Project No. 10-23 KA-3634-01

SLT South Lawrence Trafficway

APPENDIX D: Traffic & Safety Report

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Kansas Department of Transportation

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KDOT IKE THE EISENHOWER LEGACY TRANSPORTATION PROGRAM

Appendix D

South Lawrence Trafficway – West Leg
Supplemental Environmental Impact Statement

Traffic & Safety Appendix

November 30, 2020

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1.0 Introduction

The Kansas Department of Transportation (KDOT) is conducting a supplemental environmental impact statement (SEIS) for the South Lawrence Trafficway (SLT). To support the SEIS process extensive traffic and safety analysis has been performed for the project area. The SEIS Traffic and Safety study summarized the analysis performed and is a continuation of the *K-10 West Leg South Lawrence Trafficway Concept Study, 2019*. The Concept Study and this Appendix also provide support to the SEIS document.

2.0 Methodology

The study approach was to analyze traffic operations and safety along the South Lawrence Trafficway's west leg to better understand current conditions, future no-build, and build conditions. Important elements of the approach and study methodology include the:

- Traffic Demand
- Operational Analysis
- Safety Analysis
- Traffic and Revenue

2.1 Traffic Demand

Existing AM and PM peak hour traffic operations analysis was conducted by collecting existing 2017 and 2018 traffic volumes along the SLT mainline and at the study intersections after the SLT East Leg was open in 2016. Peak hour turning movement data was collected at seven interchanges along the corridor. The intersection data collected included personal vehicles and trucks.

Future 2045 design year traffic forecasts were developed by KDOT for Future No-Build and Build Toll-Free Freeway based on future Lawrence land use plans, the Lawrence/Douglas County travel demand model and historical trends. The 2045 design year traffic forecasts for the Future Build Tolled Freeway using an express toll lane (ETL) were developed by the study team using KDOT's 5-County travel demand model. The 5-County model was used to capture toll users on a wider regional basis.

Future forecasts were developed for daily, AM and PM peak hour time periods.

2.2 Operation Analysis

A VISSIM (version 11) micro simulation model was developed for the study corridor to analyze existing and future traffic operations. The existing VISSIM model was calibrated to current 2017/2018 conditions (post SLT East Leg opening) based on traffic data, travel time runs, and saturation flow rates collected in the field. The calibrated model was approved by KDOT staff and provided to KDOT.

Traffic operations were analyzed based on the Highway Capacity Manual (HCM) 6th Edition Level of Service (LOS) Thresholds as shown in Table 1. KDOT's standard is to achieve LOS D or better for each intersection and highway segment.

Table 1: HCM LOS Thresholds

Facility Type	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	Measure
Signalized Intersection	≤10	>10-20	>20-35	>35-55	>55-80	>80	Delay (sec/veh) – total Int.
Unsignalized Intersection	≤10	>10-15	>15-25	>25-35	>35-50	>50	Delay (sec/veh) – worst leg
Class 1 Two-Lane Highway	>55	>50-55	>45-50	>40-45	≤40	NA	Avg. Travel Speed (MPH)
Basic Freeway Segment	≤11	>11-18	>18-26	>26-35	>35-45	>45	Density (pc/mi/ln)
Merge/Diverge Freeway Segment	≤10	>10-20	>20-28	>28-35	>35	DEC*	Density (pc/mi/ln)
Weave Freeway Segment	≤10	>10-20	>20-28	>28-35	>35	DEC*	Density (pc/mi/ln)

Source: Highway Capacity Manual, V8
DEC = Demand Exceeds Capacity

Synchro was used to store the existing traffic signal data and optimize the traffic signal timings for future scenarios. Synchro was also used to analyze initial interchange concepts prior to the reasonable alternative analysis.

Two-Lane Interim Highway Analysis

The SLT two-lane highway analysis was completed using HCS7 version 7.8.5 highway capacity software which was released in 2018. The purpose of the analysis was to determine how long an improved two-lane highway could operate at a safe level. The study area of SLT consisted of the eastbound and westbound roadway segments between Iowa Street and US 40/6th Street.

The existing two-lane segments between US 40/6th Street and I-70 were removed from the two-lane analysis after HCS and VISSIM analysis indicated that the existing two-lane facility would require upgrades to a four-lane facility as part of the initial improvements.

The HCS two-lane highway models assumed a speed of 65 mph to match the existing posted speed limit on the existing trafficway. Between Iowa Street and US 40/6th Street, the existing Wakarusa at-grade intersection was removed, and a new interchange was included. Within the analysis limits, the new interchange at Clinton Parkway and associated alignment improvements were also included. These geometric modifications included updated passing zones along SLT. The results provided by the HCS7 software reflect the latest version of the Highway Capacity Manual (HCM) version 6. This includes an addendum that was published in late 2018 that calculates the level of service (LOS) of a two-lane highway based on car follower density. This overrides the previous method of calculating LOS of a two-lane highway based on average travel speeds and percent time spent following. The HCM LOS thresholds for a two-lane highway is shown in Table 2.

