gathering form used in survey.

of the service position, for waiting in line as those ahead are served first.

When attempting to project lengths of automobile queues at proposed drive-thru facilities, the municipal or private consulting engineers may not find available data by which a projection can be made. While such data may be known by larger business chains that have drive-thru operations, the data do not seem to be generally available to the average traffic engineer trying to size or evaluate automobile queue storage area. True, some publications present results of queuing studies or equations for estimating queue lengths based on known system arrival and service rates.[1-9] But the proposed-site arrival and service rates may be unknown, and the proposed system may not possess attributes (such as negative exponential service time rates) needed for certain equations to properly predict queue lengths.

Drive-thru facilities are perceived as time-savers; as a convenience to the physically challenged, elderly and parents with young children; and as a way to avoid going out into inclement weather. Due to vehicle idling while in line, drive-thru facilities may also be viewed as causing unnecessary fuel consumption and air pollution. The popularity of drive-thru services creates a need to evaluate the queuing capacities of the varied drive-thru facilities. This report provides some basic drive-thru facility queue length information. It is hoped that the database will continue to grow, so that a comprehensive analytical tool may be available for the transportation professional.

Methods

The queue length data gathering form shown in Figure 1 was distributed to committee members in November 1987. The form was accompanied by specific user-instructions to ensure uniformity of procedures and compatibility of results.

Completed forms were returned to the committee chair and data were cataloged by land-use type. The maximum observed queue lengths and the maximum observed queue length frequencies were compiled. Cumulative frequencies and the probability that queues would not exceed an absolute maximum were calculated and shown graphically.

Table 1. Ranges of Fast Food Queue Lengths by Food Type

Food Type	*Maximum Queue Range (# in system)*	*Average Maximum Queue (# in system)*	*Studies*
Donuts	4	4	2
Steak	4	4	2
Chicken	2–9	5	5
Fish	5	5	1
Sandwiches	5	5	1
Mexican	7	7	1
Roast Beef	6–8	7	2
Hamburgers	4–13	7	27

Table 2. Fast Food Queue Lengths

Maximum Queue Length (# in system)	*Frequency*	*Cumulative Frequency*	*P(q≤N)*
1	0	0	0.00
2	2	2	0.05
3	0	2	0.05
4	6	8	0.18
5	4	12	0.27
6	7	19	0.43
7	10	29	0.66
8	7	36	0.82
9	5	41	0.93
10	1	42	0.95
11	0	42	0.95
12	1	43	0.98
13	1	44	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length "q" not exceeding length "N".

Findings

Within this report, data have been compiled for banks, car washes, day care facilities, dry cleaners and fast-food restaurants.

Fast Food

This category includes restaurants characterized by food being prepared in advance of, or shortly after, ordering; by high turnover for eat-in customers; and by long business hours. The ITE land-use codes (LUCs) for this use are LUC 834 (*Trip Generation*, 1991) and 836 (*Parking Generation*, 1987).

Forty-four fast-food restaurants were observed for this study. They ranged from those serving chicken to the hamburger chains. All sites were suburban locations. Queuing was observed mainly during the weekday mid-day peak from the 1970s through the 1990s, at sites in Florida, Kansas, Illinois, Minnesota, Montana, New Jersey, Oklahoma, Pennsylvania and Texas. All fast-food facilities observed for this study had a single-window drive-thru system. The industry is changing, with double- and even triple-window systems being utilized. Further information will be needed on queuing characteristics of these facilities.

The average observed service rate was 54 vehicles per hour (vph); the maximum rate was 108 vph. The maximum observed queue lengths (number of vehicles in line, including vehicle at service position) ranged from two to 13 vehicles (see Table 1). Where there was a menu-order board followed by a service window, the combined total of vehicles in both sequential lines was reported.

The restaurants featuring hamburgers had maximum queues in the upper part of the range. Table 2 shows the frequencies of the observed maximum queue lengths, as well as a probability of a queue of less than a given number

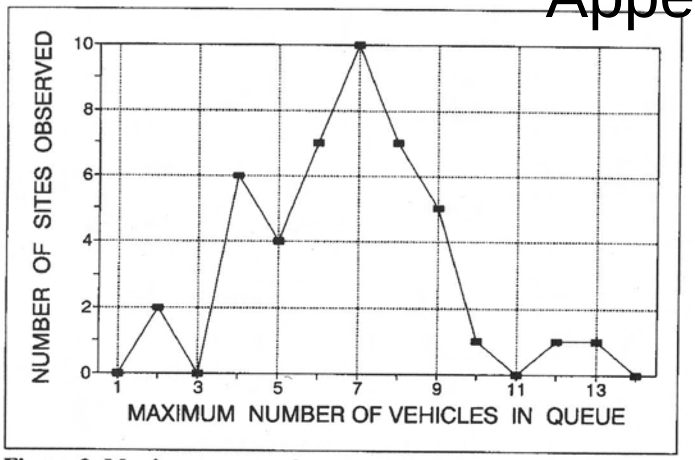

Figure 2. Maximum queue lengths at fast-food.

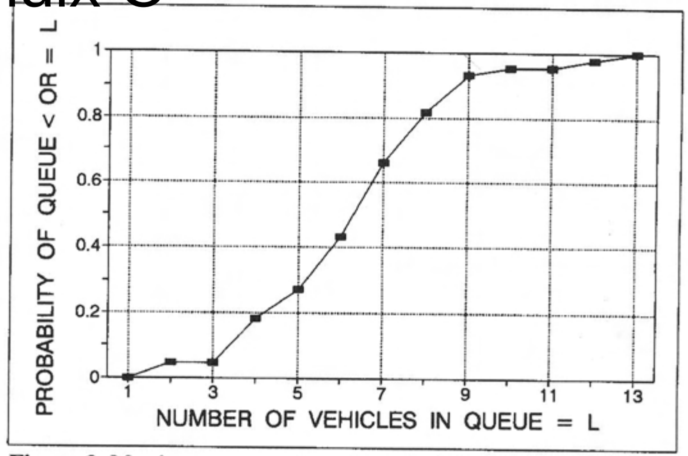

Figure 3. Maximum queue length probability at fast-food.

of vehicles. Figure 2 plots maximum queue length against the observed frequency of occurrence. Figure 3 depicts the probability that at any fast-food site, the queue will not exceed a given maximum queue length. From Table 2 or Figure 3, it can be seen that there was a 95 percent probability that the maximum queue at a site would be no more than 10 vehicles.

The maximum queues were evaluated against days of the week and were found to have no statistical relationship. Likewise, when evaluated against different levels of competition within the area and against service rates, there was no statistical relationship.

Bank

This category includes savings-and-loans with or without automatic teller machines (ATMs) and commercial banks with or without ATMs. Although there were historical differences between banks and savings-and-loans, they are now often indistinguishable to the public. The ITE land-use codes for this use are LUC 912 and 914 (*Trip Generation*, 1991) and LUC 912 (*Parking Generation*, 1987).

The studies analyzed were conducted from the late 1960s through the late 1980s; many were in Illinois, Minnesota, New Jersey and Texas. The size of the bank drive-thru facilities ranged from a minimum of one lane with one teller-window up to an institution with 10 lanes and four tellers.

Observed service rates for these institutions went up to a maximum of 35 vehicles per lane-hour. Maximum observed queues per lane ranged from two to eight vehicles. The maximum system queue lengths (all lanes combined) ranged from five to 29 vehicles. At two sites, it was observed that a queue length exceeding eight vehicles per lane was not tolerated by customers. When the queue length became excessive, customers would park and use walk-in facilities rather than the drive-thru. Thus the collected data reflect a maximum queue per lane of eight vehicles.

Table 3 shows the observed frequency of occurrence of maximum queue lengths per lane. Figure 4 plots the maximum number of vehicles per lane observed. On the basis of the studies received, there is a 100 percent probability that the queue length at a bank drive-thru facility will not exceed eight vehicles per lane, as Figure 5 shows.

Table 4 presents the maximum number of vehicles in an entire drive-thru system (all lanes combined) by ranges, along with the frequency of occurrence. This table shows that the most common maximum number-in-the-system at a bank drive-thru facility fell between six and 10 vehicles, as most observed facilities consisted of two lanes. Table 4 also

Table 3. Bank Queue Lengths

	Maximum Queue Per Lane		
Queue Length	*Frequency*	*Cumulative Frequency*	*P(q≤N)*
0	0	0	0.00
1	0	0	0.00
2	1	1	0.07
3	4	5	0.33
4	2	7	0.47
5	4	11	0.73
6	1	12	0.80
7	2	14	0.93
8	1	15	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length "q" not exceeding length "N".

Table 4. Maximum Number of Vehicles in Bank System (All Lanes)

# in system	*Frequency*	*Cumulative Frequency*	*P(q≤N)*
0 – 5	2	2	0.13
6 – 10	6	8	0.53
11 – 15	3	11	0.73
16 – 20	2	13	0.87
21 – 25	1	14	0.93
26 – 30	1	15	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length "q" not exceeding length "N".

