Texas Department of Transportation

Appendix J

Amazon Fulfillment Warehouse Study

1.0 Introduction

TxDOT El Paso District requested CDM Smith to conduct a high-level planning study to determine the operational impacts of an Amazon fulfillment warehouse that is scheduled to start operating in El Paso in 2021. The District requested to investigate the operational impacts of the new Amazon fulfillment warehouse on two proposed diverging diamond interchanges at I-10/Eastlake Boulevard and I-10/Horizon Boulevard. The District provided the traffic projections at the two interchange locations from the I-10 Widening Study (2121-04-114) Traffic Projections Memo that was developed by another consultant.

The I-10 Widening Study Traffic Projections Memo stated the following in reference to the Amazon fulfillment warehouse: "Typically, Fulfillment Center Warehouses are not considered heavy trip generators due to a high-level of on-site automation and logistics management and given the size of the proposed facility, we believe any anticipated traffic from this development should be part of the proposed growth rate considered along the corridor." In addition, the I-10 Widening Study proposed 2.5 percent linear annual growth rate for the first 20 years (2020 to 2040) and 2 percent linear growth rate beyond year 2040.

This study will verify that the estimated additional trips generated by the Amazon fulfillment warehouse are significantly less than the projected AADT along I-10 and then use the provided I-10 Widening Study traffic projections as base for the intersection analysis.

The Amazon fulfillment warehouse site is delineated by Eastlake Boulevard, Rojas Drive, and I-10, and is located approximately 2.4 miles north of the I-10/Horizon Boulevard interchange. One of the recommended improvements identified in the Horizon Boulevard Corridor Master Plan is the extension of Rojas Drive to Horizon Boulevard, to form a three-legged continuous green T-intersection. This new road connection, when combined with additional trips generated by the Amazon fulfillment warehouse, will lead to an increase in the volume of vehicular traffic along Horizon Boulevard, Rojas Drive, Eastlake Boulevard, and I-10. As such, is appropriate to examine the possible traffic impacts of the Amazon fulfillment site.