Table 2: Level of Service for Two-Lane Highways from HCM Exhibit 15-6

	Follower Density (followers/mile) **Posted Speed Limit ≥ 50 mph**
LOS A	≤ 2.0
LOS B	> 2.0 – 4.0
LOS C	> 4.0 – 8.0
LOS D	> 8.0 – 12.0
LOS E	> 12.0
LOS F	Demand Exceeds Capacity

Source: HCM, V8

2.3 Safety Analysis

Georeferenced safety data was provided by KDOT along the study corridor from 2012 through 2019. The safety data was used to perform a safety assessment of total vehicle crashes by severity, type, and location for before and after the opening of the SLT East Leg. A detailed study of crashes along US 40 between I-70 and SLT was conducted separately from this analysis. Its results are included in Attachment C to this report.

A Highway Safety Manual analysis of future conditions was not conducted as part of this study, instead Crash Modification Factors were researched to develop a narrative of potential impacts under build alternatives.

2.4 Tolling

Traffic and Revenue

Toll-free traffic forecasts developed for the SLT were used to establish tolled daily traffic projections for a 30-year period. Tolled projections were developed to represent an opening year of 2025 and a bonding year of 2055. Tolled traffic and toll revenue estimates were developed for one improvement scenario consisting of one general purpose lane and one express toll lane in each direction.

Using the forecasted 30-year gross revenue, estimates of anticipated net revenue were developed accounting for annual costs for toll collection and toll operations, maintenance of the toll systems and express toll lanes, and anticipated replacement costs over the 30-year period. The resulting 30-year net revenue was determined. No financial analysis was completed of the revenue forecasts. Financial analysis is part of a formal Toll Feasibility Study which is done at the request of the local community.

A number of traffic and revenue assumptions were reviewed with KDOT and KTA and then used in the analysis to develop reasonable ranges of forecasts representing the likely order-of-magnitude toll traffic volumes and toll revenue. These assumptions are shown in Table 3.

Table 3: Traffic and Revenue Assumptions

T&R Factor	SLT Assumption
Leakage	7%
Truck Percent	6.5%
Annualization Factor	300
Value of Time	$30
Truck Multiplier	3
Car Toll Rate Inflation	2%
Toll Rate	$0.15 (2025)
GP/ETL Splits	for 2025, used the 2040 model splits

3.0 Traffic Demand

Existing AM and PM peak hour traffic was collected in 2014 for the Concept Study and updated in 2017 and 2018 for the SEIS after the opening of the SLT East Leg in 2016. Traffic counts were collected along the SLT mainline, intersections along the mainline and in Lawrence. Future 2040 design year traffic forecasts were initially developed by KDOT based on future Lawrence land use plans, the Lawrence/Douglas County travel demand model and historical trends for the Concept Study and updated to 2045 design year traffic forecasts for the SEIS. Future traffic was developed for a No-Build condition and a Build condition. The No-Build represents a four-lane freeway on the east leg of the SLT and the existing two-lane expressway on the west leg. The Build represents a four-lane freeway on the east leg of the SLT and either a new four-lane toll-free freeway on the west leg or one freeway lane in each direction and an express toll lane in each direction on the west leg. Table 4 shows the existing and future ADT in the study corridor.

Table 4: Existing and Future Daily Traffic

Scenario	Estimated ADT[4]
2018 Existing[1]	20,000
2045 Future No-Build[2]	28,000
2045 Future Build	
Toll-Free[2]	43,300
Toll[3]	42,500

Source: [1]Existing Traffic Counts, [2]KDOT Forecasts,
[3]5-County Model Forecasts, [4]Estimated Corridor Averages

Existing and future AM and PM peak hour intersection turning volumes and mainline volumes are provided in Appendix A.

Two-Lane Interim Traffic Forecasts

Traffic volumes for the two-lane highway analysis were developed using the existing traffic counts collected in 2017 and 2018 after the opening of the SLT east leg in November 2016. Mainline Average Daily Traffic (ADT) traffic counts and 2045 design year traffic volumes provided by KDOT, shown in Table 5, were used to determine three interim scenarios to analyze when the two-lane facility would experience congestion problems.

Table 5: Existing and Future Mainline ADT Volumes

Location	Existing 2017-2018	KDOT Toll-Free Forecast 2045
1. SLT South of I-70	19,953	39,200
2. SLT East of Clinton Pkwy	N/A	41,800
3. SLT East of US 59	N/A	45,200
Estimated Corridor Average	**20,000**	**42,500**

Based on the existing estimated corridor average ADT of 20,000 and design year average ADT of 42,500, the three interim demand scenarios chosen for analysis were 25,000, 30,000, and 35,000 ADT. To develop peak hour volumes for each segment in the analysis, the growth factors in Table 6 were applied to the existing AM and PM peak hour volumes. Theses growth factors were calculated by determining the growth required to get from 20,000 existing ADT to the ADT for each demand scenario. The assumption was made that locations 2 and 3 in Table 6 where no existing ADT data was available would have a similar growth factor as location 1.