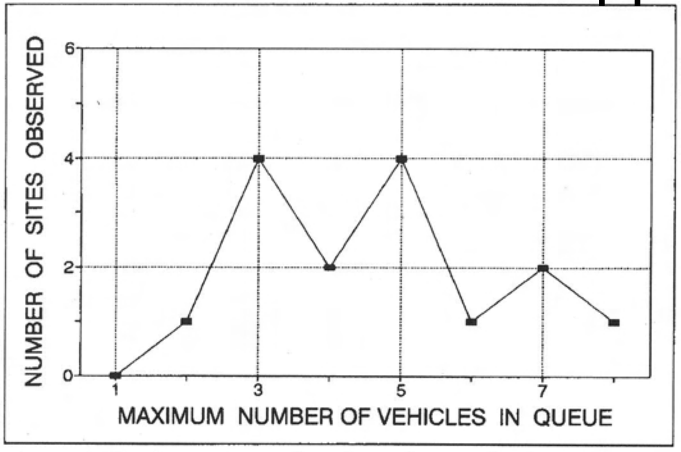

Figure 4. Maximum queue length per lane at bank.

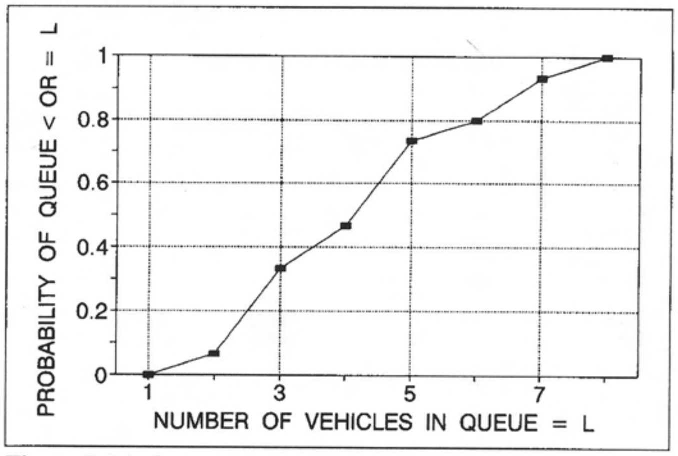

Figure 5. Maximum per lane queue length probability at bank.

gives the probability, based on the studies received, that the number of vehicles in the system will not exceed a certain range.

It should be noted that queuing lengths may be affected by time-of-day banking habits. There may be differences between the central city and a suburb. An area with a large proportion of retired persons may experience unique banking-time behaviors. In addition, the effects of banks incorporating ATMs into drive-thru aisles may also need to be investigated in future queuing studies.

Car Wash

This category includes full-service car washes (offering vacuuming and towel-drying services), exterior tunnel operation (vacuuming and towel drying not a part of the "in-line" operation, but may be offered at separate stations to the side), and self-service car washes (where customers pull into a wash bay, insert coins into a box, and proceed to wash). The ITE land-use code for these uses is LUC 847 (*Trip Generation*, 1991). This land use was not included in the 1987 *Parking Generation* report.

The studies analyzed were conducted from the late 1960s through the late 1980s in Kansas, Illinois, Montana, New Jersey and Texas. They included seven full service car washes, two exterior tunnel car washes, and nine self-service car washes. The number of self-service bays ranged from six to 14 per site. The self-service car washes typically had one or more parallel wash bays; the full-service car wash operations tended to have a single tunnel to serve customers.

Studies at the full-service car washes were made during winter or early spring months. Both full-service car washes consisted of a single tunnel. Observed service rates were 35 vph (maximum queue of nine vehicles) and 27 vph (maximum queue of 26 vehicles). At the site with a 26-vehicle queue, the queue extended off the site and onto an adjacent private street with light traffic volumes.

The self-service car wash studies were conducted on Saturday and Thursday, during late spring and/or summer months. Service rates at self-service car washes ranged from 4.1 vehicles per bay-hour to 5.4 vehicles per bay-hour. The average service rate was 4.77 vehicles per bay-hour. The maximum queue observed at two study sites was three vehicles, and at a third study site the maximum observed was one vehicle. No distinction was made as to whether these were maximum queues per bay or total maximum queues (per entire operation).

Day Care

This category includes facilities that provide a place for children during the day, often while parents are at work. After-school care may also be provided. The ITE land-use code is LUC 565 (*Trip Generation*, 1991). This land use was not included in the 1987 *Parking Generation* report.

Data were submitted for one day-care facility in Texas, during the evening peak hour. The facility had 99 children enrolled and 94 present the day the study was conducted. The day-care facility handled children age 2 through first grade. The facility was operated in a manner that required the parents to park their cars and go inside to get their children.

The hour service rate was 46 vehicles. A maximum of eight vehicles in

This is an Informational Report of the Institute of Transportation Engineers prepared by Technical Council Committee 5D-10. The information in this report has been obtained from experiences of transportation engineering professionals and research. ITE Informational Reports are prepared for informational purposes only and do not include Institute recommendations on which is the best course of action or the preferred application of the data.

Members of Technical Council Committee 5D-10 were J. L. Gattis, P.E. (M), Chair; Grant A. Bacchus, P. Eng. (F); Benedict G. Barkan (F); Robert R. Marvin, P.E. (M); Dale B. McKinney, P.E. (F); Robert A. Nelson, P.E. (F); Seyed M. Safavian (M); James M. Schoen (A); David K. Sorenson, P.E. (A); Mark J. Stuecheli (M); and Jack Wierzenski (A).

Members of the Technical Council Department 5 Standing Committee at the time of approval of this report were Dennis O'Malley (F), Chair; Carol H. Walters, P.E. (M), Assistant Chair; Robert D. McMillen, P.E. (FL); Wamahdri W. Williams (A); and Donald J. Galloway, P.E. (F). Brian S. Bochner, P.E. (F), was the Chair of Technical Council, and John M. Mason, P.E. (F), was the Assistant Chair.

Table 5. Summary of Observed Queue Distances at Drive-Thru Facilities

	Near-maximum number of queued vehicles observed in system (does not include vehicle at service position)	*Lane Length needed to store near-maximum queue (does not include) vehicle at service position)*
Fast-Food (Hamburger)	10 – 1 = 9	60 m (198 feet)
Bank	8 – 1 = 7	47 m (154 feet)
Car Wash (self-service)	3 – 1 = 2	13 m (44 feet)
Day Care	10 – 1 = 9	can store in parallel
Dry Cleaner	3 – 1 = 2	13 m (44 feet)

5 minutes (if sustained, equivalent to 96 vph) were observed; a 20-minute period had 28 vehicles (84 per hour). The maximum number of waiting vehicles was 10 vehicles.

VanWinkle and Kinton reported the results of 29 field studies at day-care establishments in Tennessee. Their findings are in the July 1994 *ITE Journal*.[8]

Dry Cleaners

This category includes facilities that clean clothing and other fabrics that should not be laundered. Often a walk-up window is present. No information is provide for this land use in either the ITE 1991 *Trip Generation* report or the ITE 1987 *Parking Generation* report.

One study was conducted at a dry cleaner with drive-thru facilities in Montana during a weekday p.m. peak period. An average service rate of 41 vph was measured at the single window. The observed maximum queue was three vehicles long. Forty-five percent of the customers used the drive-thru facility.

Conclusions

Table 5 summarizes the observed maximum or near-maximum observed queue lengths, and also lists the stacking distance needed to accommodate these observed queues, based on a front bumper-to-front bumper space occupied length of 22 feet (ft) per vehicle. This 22 ft may not be the exact space that vehicles occupy, but a value ranging from 20 ft to 25 ft seems appropriate for many situations. Because only one day-care facility was observed, and because parents picking up children may park in parallel or in a lot instead of in a single-file line, no stacking length was calculated for this land use.

Due to a change of committee personnel during the course of the data-gathering effort, some of the original forms submitted by committee members are not available. There are some apparent errors in the tables. For instance, the number of studies tallied in Table 1 is 41, while the number in Table 2 is 44. It is not known whether three studies were not included in Table 1, or whether there was double counting in Table 2. The unavailability of the original data forms makes it impossible to recheck the numbers.

The size of this drive-thru facility queuing characteristic database was limited. There is a need to accumulate and analyze more drive-thru queuing system data, so transportation engineers and site planners can be better informed. Additional observations of service rates are also needed in order to determine relationships between service rates and queue lengths, and to evaluate long-term trends in service rates. Finally, investigations of the amount of space occupied per vehicle within a queue are needed so that engineers will have the ability to project not only the number of vehicles that will be in the maximum queue for a given site, but also the queue storage length required for a site.

When collecting queuing data, the recorder should clearly indicate whether the number of vehicles recorded includes or excludes the vehicle(s) in the service position (that is, at the window). The data record must indicate which numbers are for a single queuing line and which totals are for the entire system of multiple queuing lines. An observer should also note instances of arriving vehicles balking or refusing to enter a queue due to excessive length, and how many vehicles were in the queue when the next arrival balked.

Other types of drive-thru operations that could be studied include those at credit unions, funeral homes, gas stations (either gas only, full-service, self-service, or a combination with convenience stores or car washes), libraries, liquor stores, movie theater ticket booths, parking lots and garages (either pick-up ticket or pay, or key, tag, or card), post offices, pre-schools, baby-sitting or school combinations, lower grade schools, stadium ticket sales machines, truck stops and places of worship.