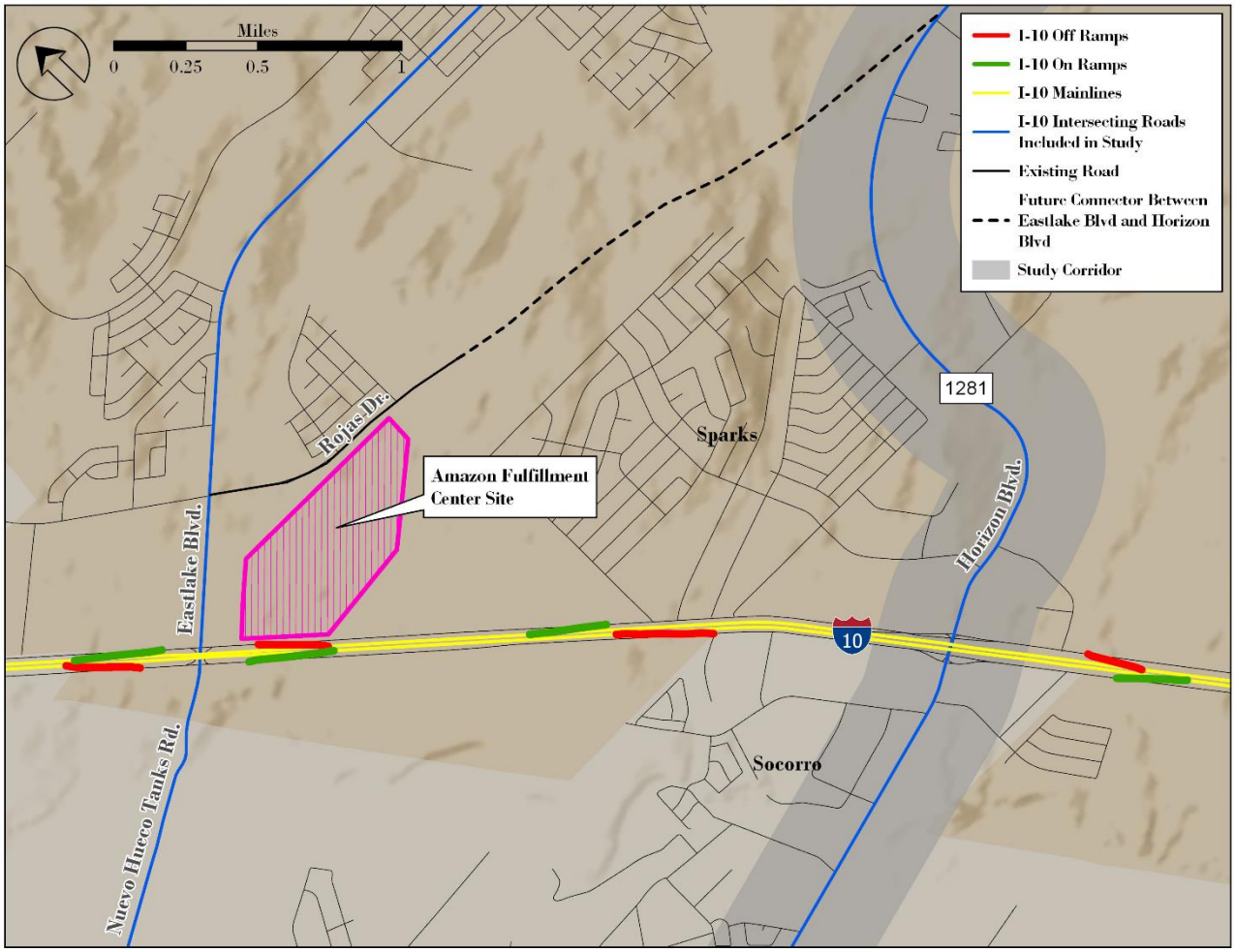

Figure J.1: Project Site and Roadway Network. *Source: CDM Smith, 2021.*

The Amazon warehouse site is located on approximately 115 acres of vacant land near the southeast corner of Rojas Drive and Eastlake Boulevard, according to a subdivision plat named Project William Unit One, which was previously filed with the El Paso Planning and Inspections Department[1]. The land is outside the El Paso city limits, but within the city's extraterritorial jurisdiction. The approximate location of the proposed site in relation to the local road network is shown in **Figure J.1**, which also shows the configuration of the on and off ramps along I-10 at both Eastlake Boulevard/I-10 and Horizon Boulevard/I-10.

I-10 at Eastlake Boulevard Interchange

The configuration of on and off ramps at Eastlake Boulevard/I-10 show that the existing on ramps and off ramps can provide the Amazon site access to I-10 through the frontage roads and Eastlake Boulevard. Amazon site traffic coming from the west or going to the west would access I-10 through the off ramp and on ramp west of the Eastlake Boulevard/I-10

[1] Source: https://www.elpasotimes.com/story/news/2020/06/15/giant-amazon-distribution-center-may-be-built-el-paso-county/3176854001/

intersection, while traffic from the site going east would access the on ramp east of the intersection. All three movements would use the segment of Eastlake Boulevard between I-10 and the site and would then access the Eastlake Boulevard/I-10 intersection.

Site traffic coming from the east would use the I-10 off ramp, which is less than 900 feet from the intersection. Traffic would have the choice of either immediately crossing two lanes on the frontage road to access the site directly or proceed to Eastlake Boulevard to access the site. In either case, the short weaving distance creates a potential operational and safety issue.

I-10 at Horizon Boulevard Interchange

Traffic from the Amazon site going toward Horizon Boulevard would likely exit the Amazon site along Rojas Drive, turning left onto Eastlake Boulevard and then left again through the Eastlake/I-10 interchange to access I-10 eastbound, and subsequently exiting I-10 through the I-10 off ramp to the west of the Horizon Boulevard/I-10 interchange, using the frontage road to access Horizon Boulevard. However, once Rojas Drive is connected to Horizon Boulevard, site traffic to Horizon Boulevard would also have the option of using Rojas Drive to access Horizon Boulevard, thereby increasing traffic volume along Rojas Drive and Horizon Boulevard.

2.0 Traffic Impacts

An Amazon fulfillment warehouse can be classified as a new type of warehouse, distinct from traditional general warehouses both in size and in operations, called a "high-cube warehouse". The *ITE Trip Generation Manual* provides estimates of trip rates for several examples of traditional warehouses, but does not cover the new type of high-cube warehouse or Amazon warehouses in particular. Trip generation for fulfillment warehouses and other large warehouses are explored in two publications: *NCHRP Synthesis 298 – Truck Trip Generation Data*, and a January 2019 report *High-Cube Warehouse Trip Generation Study*, prepared for the Western River MPO in Riverside, California. These recent studies found that high cube warehouses have higher trip rates than traditional warehouses and that Amazon warehouses were outliers in that data. Since the data from the recent studies is more recent and more focused on Amazon warehouses, their data was used instead of the rates from the *ITE Trip Generation Manual.* In general, the studies found that high-cube warehouses generate more total trips than traditional warehouses but generate about the same number of combination truck trips. The increased number of trips for high-cube warehouses (and specifically for Amazon warehouses) were observed to come from commercial 4-tire vehicles, vans, and single unit trucks.

Figure J.2 provides an example showing Amazon warehouses as an outlier in the data, showing how the surveyed Amazon site had a significantly higher number of total daily trips generated per thousand square feet of space than other high-cube warehouses.