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Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	912
Land Use/Building Type*:	Drive-in Bank
Name of Business:	Citizens Independent Bank
Address:	3700 W Broadway Ave
City:	Robbinsdale
State:	MN
Zip Code:	55422
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description	4 Lanes + 1 ATM Lane
Gross Floor Area (estimated)	6300

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**5**	**3:36pm**
Wednesday	**5**	**2:37pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	912
Land Use/Building Type:	Drive-in Bank
Name of Business:	SharePoint Credit Union
Address:	3670 Aquila Ave S
City:	St. Louis Park
State:	MN
Zip Code:	55426
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	2 Lanes + 1 ATM Lane
Gross Floor Area (estimated)	7,850 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**3**	**3:28pm**
Thursday	**3**	**8:51am, 10:37am**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	912
Land Use/Building Type:	Drive-in Bank
Name of Business:	TCF Bank
Address:	8020 Highway 7
City:	St. Louis Park
State:	MN
Zip Code:	55426
Date(s)	August 5-7, 2011 (Friday-Sunday)
Weather Conditions	High 84-88 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	5 Lanes + 1 ATM Lane
Gross Floor Area (estimated)	6,000 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday	**4**	**5:18pm**
Monday		
Tuesday		
Wednesday		
Thursday		
Friday	**8**	**12:20pm, 2:20pm**
Saturday	**8**	**11:40am**

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	912
Land Use/Building Type:	Drive-in Bank
Name of Business:	US Bank
Address:	4000 W Broadway Ave
City:	Robbinsdale
State:	MN
Zip Code:	55422
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	3 Lanes + 1 ATM Lane
Gross Floor Area (estimated)	21,550 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**7**	**4:47pm, 5:04pm**
Wednesday	**7**	**3:00pm, 5:26pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	912
Land Use/Building Type:	Drive-in Bank
Name of Business:	Wells Fargo
Address:	425 E Hennepin Ave
City:	Minneapolis
State:	MN
Zip Code:	55414
Date(s)	February 7, 2012 (Tuesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	4 Lanes + 1 ATM Lane
Gross Floor Area (estimated)	12,000 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**6**	**1:18pm**
Wednesday		
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	912
Land Use/Building Type:	Drive-in Bank
Name of Business:	Wells Fargo
Address:	2329 Central Ave NE
City:	Minneapolis
State:	MN
Zip Code:	55418
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	7 Lanes (4-5 Lanes were open at various points) + 1 ATM Lane
Gross Floor Area (estimated)	20,125 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**8**	**4:41pm**
Wednesday	**6**	**11:27am, 1:48pm, 2:23pm, 4:32pm, 5:25pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	948
Land Use/Building Type:	Automated Car Wash
Name of Business:	BP
Address:	3012 Excelsior Blvd
City:	Minneapolis
State:	MN
Zip Code:	55416
Date(s)	February 1-2, 2012, (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description :	1 Lane. Only counted the vehicles waiting in line, not the vehicles currently being washed.
Gross Floor Area (estimated)	3,375 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**6**	**3:08pm**
Thursday	**6**	**3:07pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	948
Land Use/Building Type:	Automated Car Wash
Name of Business:	BP
Address:	2441 Fariview Ave N
City:	Roseville
State:	MN
Zip Code:	55113
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description :	1 Lane. Only counted the vehicles waiting in line, not the vehicles currently being washed.
Gross Floor Area (estimated)	3,150 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**1**	**12:58pm**
Wednesday	**3**	**2:53pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	948
Land Use/Building Type:	Automated Car Wash
Name of Business:	BP
Address:	1691 Snelling Ave N
City:	Falcon Heights
State:	MN
Zip Code:	55113
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description : 1 Lane. Only counted the vehicles waiting in line, not the vehicles currently being washed.

Gross Floor Area (estimated): 1,500 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**4**	**1:48pm**
Wednesday	**3**	**4:29pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	948
Land Use/Building Type:	Automated Car Wash
Name of Business:	Holiday Gas Station Carwash
Address:	5430 Minnetonka Blvd
City:	St. Louis Park
State:	MN
Zip Code:	55416
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description :	1 Lane. Only counted the vehicles waiting in line, not the vehicles currently being washed.
Gross Floor Area (estimated)	3,000 sq. ft

	Maximum Queue	**Time Max Queue Occurred**
Sunday		
Monday		
Tuesday		
Wednesday	**3**	**12:37pm, 1:50pm, 3:43pm, 4:41pm, 5:10pm, 7:04pm, 7:30pm**
Thursday	**4**	**2:38pm, 4:20pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	948
Land Use/Building Type:	Automated Car Wash
Name of Business:	Mister Car Wash
Address:	8650 Highway 7
City:	St. Louis Park
State:	MN
Zip Code:	55426
Date(s)	February 1-2, 2011 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description :	2 Lanes, Full Service Wash, only vehicles in line were counted, not the vehicles being washed.
Gross Floor Area (estimated)	8,250 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**10**	**1:03pm**
Thursday	**6**	**4:02pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	948
Land Use/Building Type:	Automated Car Wash
Name of Business:	Mobil Car Wash
Address:	3864 Hopkins Crossroad
City:	Minnetonka
State:	MN
Zip Code:	55305
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description :	2 lanes. Only vehicles in line were counted, not vehicles being washed.
Gross Floor Area (estimated)	1,225 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**4**	**6:03pm**
Thursday	**3**	**4:37pm, 6:28pm, 7:39pm, 7:51pm, 8:04pm, 8:23pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	937
Land Use/Building Type:	Coffee/Donut Shop w/ Drive Thru
Name of Business:	Caribou Coffee
Address:	4745 Cedar Ave S
City:	Minneapolis
State:	MN
Zip Code:	55407
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	1,950 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**11**	**8:50am**
Thursday	**10**	**7:57am**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	937
Land Use/Building Type:	Coffee/Donut Shop w/ Drive Thru
Name of Business:	Caribou Coffee
Address:	5330 Cedar Lake Rd
City:	St. Louis Park
State:	MN
Zip Code:	55416
Date(s)	August 5-9, 2011 (Friday-Tuesday)
Weather Conditions	High 82-88 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	3,600 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday	**7**	**9:39am, 9:41am**
Monday	**10**	**8:39am**
Tuesday	**12**	**9:26am**
Wednesday		
Thursday		
Friday	**12**	**8:12am**
Saturday	**8**	**8:52am, 10:24am**

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	937
Land Use/Building Type:	Coffee/Donut Shop w/ Drive Thru
Name of Business:	Starbucks
Address:	5121 Gus Young Lane
City:	Edina
State:	MN
Zip Code:	55436
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	
Low	X

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	3,000 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**14**	**7:22am, 7:49am**
Thursday	**16**	**8:56am**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	937
Land Use/Building Type:	Coffee/Donut Shop w/ Drive Thru
Name of Business:	Starbucks
Address:	1505 Highway 7
City:	Hopkins
State:	MN
Zip Code:	55305
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane, Queuing Went Out Onto the Street
Gross Floor Area (estimated)	1,800 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**10**	**7:42am, 8:41am, 8:59am**
Thursday	**11**	**7:33am**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	937
Land Use/Building Type:	Coffee/Donut Shop w/ Drive Thru
Name of Business:	Starbucks
Address:	4201 Minnetonka Blvd
City:	St. Louis Park
State:	MN
Zip Code:	55416
Date(s)	November 3, 2010 (Wednesday)
Weather Conditions	High 56 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane, Queue Lengths Recorded at 5 min Intervals
Gross Floor Area (estimated)	2,550 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**11**	**8:45am**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	937
Land Use/Building Type:	Coffee/Donut Shop w/ Drive Thru
Name of Business:	Starbucks
Address:	2305 Fairview Ave
City:	Roseville
State:	MN
Zip Code:	55113
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	1,500 sq. ft

	Maximum Queue	**Time Max Queue Occurred**
Sunday		
Monday		
Tuesday	**10**	**8:09am**
Wednesday	**12**	**7:57am**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	934
Land Use/Building Type:	Fast Food with Drive Thru
Name of Business:	Arby's
Address:	1116 W Lake St
City:	Minneapolis
State:	MN
Zip Code:	55408
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	3,000 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**5**	**6:04pm**
Thursday	**5**	**6:55pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	934
Land Use/Building Type:	Fast Food with Drive Thru
Name of Business:	Burger King
Address:	6660 Wayzata Blvd
City:	Golden Valley
State:	Minnesota
Zip Code:	55426
Date(s)	August 5-8, 2011
Weather Conditions	High 82-88 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	3,300 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday	**6**	**4:30pm**
Monday	**12**	**12:10pm**
Tuesday		
Wednesday		
Thursday		
Friday	**10**	**12:12pm**
Saturday	**8**	**9:38pm**

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	934
Land Use/Building Type:	Fast Food with Drive Thru
Name of Business:	McDonald's
Address:	5200 Excelsior Blvd
City:	St. Louis Park
State:	MN
Zip Code:	55416
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	2 Order Stations
Gross Floor Area (estimated)	3,600 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**12**	**11:46am**
Thursday	**13**	**12:23pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	934
Land Use/Building Type:	Fast Food with Drive Thru
Name of Business:	McDonald's
Address:	2929 Hennepin Ave S
City:	Minneapolis
State:	MN
Zip Code:	55408
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	3,825 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**9**	**8:48am**
Thursday	**8**	**8:54am**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	934
Land Use/Building Type:	Fast Food with Drive Thru
Name of Business:	Taco Bell
Address:	819 Cambridge St
City:	Hopkins
State:	MN
Zip Code:	55343
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	2,500 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**10**	**12:26pm**
Thursday	**8**	**12:17pm, 6:57pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	934
Land Use/Building Type:	Fast Food with Drive Thru
Name of Business:	White Castle
Address:	1111 Cambridge St
City:	Hopkins
State:	MN
Zip Code:	55343
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	1,750 sq. ft

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**8**	**5:26pm**
Thursday	**5**	**8:13am, 12:10pm, 1:25pm, 3:22pm, 8:54pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	881
Land Use/Building Type:	Pharmacy/Drugstore w/ Drive-Thru
Name of Business:	CVS Pharmacy
Address:	Medicine Lake Rd & Winnetka Ave
City:	New Hope
State:	MN
Zip Code:	55427
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	X
Medium	
Low	

Drive-Through Description :	2 Lanes
Gross Floor Area (estimated)	18, 700 sq. ft.

	Maximum Queue	Time Max Queue Occurred
Sunday		
Monday		
Tuesday	**1**	**13 times**
Wednesday	**2**	**5:55pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	881
Land Use/Building Type:	Pharmacy/Drugstore w/ Drive-Thru
Name of Business:	CVS
Address:	2426 W Broadway Ave
City:	Minneapolis
State:	MN
Zip Code:	55411
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	2 Lanes
Gross Floor Area (estimated)	14,200 sq. ft

	Maximum Queue	Time(s) Max Queue Occurred
Sunday		
Monday		
Tuesday	**4**	**5:28pm**
Wednesday	**4**	**6:38pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	881
Land Use/Building Type:	Pharmacy/Drugstore w/ Drive-Thru
Name of Business:	CVS
Address:	3655 Central Ave NE
City:	Minneapolis
State:	MN
Zip Code:	55418
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	X
Suburban (non-CBD)	
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	2 Lanes
Gross Floor Area (estimated)	14,200 sq. ft

	Maximum Queue	**Time(s) Max Queue Occurred**
Sunday		
Monday		
Tuesday	**2**	**1:57pm, 3:35pm, 5:48pm, 6:07pm, 7:10pm**
Wednesday	**2**	**3:03pm, 3:52pm, 4:07pm, 4:46pm, 5:12pm, 5:20pm, 6:43pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	881
Land Use/Building Type:	Pharmacy/Drugstore w/ Drive-Thru
Name of Business:	Walgreens
Address:	540 Blake Rd N
City:	Hopkins
State:	MN
Zip Code:	55343
Date(s)	February 1-2, 2012 (Wednesday-Thursday)
Weather Conditions	High 32-36 °F and Fog

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	
Medium	X
Low	

Drive-Through Description :	2 Lanes
Gross Floor Area (estimated)	14,375 sq. ft

	Maximum Queue	Time(s) Max Queue Occurred
Sunday		
Monday		
Tuesday		
Wednesday	**4**	**2:33pm, 3:31pm, 4:46pm, 4:57pm, 5:28pm, 6:26pm, 6:38pm, 8:20pm, 9:20pm**
Thursday	**5**	**4:30pm, 4:52pm, 5:56pm, 6:00pm**
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	881
Land Use/Building Type:	Pharmacy/Drugstore w/ Drive-Thru
Name of Business:	Walgreens
Address:	4200 Winnetka Ave N
City:	New Hope
State:	MN
Zip Code:	55428
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	X
Medium	
Low	

Drive-Through Description :	2 Lanes
Gross Floor Area (estimated)	16675 sq. ft.

	Maximum Queue	Time(s) Max Queue Occurred
Sunday		
Monday		
Tuesday	**3**	**4:03pm**
Wednesday	**3**	**8:34am, 4:04pm, 4:51pm**
Thursday		
Friday		
Saturday		

Appendix D

Drive-Through Queuing Data Form

ITE Land Use Code:	881
Land Use/Building Type:	Pharmacy/Drugstore w/ Drive-Thru
Name of Business:	Walgreens
Address:	4100 W Broadway Ave
City:	Robbinsdale
State:	MN
Zip Code:	55422
Date(s)	February 7-8, 2012 (Tuesday-Wednesday)
Weather Conditions	High 32 °F and Clear

Location Within Area (select one):

CBD	
Urban (non-CBD)	
Suburban (non-CBD)	X
Suburban CBD	
Rural	
Not Given	

Competition Within Area (select one):

High	X
Medium	
Low	

Drive-Through Description :	1 Lane
Gross Floor Area (estimated)	14,400 sq. ft.

	Maximum Queue	Time(s) Max Queue Occurred
Sunday		
Monday		
Tuesday	**3**	**4:49pm**
Wednesday	**2**	**12:49pm**
Thursday		
Friday		
Saturday		

APPENDIX G

SIGHT DISTANCE STANDARDS

CHAPTER 200 – GEOMETRIC DESIGN AND STRUCTURE STANDARDS

Topic 201 – Sight Distance

Index 201.1 – General

Sight distance is the continuous length of highway ahead, visible to the highway user. Four types of sight distance are considered herein: passing, stopping, decision, and corner. Passing sight distance is used where use of an opposing lane can provide passing opportunities (see Index 201.2). Stopping sight distance is the minimum sight distance for a given design speed to be provided on multilane highways and on 2-lane roads when passing sight distance is not economically obtainable. Stopping sight distance also is to be provided for all users, including motorists and bicyclists, at all elements of interchanges and intersections at grade, including private road connections (see Topic 504, Index 405.1, & Figure 405.7). Decision sight distance is used at major decision points (see Indexes 201.7 and 504.2). Corner sight distance is used at intersections (see Index 405.1, Figure 405.7, and Figure 504.3I).

Table 201.1 shows the minimum standards for stopping sight distance related to design speed for motorists. Stopping sight distances given in the table are suitable for Class II and Class III bikeways. The stopping sight distances are also applicable to roundabout design on the approach roadway, within the circulatory roadway, and on the exits prior to the pedestrian crossings. Also shown in Table 201.1 are the values for use in providing passing sight distance.

See Chapter 1000 for Class I bikeway sight distance guidance.

Chapter 3 of "A Policy on Geometric Design of Highways and Streets," AASHTO, contains a thorough discussion of the derivation of stopping sight distance.

201.2 Passing Sight Distance

Passing sight distance is the minimum sight distance required for the driver of one vehicle to pass another vehicle safely and comfortably. Passing must be accomplished assuming an oncoming vehicle comes into view and maintains the design speed, without reduction, after the overtaking maneuver is started.

Table 201.1

Sight Distance Standards

Design Speed[(1)] (mph)	Stopping[(2)] (ft)	Passing (ft)
10	50	---
15	100	---
20	125	800
25	150	950
30	200	1,100
35	250	1,300
40	300	1,500
45	360	1,650
50	430	1,800
55	500	1,950
60	580	2,100
65	660	2,300
70	750	2,500
75	840	2,600
80	930	2,700

Notes:

(1)See Topic 101 for selection of design speed.

(2)For sustained downgrades, refer to underlined standard in Index 201.3

The sight distance available for passing at any place is the longest distance at which a driver whose eyes are 3 ½ feet above the pavement surface can see the top of an object 4 ¼ feet high on the road. See Table 201.1 for the calculated values that are associated with various design speeds.

In general, 2-lane highways should be designed to provide for passing where possible, especially those routes with high volumes of trucks or recreational vehicles. Passing should be done on tangent horizontal alignments with constant grades or a slight sag vertical curve. Not only are drivers reluctant to pass on a long crest vertical curve, but it is impracticable to design crest vertical curves to provide for passing sight distance because of high cost where crest cuts are involved. Passing sight distance for crest vertical curves is 7 to 17 times longer than the stopping sight distance.

Ordinarily, passing sight distance is provided at locations where combinations of alignment and profile do not require the use of crest vertical curves.

Passing sight distance is considered only on 2-lane roads. At critical locations, a stretch of 3- or 4-lane passing section with stopping sight distance is sometimes more economical than two lanes with passing sight distance.

Passing on sag vertical curves can be accomplished both day and night because headlights can be seen through the entire curve.

See Part 3 of the California Manual on Uniform Traffic Control Devices (California MUTCD) for criteria relating to the placement of barrier striping for no-passing zones. Note, that the passing sight distances shown in the California MUTCD are based on traffic operational criteria. Traffic operational criteria are different from the design characteristics used to develop the values provided in Table 201.1 and Chapter 3 of AASHTO, A Policy on Geometric Design of Highways and Streets. The aforementioned table and AASHTO reference are also used to design the vertical profile and horizontal alignment of the highway. Consult the District Traffic Engineer or designee when using the California MUTCD criteria for traffic operating-control needs.

Other means for providing passing opportunities, such as climbing lanes or turnouts, are discussed in Index 204.5. Chapter 3 of AASHTO, A Policy on Geometric Design of Highways and Streets, contains a thorough discussion of the derivation of passing sight distance.