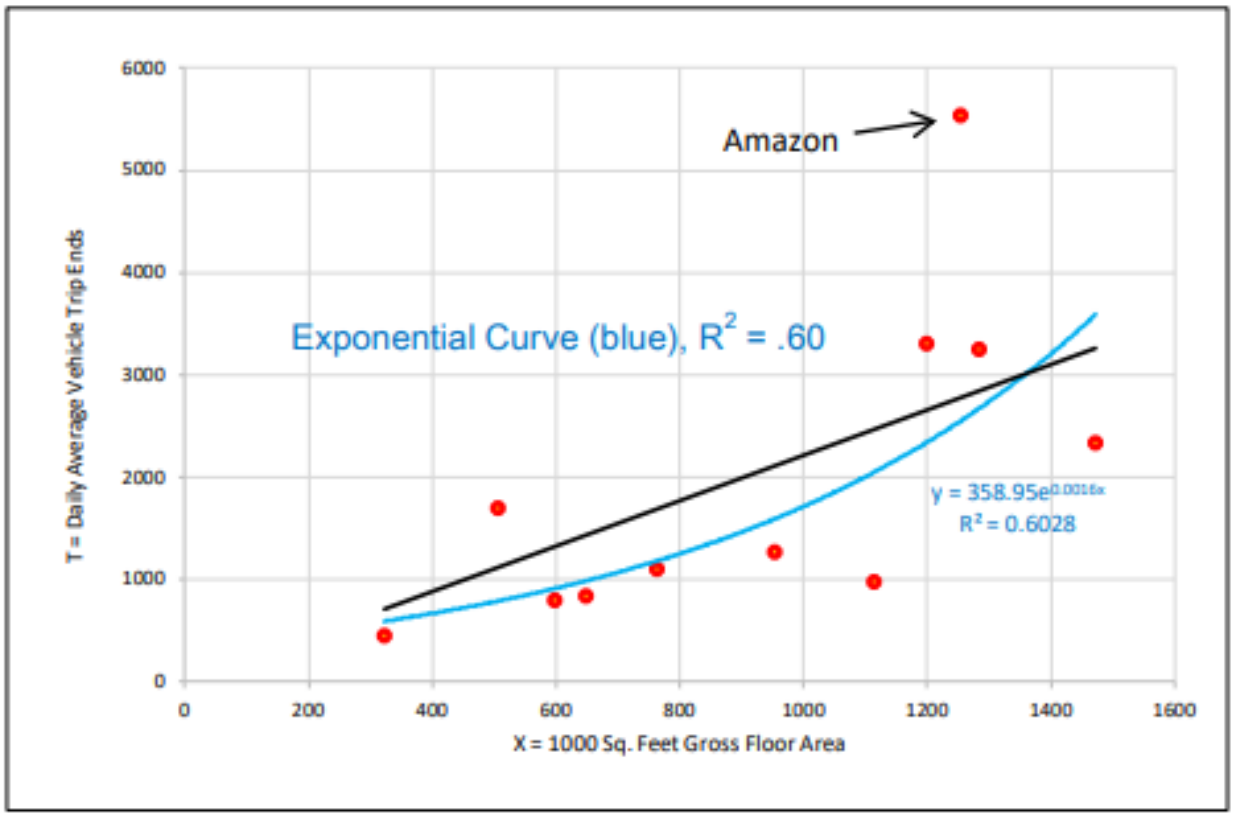

Figure J.2: Daily Vehicle Trip Generation per Thousand Feet of Space for High-Cube Warehouses.
Source: TUMF High-Cube Warehouse Trip Generation Study, 2019

An Amazon fulfillment warehouse was an outlier in the trip rate per employee, having a significantly lower rate than other high-cube warehouses. This illustrates how the automation and operations of Amazon sites is different from other types of warehouse.

Daily trip generation for an Amazon fulfillment warehouse is cited in the Western River Study as 4.480 per thousand square feet. With a planned size of 625,000 square feet, the Amazon warehouse site in El Paso site is estimated to produce 2,800 daily trips. The warehouse site is estimated to generate a total of 1,391 trips in the inbound direction (542 trucks), and 1,409 trips in the outbound direction (648 trucks) per day.

Table J.1 presents the estimated distribution of the daily trips by combination trucks and other commercial vehicles for the El Paso warehouse by time period for inbound and outbound trips, as derived from factors presented in the NCHRP study. It should be noted that Amazon

fulfillment warehouses have round-the-clock shifts, so this can result in a steady distribution of trips throughout the day[2].

Table J.1: Estimated Trips by Direction, Time Period, and Vehicle Type

		Inbound Direction			Outbound Direction		
	Two-way Total	Total	Trucks	Other	Total	Trucks	Other
AM Peak Period	676	507	198	309	169	78	91
Midday	802	401	173	228	401	181	220
Afternoon	677	251	108	143	426	183	243
PM Peak Period	645	232	107	125	413	231	182
Daily Total	2,800	1,391	586	805	1,409	673	736

Source: CDM Smith, 2021

3.0 Intersection Analysis

A comparison of the volumes used in the Horizon Boulevard Study (Build 2040) with the volumes used in the I-10 Widening Study (Build 2043) revealed that the total number of vehicles entering the interchange of I-10/Horizon Boulevard from the I-10 Widening Study was approximately 30,200 greater than what was considered in the Horizon Boulevard Study. The additional 30,200 daily trips is significantly higher than the estimated 2,800 trips generated by the Amazon fulfillment warehouse; therefore, the study team will use the volumes developed by the *I-10 Widening Study Traffic Projection Memo* to study the operational impact on the interchanges of I-10/Eastlake Boulevard and I-10/Horizon Boulevard.

Figure J.3 and **Figure J.4** show the daily Build turning movement volumes from the I-10 Widening Study.

[2] Source: https://www.amazondelivers.jobs/about/warehouse-jobs

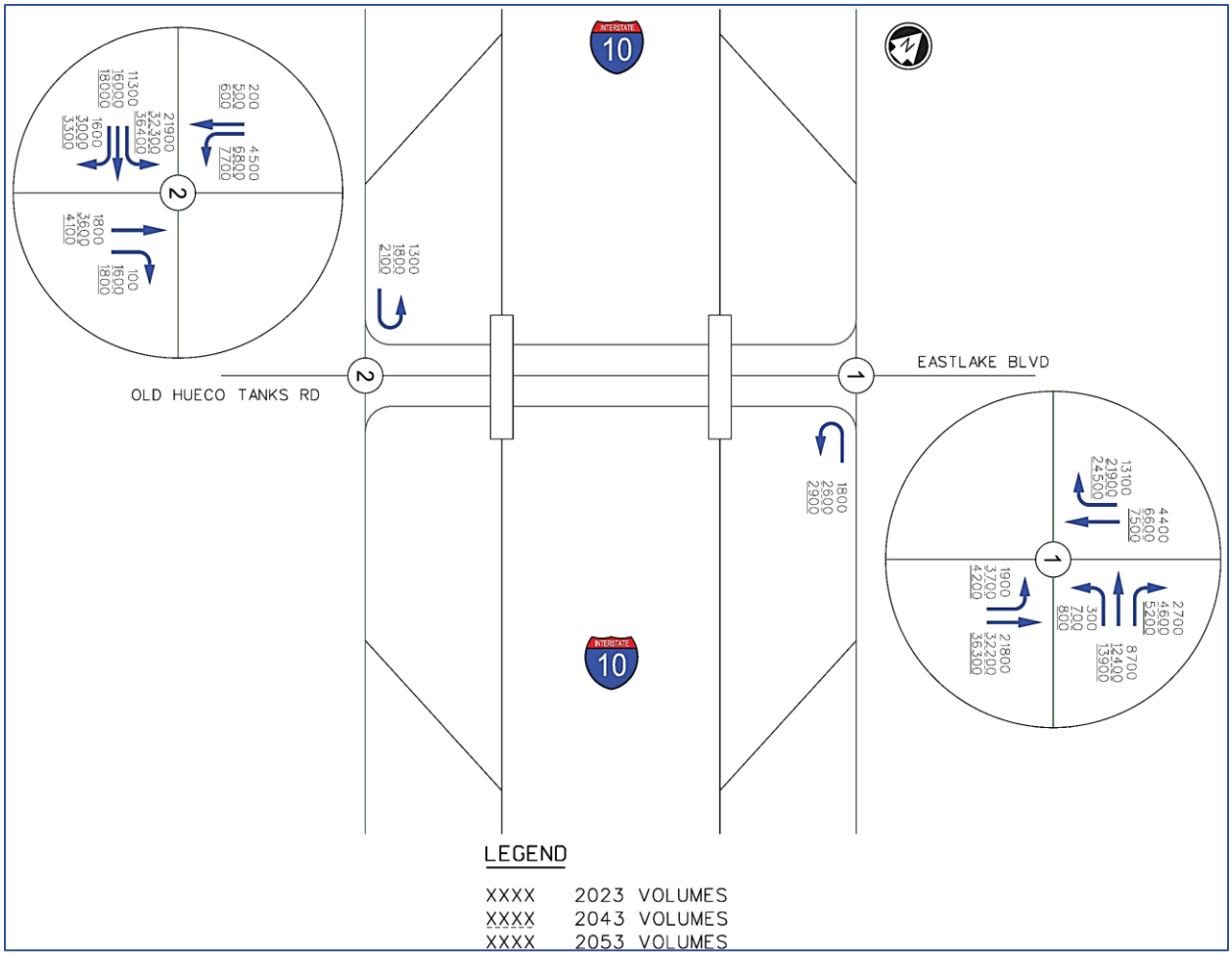

Figure J.3: Future Year Build Volumes at Eastlake Boulevard *Source: I-10 Widening Study, WSP, 2020*