201.3 Stopping Sight Distance

The minimum stopping sight distance is the distance required by the user, traveling at a given speed, to bring the vehicle or bicycle to a stop after an object ½-foot high on the road becomes visible. Stopping sight distance for motorists is measured from the driver's eyes, which are assumed to be 3 ½ feet above the pavement surface, to an object ½-foot high on the road. See Index 1003.1(10) for Class I bikeway stopping sight distance guidance.

The stopping sight distances in Table 201.1 should be increased by 20 percent on sustained downgrades steeper than 3 percent and longer than one mile.

201.4 Stopping Sight Distance at Grade Crests

Figure 201.4 shows graphically the relationships between length of highway crest vertical curve, design speed, and algebraic difference in grades. Any one factor can be determined when the other two are known.

201.5 Stopping Sight Distance at Grade Sags

From the curves in Figure 201.5, the minimum length of vertical curve which provides headlight sight distance in grade sags for a given design speed can be obtained.

If headlight sight distance is not obtainable at grade sags, lighting may be considered. The District approval authority or Project Delivery Coordinator, depending upon the current District Design Delegation Agreement, and the District Traffic Engineer or designee shall be contacted to review proposed grade sag lighting to determine if such use is appropriate.

201.6 Stopping Sight Distance on Horizontal Curves

Where an object off the pavement such as a bridge pier, building, cut slope, or natural growth restricts sight distance, the minimum radius of curvature is determined by the stopping sight distance.

Available stopping sight distance on horizontal curves is obtained from Figure 201.6. It is assumed that the driver's eye is 3 ½ feet above the center of the inside lane (inside with respect to curve) and the object is ½-foot high. The line of sight is assumed to intercept the view obstruction at the midpoint of the sight line and 2 feet above the center of the inside lane when the road profile is flat (i.e. no vertical curve). Crest vertical curves can cause additional reductions in sight distance. The clear distance (*m*) is measured from the center of the inside lane to the obstruction.

The design objective is to determine the required clear distance from centerline of inside lane to a retaining wall, bridge pier, abutment, cut slope, or other obstruction for a given design speed. Using radius of curvature and minimum sight distance for that design speed, Figure 201.6 gives the clear distance (*m*) from centerline of inside lane to the obstruction.

See Index 1003.1(13) for bikeway stopping sight distance on horizontal curve guidance.

When the radius of curvature and the clear distance to a fixed obstruction are known, Figure 201.6 also gives the sight distance for these conditions.

See Index 101.1 for technical reductions in design speed caused by partial or momentary horizontal sight distance restrictions. See Index 203.2 for additional comments on glare screens.

Cuts may be widened where vegetation restricting horizontal sight distance is expected to grow on finished slopes. Widening is an economic trade-off that must be evaluated along with other options. See Topic 902 for sight distance requirements on landscape projects.

201.7 Decision Sight Distance

At certain locations, sight distance greater than stopping sight distance is desirable to allow drivers time for decisions without making last minute erratic maneuvers (see Chapter III of AASHTO, A Policy on Geometric Design of Highways and Streets, for a thorough discussion of the derivation of decision sight distance.)

<u>On freeways and expressways the decision sight distance values in Table 201.7 should be used at lane drops and at off-ramp noses to interchanges, branch connections, safety roadside rest areas, vista points, and inspection stations</u>. When determining decision sight distance on horizontal and vertical curves, Figures 201.4, 201.5, and 201.6 can be used. Figure 201.7 is an expanded version of Figure 201.4 and gives the relationship among length of crest vertical curve, design speed, and algebraic difference in grades for much longer vertical curves than Figure 201.4.

Decision sight distance is measured using the 3 ½-foot eye height and ½-foot object height. See Index 504.2 for sight distance at secondary exits on a collector-distributor road.

Table 201.7

Decision Sight Distance

Design Speed(mph)	Decision Sight Distance(ft)
30	450
35	525
40	600
45	675
50	750
55	865
60	990
65	1,050
70	1,105
75	1,180
80	1,260

Topic 202 – Superelevation

202.1 Basic Criteria

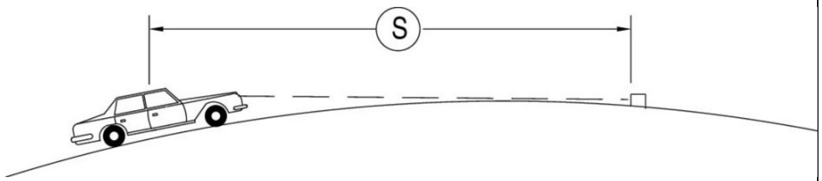
When a vehicle moves in a circular path, it undergoes a centripetal acceleration that acts toward the center of curvature. This force is countered by the perceived centrifugal force experienced by the motorist.

On a superelevated highway, this force is resisted by the vehicle weight component parallel to the superelevated surface and by the side friction developed between the tires and pavement. It is impractical to balance centrifugal force by superelevation alone, because for any given curve radius a certain superelevation rate is exactly correct for only one driving speed. At all other speeds there will be a side thrust either outward or inward, relative to the curve center, which must be offset by side friction.

If the vehicle is not skidding, these forces are in equilibrium as represented by the following simplified curve equation, which is used to design a curve for a comfortable operation at a particular speed:

Figure 201.4

Stopping Sight Distance on Crest Vertical Curves



Drivers eye height is 3 ½ feet.
Object height is ½-foot.

L = Curve Length (feet)

A = Algebraic Grade Difference (%)

S = Sight Distance (feet)

V = Design Speed for "S" in mph

K = Distance in feet required to achieve a 1% change in grade. K value as shown on graph is valid when S < L.

Notes:

- Before using this figure for intersections, branch connections and exits, see Indexes 201.7 and 405.1, and Topic 504.
- See Figure 204.4 for vertical curve formulas.
- See Index 204.4 for minimum length of vertical curve

When S > L	When S < L
L = 2S – 1329/A	L = AS^2 /1329

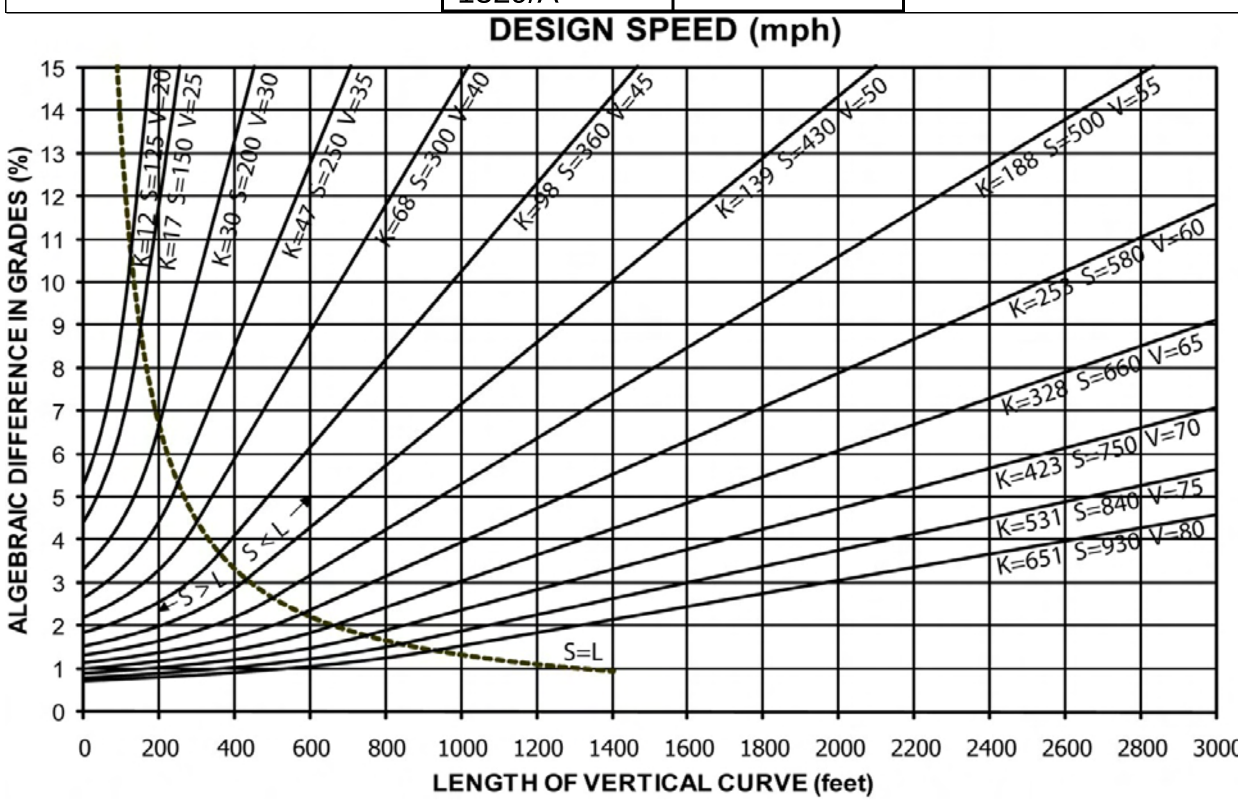
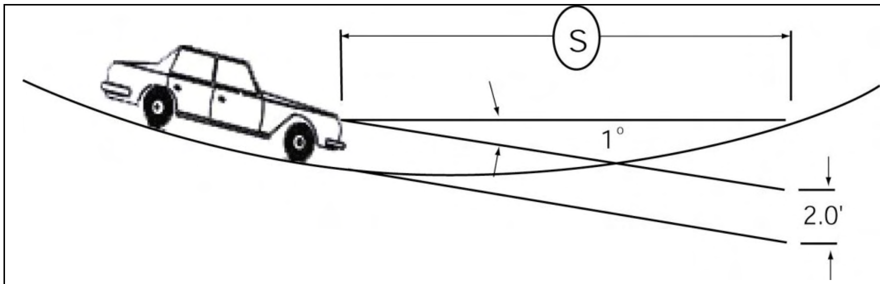


Figure 201.5

Stopping Sight Distance on Sag Vertical Curves



L = Curve Length (feet)
A = Algebraic Grade Difference (%)
S = Sight Distance (feet)
V = Design Speed for "S" in mph
K = Distance in feet required to achieve a 1% change in grade. K value as shown on graph is valid when S < L.