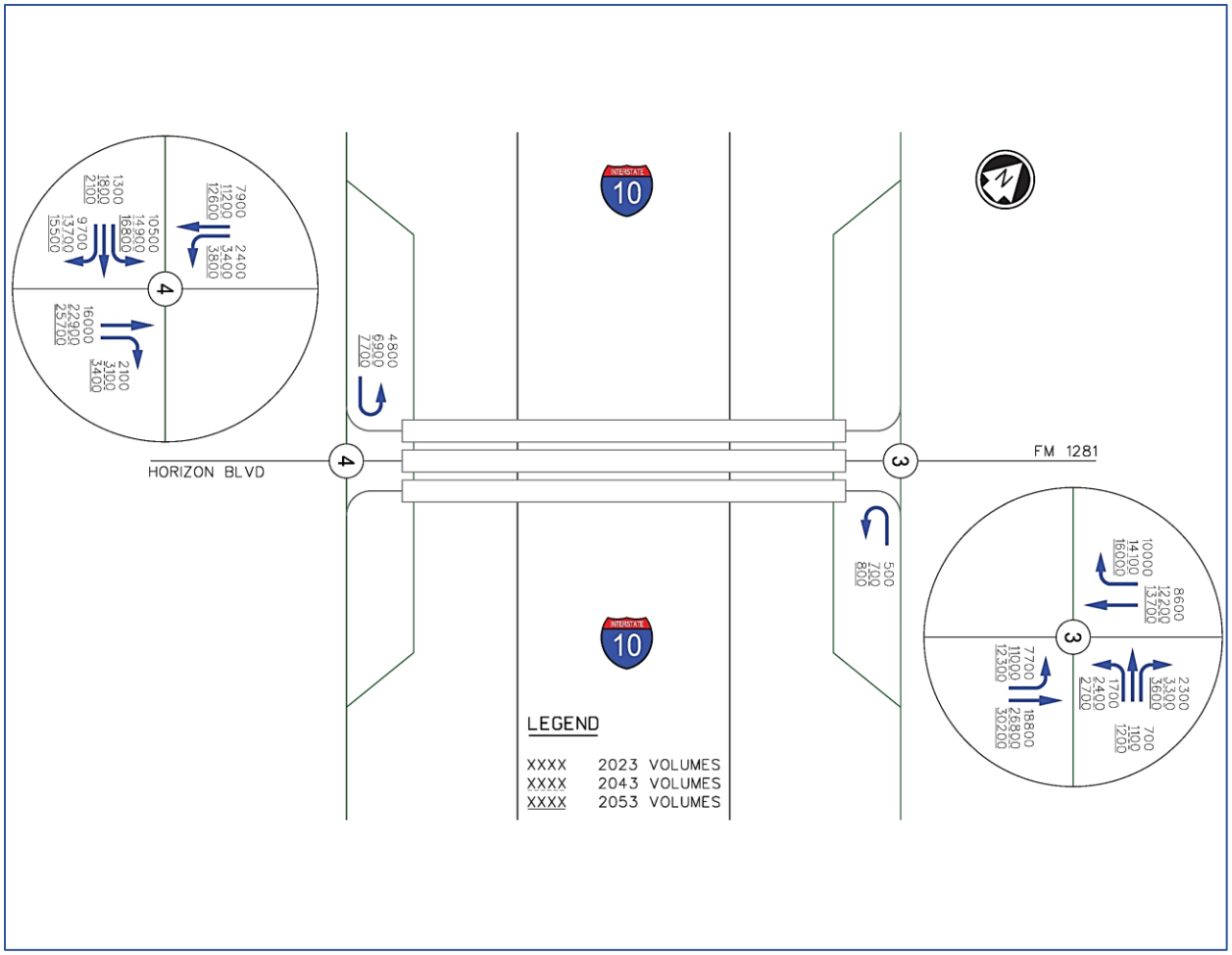

Figure J.4: Future Year Build Volumes at Horizon Boulevard *Source: I-10 Widening Study, WSP, 2020*

Four different scenarios are studied to verify whether the Diverging Diamond Interchange (DDI) still operates with acceptable level-of-service at the interchanges of I-10/Horizon Boulevard and I-10/Eastlake Boulevard. The four scenarios are listed below:

1. DDI at I-10/Eastlake Boulevard (AM Peak Hour)
2. DDI at I-10/Eastlake Boulevard (PM Peak Hour)
3. DDI at I-10/Horizon Boulevard (AM Peak Hour)
4. DDI at I-10/Horizon Boulevard (PM Peak Hour)

The steps used to determine the 2040 turning movement volumes (starting with the 2023 and 2043 turning movement volumes that were provided by the I-10 Widening Study) are summarized below.

a. Interpolate volumes between years 2023 and 2043 to determine the daily 2040 volumes.
b. To determine the peak hour volumes from the provided daily volumes, use factors developed using TxDOT STARS II data. The factors are determined by dividing the peak hour volume by the total daily volume.
c. Use turning movement volumes from the 2040 Horizon Boulevard Study for the Horizon Boulevard interchange and grow it by a factor to ensure that the total volume entering the intersection matches with the interpolated 2040 volumes from the I-10 Widening Study.
d. Adjust/Round volumes to ensure that turning movement volumes are balanced within the intersection.

Figure J.5 and **Figure J.6** show the AM and PM Peak hour volumes at I-10/Eastlake Boulevard and I-10/Horizon Boulevard.

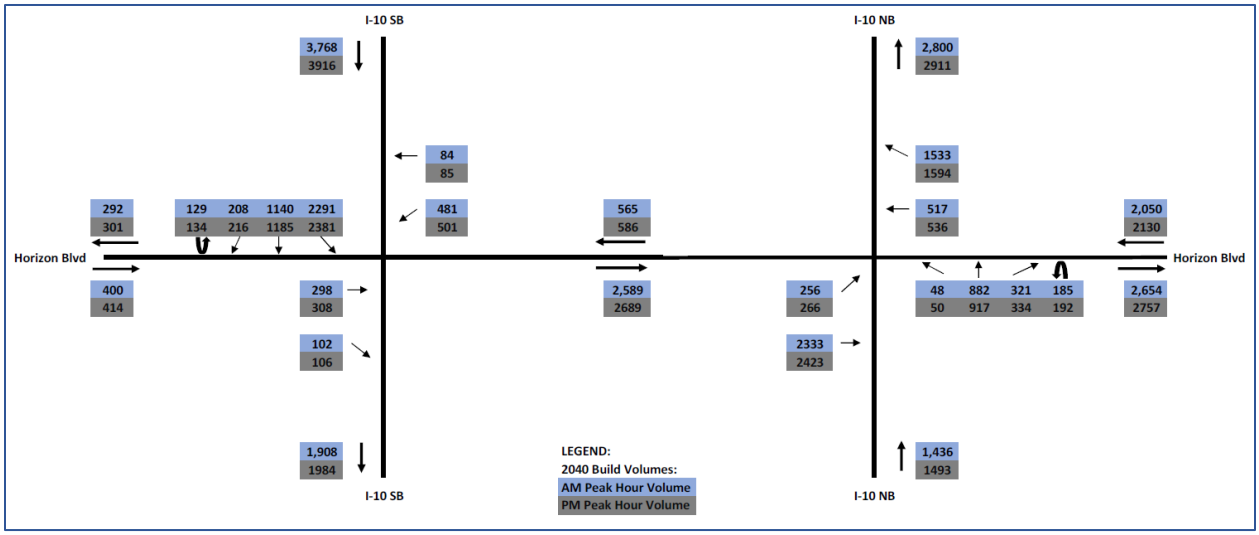

Figure J.5: 2040 Build AM and PM Peak Hour Volumes at Eastlake Boulevard *Source: CDM Smith, 2021*

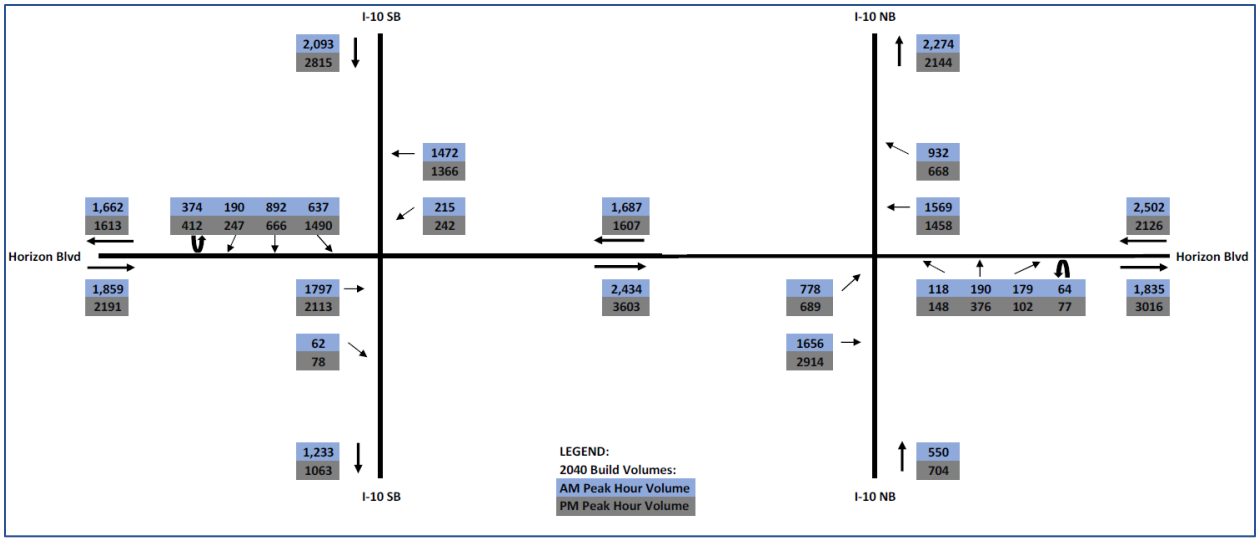

Figure J.6: 2040 Build AM and PM Peak Hour Volumes at Horizon Boulevard *Source: CDM Smith, 2021*

The next step was to input the volume data, intersection geometry, and control settings using Synchro (version 10.2). The control delay was then extracted for each Origin-Destination (O-D) turning movement to calculate overall intersection level of service.

The Highway Capacity Manual (HCM) 6th ed. has a methodology for LOS designation based on the operational performance of O-D demands through the interchange/intersection. This method is detailed in Chapter 23 with supplemental information in Chapter 34 of the HCM 6th ed. The LOS service measure is the experienced travel time (ETT) of that demand as it travels through the interchange/intersection.

The ETT is calculated based on the following formula:

$$ETT = \sum di \ + \sum EDTT$$

Where di is the control delay at each junction i and EDTT is the extra distance travel time and is calculated using the following equation:

$$EDTT = \frac{Dt}{1.47 \times vD} + a$$

Where Dt is the distance travelled along the O-D movement, vD is the design speed of that movement(mi/h), and a is the delay due to deceleration into a turn along that movement. Synchro was used to get the control delay at junctions and the deceleration delay (a) was estimated manually.