Notes:

- For sustained downgrades, see Index 201.3.
- Before using this figure for intersections, branch connections and exits, see Indexes 201.7 and 405.1, and Topic 504.
- See Figure 204.4 for vertical curve formulas.
- See Index 204.4 for minimum length of vertical curve.

When S > L	When S < L
$L = 2S - (400 + 3.5S)/A$	$L = AS^2/(400 + 3.5S)$

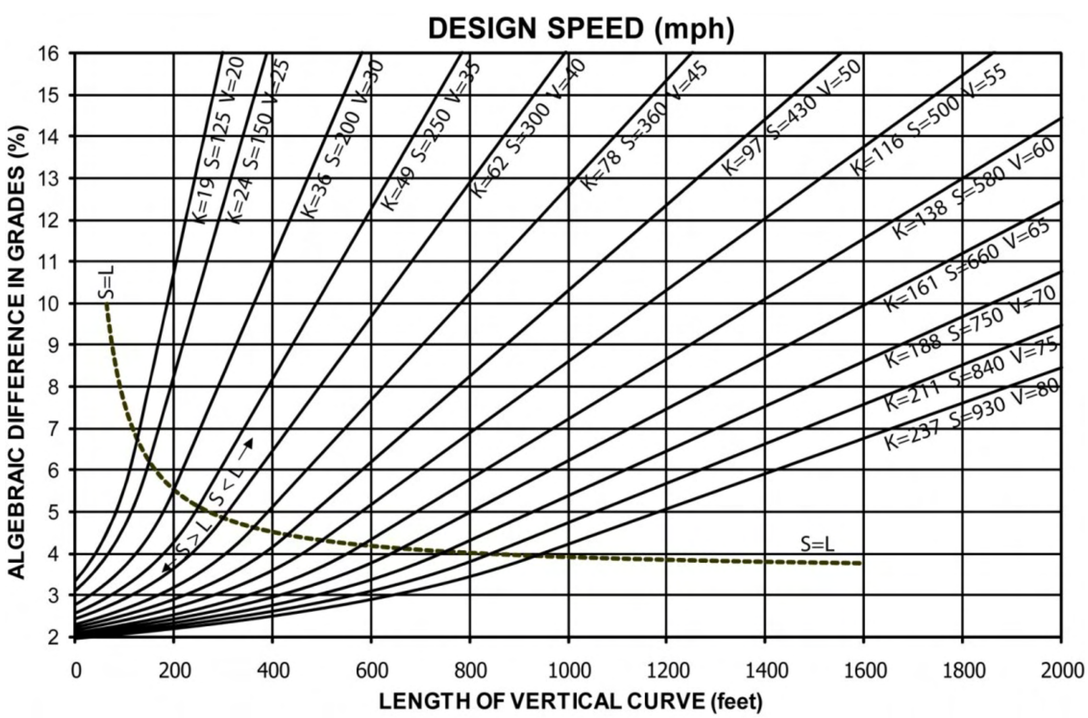
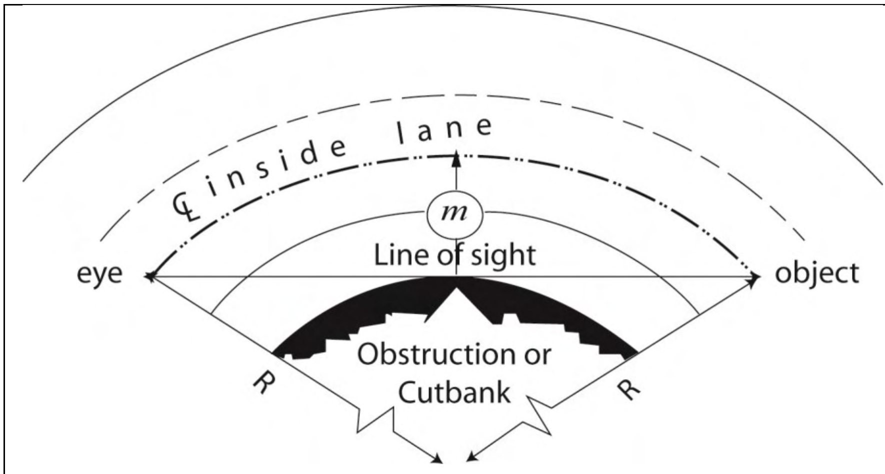


Figure 201.6

Stopping Sight Distance on Horizontal Curves



Line of sight is 2.0 feet above the centerline inside lane at point of obstruction.

R = Radius of the centerline of the lane nearest the obstruction (feet).

S = Sight Distance (feet)

V = Design Speed for “S” in mph

m = Clear distance from centerline of the lane nearest the obstruction (feet).

Notes:

- For sustained downgrades, see Index 201.3.
- Formulas apply only when “S” is equal to or less than length of curve.
- Angles in formulas are expressed in degrees.

$$m = R\left[1 - \cos\left(\frac{28.65S}{R}\right)\right]$$

$$S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R - m}{R}\right)\right]$$

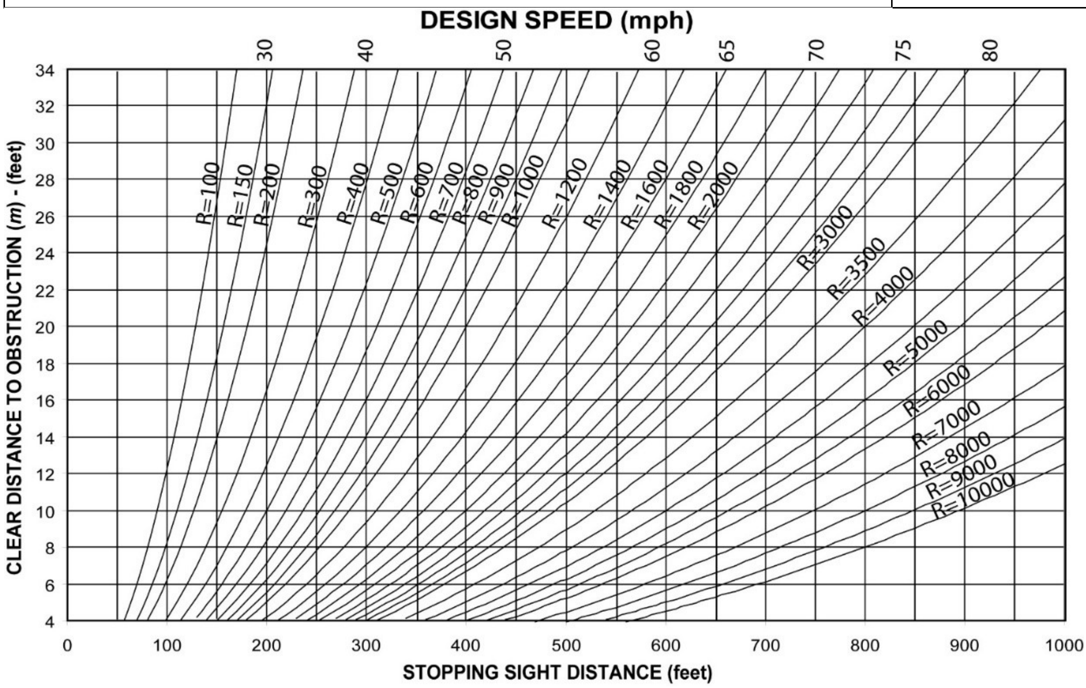
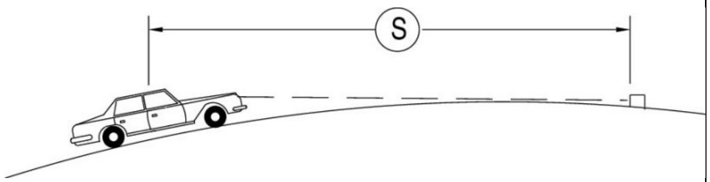


Figure 201.7

Decision Sight Distance on Crest Vertical Curves



Drivers eye height is 3½ feet.
Object height is ½-foot.