The LOS criteria as per HCM 6th ed. is represented in **Table J.2.**

Table J.2: LOS Criteria for Signalized Interchanges and Alternative Intersections

LOS	Signalized Interchanges ETT (s/veh)
A	≤15
B	> 15 – 30
C	> 30 – 55
D	> 55 – 85
E	> 85 – 120
F	> 120

Source: HCM 6th ed.

Table J.3 and **Figure J.7** show the summarized results for the interchange of I-10 Frontage Roads at Eastlake Boulevard. The results show that the overall interchange level of service during AM and PM peak hours is C, which is a desirable outcome.

Table J.3: Level of Service Results at Interchange of I-10 Frontage Roads at Eastlake Boulevard

Movement	Control Delay Components	AM Peak Hour (7-8 AM) Demand (vph)	ETT (s/veh)	LOS	PM Peak Hour (5-6 PM) Demand (vph)	ETT (s/veh)	LOS
NBU	M3	185	21.7	B	192	20.5	B
NBL	M3+M5	48	26.4	B	50	25.1	B
NBR	M4	321	17.4	B	334	21.5	B
SBR	M8	208	15.6	B	216	16.1	B
SBU	M7	129	33.2	C	134	40.9	C
SBL	M7+M1	2291	51.5	C	2381	69.4	D
EBL	M6	256	24.1	B	266	24.2	B
WBL	M2	481	17.9	B	501	20.7	B
EBT	M6+M1	42	42.4	C	42	52.7	C
WBT	M2+M5	36	22.6	B	35	25.3	B
Overall	All	3997	38.5	C	4151	49.7	C

Source: CDM Smith, 2021

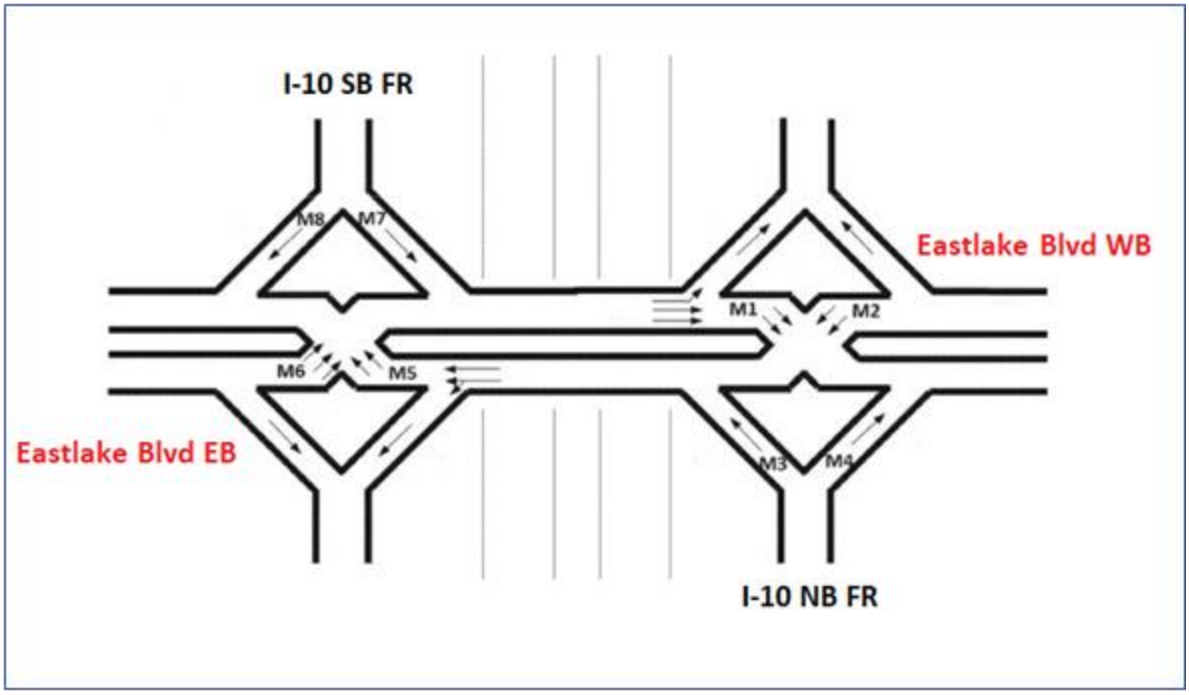

Figure J.7: Intersection Delay Components at Interchange of I-10 Frontage Roads at Eastlake Boulevard *Source: CDM Smith, 2021*

Table J.4 and **Figure J.8** present the summarized results for the interchange of I-10/Horizon Boulevard. The results show that the level of service for the overall interchange during the PM peak hour is D, which is acceptable but not a desirable outcome.

Table J.4: Level of Service Results at Interchange of I-10 Frontage Roads at Horizon Boulevard

Movement	Control Delay Components	AM Peak Hour (7-8 AM) Demand (vph)	AM Peak Hour (7-8 AM) ETT (s/veh)	AM Peak Hour (7-8 AM) LOS	PM Peak Hour (5-6 PM) Demand (vph)	PM Peak Hour (5-6 PM) ETT (s/veh)	PM Peak Hour (5-6 PM) LOS
NBU	M3	64	21.4	B	77	16.5	B
NBL	M3+M5	118	50.6	C	148	52.5	C
NBR	M4	178	9.2	A	102	20.0	B
SBR	M8	190	8.4	A	247	12.3	A
SBU	M7	373	22.2	B	411	48.3	C
SBL	M7+M1	636	36.6	C	1488	83.3	D
EBL	M6	777	26.9	B	688	39.3	C
WBL	M2	214	16.2	B	241	34.2	C
EBT	M6+M1	1018	41.3	C	1423	74.3	D
WBT	M2+M5	1353	45.3	C	1216	70.2	D
Overall	All	4920	34.5	C	6041	63.6	D

Source: CDM Smith, 2021

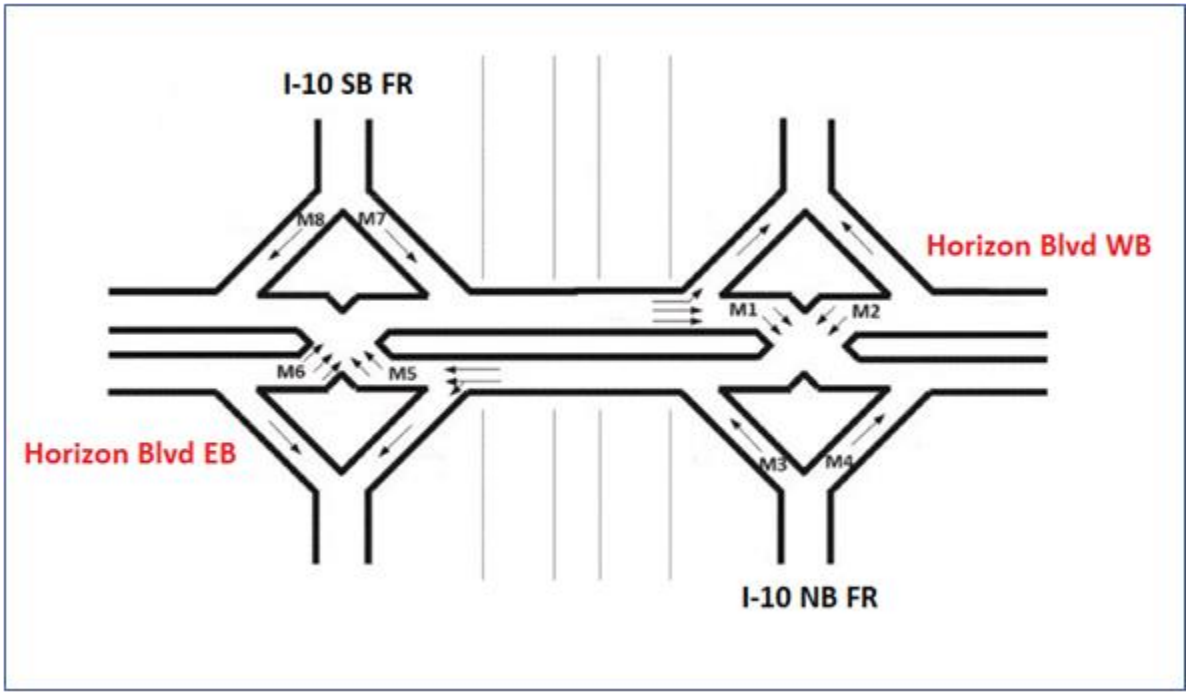

Figure J.8: Intersection Delay Components at Interchange of I-10 Frontage Roads at Horizon Boulevard *Source: CDM Smith, 2021*

4.0 Conclusions

The traffic impacts of the Amazon fulfillment warehouse in El Paso were investigated in the context of a high-level planning study. The key takeaways of this study are summarized in this section.

The traffic impacts produced by the Amazon fulfillment site can be accounted for using a high growth volume forecasting scenario from the I-10 widening study. This high growth scenario flags potential LOS issues at I-10/Horizon intersection (overall intersection LOS D during peak PM hour – which is acceptable but not desirable). This may necessitate revisiting existing recommendations in Horizon Boulevard CMP Chapter 7, as the future growth may necessitate the reprioritization of certain long-term improvements, meaning that they may have to be implemented on a shorter timeframe.

Additional information could be estimated from TDM and VISSIM Modeling in a future study for determining impacts on LOS for road links and intersections. Models could provide more precise information for estimating appropriate timelines for recommended improvements in the Horizon CMP. A future study could also access the El Paso TDM model to obtain trip generation rates by trip purpose, which could provide a more accurate estimated volumes and patterns.

Additional truck traffic around the Amazon site could suggest the need for examining multimodal improvements around Eastlake Boulevard and Rojas Drive. Multimodal improvements may need to be extended outside of study area to create linkages and safeguard this population and ensure safety along travel paths. Additional Amazon workers could also have significant impact on pedestrian, bicycle and transit demand.

Amazon fulfillment warehouses have around-the-clock shifts, so site trips will likely be around-the-clock. A future study could investigate lighting and signage needs to ensure road safety at all times. Finally, a formal Traffic Impact Analysis (TIA) study is recommended to investigate traffic patterns and operational impacts on nearby intersections.