L = Curve Length (feet)

A = Algebraic Grade Difference (%)

S = Sight Distance (feet)

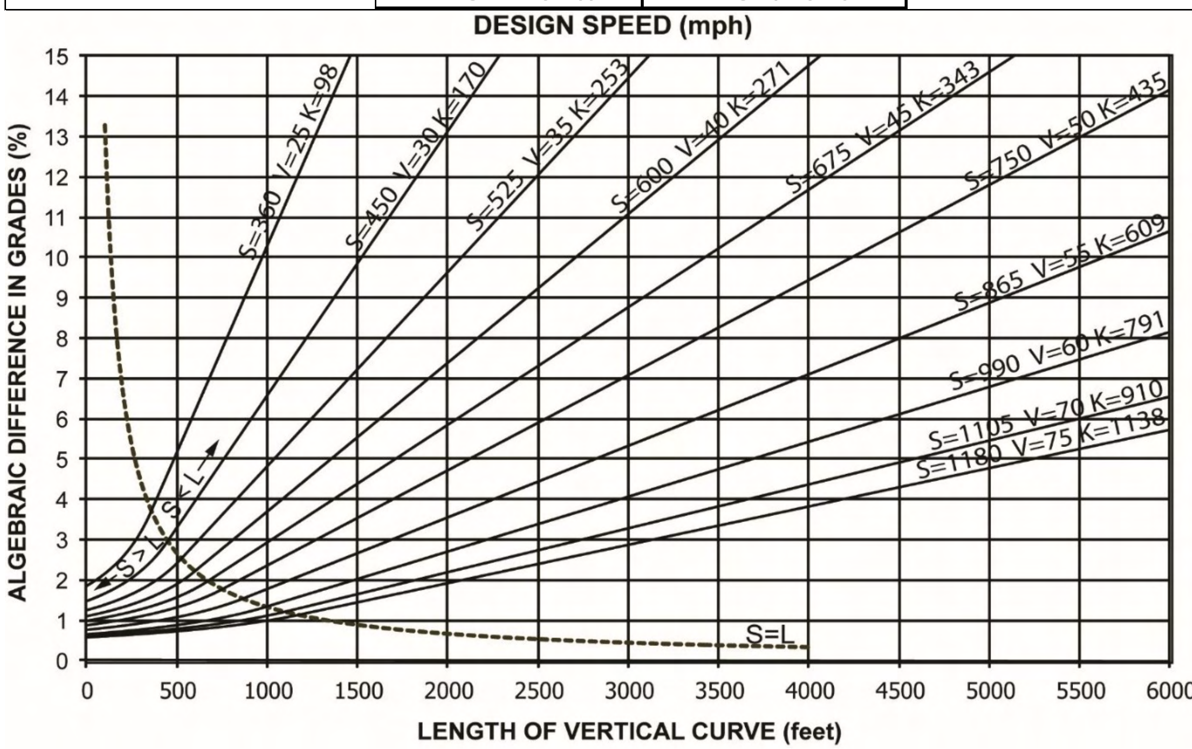
V = Design Speed for "S" in mph

K = Distance in feet required to achieve a 1% change in grade. K value as shown on graph is valid when S < L.

Notes:

- Before using this figure for intersections, branch connections and exits, see Indexes 201.7 and 405.1, and Topic 504.
- See Figure 204.4 for vertical curve formulas.
- See Index 204.4 for minimum length of vertical curve.

When S > L	When S < L
$L = 2S – 1329/A$	$L = AS^2 /1329$



$$e+f = \frac{0.067V^2}{R} = \frac{V^2}{15R}$$

Where:

e = Roadway superelevation slope, feet per foot
f = Side friction factor
R = Curve radius, feet
V = Vehicle speed, miles per hour

Standard superelevation rates are designed to hold the portion of the centrifugal force that must be taken up by tire friction within allowable limits. Friction factors as related to speed are shown on Figure 202.2. The factors apply equally to flexible and rigid pavements.

202.2 Standards for Superelevation

(1) Highways. Maximum superelevation rates for various highway conditions are shown in Tables 202.2A through 202.2E. The maximum rates of superelevation (e_{max}) used on highways are controlled by four factors: climate conditions (i.e., frequency and amount of snow and ice); terrain conditions (i.e., flat, rolling, or mountainous); type of area (i.e., rural or urban); and frequency of slow-moving vehicles whose operations might be affected by high superelevation rates. Consideration of these factors jointly leads to the conclusion that no single maximum superelevation rate is universally applicable.

The highest superelevation rate for highways in common use is 10 percent, although 12 percent is used in some cases. Superelevation rates above 8 percent are only used in areas without snow and ice. Although higher superelevation rates offer an advantage to vehicles at high speeds, current practice considers that rates in excess of 12 percent are beyond practical limits. This practice recognizes the combined effects of construction processes, maintenance difficulties, and operation of vehicles at low speeds.

Where traffic congestion or the clustered land use of developing corridors (i.e., industrial, commercial, and residential) restricts top speeds, it is common practice to utilize a lower maximum rate of superelevation (typically 4 to 6 percent). Similarly, either a low maximum rate of superelevation or no superelevation is employed within intersection areas or where there is a tendency to drive slowly because of turning and crossing movements, warning devices, and signals. In these areas it is difficult to warp crossing pavements for drainage without providing negative superelevation for some turning movements. Therefore, use of Tables 202.2D and 202.2E for urban roads may not apply in these locations.

Roadways described below, (a) through (e), shall be designed with the e_{max} indicated. Design of local roads should generally use (d) and (e).

(a) Use e_{max}=12% for ramps, connectors, 2-lane conventional highways, and frontage roads. See Index 202.7 for frontage roads under other jurisdictions.

(b) Use e_{max}=10% for freeways, expressways, and multilane conventional highways.

(c) Use e_{max}=8% when snow and ice conditions prevail (usually over 3,000 feet elevation).

(d) Use e_{max}=6% for urban roads with design speeds 35 to 45 miles per hour.

(5) Lock To Lock Time - The time in seconds that an average driver would take under normal driving conditions to turn the steering wheel of a vehicle from the lock position on one side to the lock position on the other side. The default in AutoTurn software is 6 seconds.

(6) Steering Lock Angle - The maximum angle that the steering wheels can be turned. It is further defined as the average of the maximum angles made by the left and right steering wheels with the longitudinal axis of the vehicle.

(7) Articulating Angle - The maximum angle between the tractor and semitrailer.

Topic 405 – Intersection Design Standards

405.1 Sight Distance

(1) Stopping Sight Distance. See Index 201.1 for minimum stopping sight distance requirements.

(2) Corner Sight Distance.

(a) General. At unsignalized intersections a substantially clear line of sight should be maintained between the driver of a vehicle, bicyclist or pedestrian stopped on the minor road and the driver of an approaching vehicle on the major road that has no stop. Line of sight for all users should be included in right of way, in order to preserve sight lines.

See DIB 79 for 2R, 3R, certain storm damage, protective betterment, operational, and safety projects on two-lane and three-lane conventional highways.

Adequate time should be provided for the stopped vehicle on the minor road to either cross all lanes of through traffic, cross the near lanes and turn left, or turn right, without requiring through traffic to radically alter their speed. The visibility required for these maneuvers form a clear sight triangle with the corner sight distance b and the crossing distance a_1 or a_2 (see Figure 405.1 as an example of corner sight distance at a two-lane, two-way highway). Dimensions a_1 and a_2 are measured from the decision point to the center of the lane. The actual number of lanes will vary on the major and minor roads. <u>There should be no sight obstruction within the clear sight triangle.</u>

The methodology used for the driver on the minor road that is stopped to complete the necessary maneuver while the approaching vehicle travels at the design speed of the major road is based on gap-acceptance behavior. A 7-1/2 second criterion is applied to a passenger car (including pickup trucks) for a left turn from a stop on the minor road. However, this time gap does not account for a single-unit truck (no semitrailer), a combination truck (see Index 404.4 for truck tractor-semitrailer guidance), a right-turn from a stop, or for a crossing maneuver. See Table 405.1A for the time gap that addresses these situations for the assumed design vehicle making these maneuvers from the minor road.

In determining corner sight distance, a set back distance for the vehicle waiting on the minor road must be assumed as measured from the edge of traveled way of the major road. <u>Set back for the driver of the vehicle on the minor road should be a minimum of 10 feet plus the shoulder width of the major road but not less than 15 feet.</u> The location of the driver's eye for the set back is the decision point per Figure 405.1. Corner sight distance and the driver's eye set back are also illustrated in Figures 405.7 and 504.3I. Line of sight for corner sight distance for passenger cars is to be determined from a 3 and 1/2-foot height at the location of the driver of the vehicle in the center of the minor road lane to a 3 and 1/2-foot object height in the center of the approaching outside lane of the major road. This provides for reciprocal sight by both vehicles. The passenger car driver's eye height should be applied to all minor roads. In addition, a truck driver's eye height of 7.6 feet should be applied to the minor road where applicable. Additionally, if the major road has a median barrier, a 2-foot object height should be used to determine the median barrier set back. A median that is wide enough to accommodate a stopped vehicle should also provide a clear sight triangle.

The minimum corner sight distance (feet) should be determined by the equation: $1.47V_mT_g$, where V_m is the design speed (mph) of the major road and T_g is the time gap (seconds) for the minor road vehicle to enter the major road. The values given in Table 405.1A should be used to determine T_g based on the design vehicle, the type of maneuver, and whether the stopped vehicle's rear wheels are on an upgrade exceeding 3 percent. The distance from the edge of traveled way to the rear wheels at the minor road stop location should be assumed as: 20 feet for a passenger car, 30 feet for a single-unit truck, and 72 feet for a combination truck.

(b) Public Road Intersections (Refer to Topic 205 and Index 405.7); corner sight distance applies, see Table 405.1A.

At signalized intersections the corner sight distances should also be applied whenever possible. Even though traffic flows are designed to move at separate times, unanticipated conflicts can occur due to violation of signal, right turns on red, malfunction of the signal, or use of flashing red/yellow mode.

The minimum value for corner sight distance at signalized intersections should be equal to the stopping sight distance as given in Table 201.1, measured as previously described. This includes an urban driveway that forms a leg of the signalized intersection.

(c) Private Road Intersections (Refer to Index 205.2) and Rural Driveways (Refer to Index 205.4); corner sight distance applies, see Table 405.1A. If signalized, the minimum corner sight distance should be equal to the stopping sight distance as given in Table 201.1, measured as previously described.

(d) Urban Driveways (Refer to Index 205.3); corner sight distance requirements as described above are not applied to urban driveways unless signalized. See Index 405.1(2)(b) underlined standard. If parking is allowed on the major road, parking should be prohibited on both sides of the driveway per the California MUTCD, 3B.19.

(3) *Decision Sight Distance.* At intersections where the State route turns or crosses another State route, the decision sight distance values given in Table 201.7 should be used. In computing and measuring decision sight distance, the 3.5-foot eye height and the 0.5-foot object height should be used, the object being located on the side of the intersection nearest the approaching driver.

The application of the various sight distance requirements for the different types of intersections is summarized in Table 405.1B

Table 405.1B

Application of Sight Distance Requirements

Intersection Types	Sight Distance		
	Stopping	Corner	Decision
Private Roads	X	X[(1)]	
Public Streets and Roads	X	X	
Signalized Intersections	X	X[(2)]	
State Route Intersections & Route Direction Changes, with or without Signals	X	X	X

NOTES:

(1) Per Index 405.1(2)(c), the minimum corner sight distance shall be equal to the stopping sight distance as given in Table 201.1. See Index 405.1(2)(a) for setback requirements.

(2) Apply corner sight distance requirements at signalized intersections whenever possible due to unanticipated violations of the signals or malfunctions of the signals. See Index 405.1(2)(b).

(4) Acceleration Lanes for Turning Moves onto State Highways. At rural intersections, with "STOP" control on the local cross road, acceleration lanes for left and right turns onto the State facility should be considered. At a minimum, the following features should be evaluated for both the major highway and the cross road:

- divided versus undivided
- number of lanes
- design speed
- gradient
- lane, shoulder and median width
- traffic volume and composition of highway users, including trucks and transit vehicles

Figure 405.1
Corner Sight Distance (b)

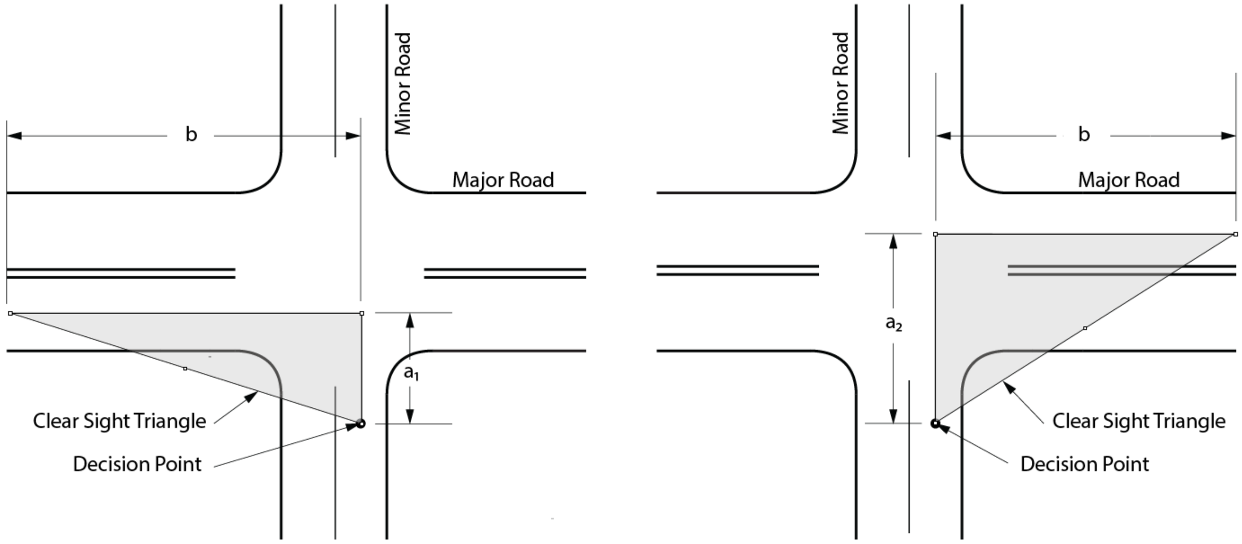


Table 405.1A
Corner Sight Distance Time Gap (T_g) for Unsignalized Intersections

Design Vehicle	Left-turn from Stop (s) [(4)]	Right-turn from Stop and Crossing Maneuver (s)
Passenger Car Private Road Intersection Rural Driveway	7½	6½
Single-Unit Truck Public Road Intersection	9½	8½
Combination Truck Major and Minor Roads on Routes: National Network Terminal or Service Access California Legal KPRA Advisory	11½	10½

Notes: Time gaps are for a stopped vehicle to turn left, right or cross a two-lane highway with no median and with minor road grades of 3 percent or less. The table values should be adjusted as follows:

(1) For multilane highways—When crossing or making a left-turn onto a two-way major road with more than two lanes, add 0.5 s for passenger cars or 0.7 s for trucks for each additional lane to be crossed. Median widths should be converted to an equivalent number of lanes in applying the 0.5 s and 0.7 s criteria. For example, an 18-foot wide median is equivalent to 1.5 lanes; this requires an additional 0.75 s for a passenger car to cross or an additional 1.05 s for a truck to cross.

(2) For minor road approach grades—If the minor road approach grade is an upgrade that exceeds 3 percent and the rear wheels of the design vehicle are on the grade exceeding 3 percent, add 0.2 s for each percent grade for left-turns and crossing maneuvers; or add 0.1 s for each percent grade for right-turns. For example, a passenger car is turning right from a minor road and at the stop location its rear wheels are on a 4 percent upgrade; this requires an additional 0.4 s for the right-turn.

(3) Unique situations may necessitate a different design vehicle for a particular minor road than those listed here (e.g., predominant combination trucks out of a rural driveway). Additionally, for intersections at skewed angles less than 60 degrees, a further adjustment is needed. See the AASHTO “A Policy on Geometric Design of Highways and Streets” for guidance.

(4) Time gap for vehicles approaching from the left can be the same as the right-turn from stop maneuver.

- turning volumes
- horizontal curve radii
- sight distance
- proximity of adjacent intersections
- types of adjacent intersections

For additional information and guidance, refer to AASHTO, A Policy on Geometric Design of Highways and Streets, the District Traffic Engineer or designee, the District Design Liaison, and the Project Delivery Coordinator.

405.2 Left-turn Channelization

(1) General. The purpose of a left-turn lane is to expedite the movement of through traffic by, controlling the movement of turning traffic, increasing the capacity of the intersection, and improving safety characteristics.

The District Traffic Branch normally establishes the need for left-turn lanes.

(2) Design Elements.

(a) Lane Width – **The lane width for both single and double left-turn lanes on State highways shall be 12 feet.**

For conventional State highways with posted speeds less than or equal to 40 miles per hour and AADTT (truck volume) less than 250 per lane that are in urban, city or town centers (rural main streets), the minimum lane width shall be 11 feet.

When considering lane width reductions adjacent to curbed medians, refer to Index 303.5 for guidance on effective roadway width, which may vary depending on drivers' lateral positioning and shy distance from raised curbs.

(b) Approach Taper – On conventional highways without a median, an approach taper provides space for a left-turn lane by moving traffic laterally to the right. The approach taper is unnecessary where a median is available for the full width of the left-turn lane. Length of the approach taper is given by the formula on Figures 405.2A, B and C.

Figure 405.2A shows a standard left-turn channelization design in which all widening is to the right of approaching traffic and the deceleration lane (see below) begins at the end of the approach taper. This design should be used in all situations where space is available, usually in rural and semi-rural areas or in urban areas with high traffic speeds and/or volumes.

Figures 405.2B and 405.2C show alternate designs foreshortened with the deceleration lane beginning at the 2/3 point of the approach taper so that part of the deceleration takes place in the through traffic lane. Figure 405.2C is shortened further by widening half (or other appropriate fraction) on each side. These designs may be used in urban areas where constraints exist, speeds are moderate and traffic volumes are relatively low.

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