Table 6: ADT Scenario Growth Factors

Scenario ADT	Growth Factor
25,000	1.25
30,000	1.50
35,000	1.75

Build Tolled Traffic Forecasts

Build tolled traffic forecasts were developed differently than the Future No-Build and Future Build Toll-Free forecasts. KDOT's 5-County travel demand model was used to develop the future tolled forecast because it provides a regional perspective of travel, accounts for both local and regional traffic diversion and tolling is included in the travel model.

The travel demand model assumes a single general purpose (GP) and express toll lane (ETL) for SLT in each direction. Access points were assumed between the GP lane and ETL between every interchange with full weaves at each access point. Speeds were assumed to be posted at 70 mph for both the GP and ETL. The 2045 traffic volumes were developed using the 5-County Travel Demand Model and calibrated to be consistent with the 2045 toll-free volumes developed by KDOT. The 5-County travel demand model assumed that the SLT express toll lane would initially be set at $0.15/mile in the 2025 opening year and increase to the design year.

Ramp and mainline volumes from the travel demand model were used as a base for volume balancing in Synchro. The arterial volumes were balanced in Synchro using the same turning movement volumes as the balanced toll-free volumes and adjusted to match the ramp volumes provided by the updated travel demand model.

Initial results from the travel demand model provided low ETL volumes and high GP volumes. After further review, it was determined that the regional travel demand model could not fully capture the express toll lane demand to the level of detailed warranted. As a result, post processing of the initial 5-County travel demand model results was performed.

As a starting point in both AM and PM models, the mainline volumes were rebalanced between ETL and GP to have a maximum of 2,200 vehicles in the GP lane at any given time. The volume that was shifted out of the GP lane was put in the ETL at the start of the ETL split on the end of the model and assumed to travel through the network. The travel demand model estimated that 53% of traffic on SLT was through traffic, justifying the assumption above to push the volume through the network. Separate origin and destinations were used for the GP lane, ETL lane, and each interchange in the network for a total of eight origin/destination matrices in the AM and PM hours. The origin/destinations were balanced manually. Interchange origin/destinations were solved to match the origin/destination and turning movement volumes in the balanced Synchro file, distributing the volume proportionately at each location. GP and ETL volumes were pushed through the network as much as possible while matching the ingress and egress volumes at each weave location provided in the travel demand model. Signal timing cycle length, splits, and offsets were optimized in Synchro.

4.0 Existing Conditions

4.1 Description

Existing SLT traffic and safety conditions were analyzed based on the SLT geometric conditions as of 2018. This includes a four-lane fully access controlled freeway from US 59 east to K-10 and a two-lane expressway with at-grade intersections between Farmers Turnpike, I-70 and Wakarusa. Existing 2017 and 2018 traffic demand was assumed.

4.2 Operations

Existing peak hour traffic analysis was performed using the VISSIM simulation model. Tables 7 and 8 show the existing AM and PM peak hour level of service results for each of the SLT corridor functional areas. Level of service is also shown graphically in Appendix B.

Table 7: Existing 2018 Number of Segments at each Level of Service – AM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound					9	
SLT Eastbound				4	5	
SLT Intersections	17	3	1	2	1	1
I-70 Westbound	3	2				
I-70 Eastbound	5					
Total Number	**25**	**5**	**1**	**6**	**15**	**1**

Source: SLT VISSIM Model

Table 8: Existing 2018 Number of Segments at each Level of Service – PM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound				3	6	
SLT Eastbound					9	
SLT Intersections	14	7	1	2		1
I-70 Westbound	5					
I-70 Eastbound	2	3				
Total Number	**21**	**10**	**1**	**5**	**15**	**1**

Source: SLT VISSIM Model

As shown in the tables above, the existing AM and PM models contain segments in all levels of service. Both AM and PM have the majority of the segments in the acceptable levels of service A, B, C, and D. This indicates that those segments contain traffic that is mostly free flowing, has minimum delay, is in stable condition, or has congestion to which travel speeds are slightly decreased during the peak hours. Out of the 53 total segments accounted for, 37 (70%) of those segments were in the acceptable range in the AM and PM peak hours.

However, there were 16 (30%) segments in the AM and PM that fell into unacceptable levels of service conditions E and F along SLT. Levels of service E and F indicate high congestion and closely spaced vehicles resulting in problematic breakdowns in traffic flow. LOS E and F locations are primarily along K-10 between Iowa and I-70 and at the at-grade intersections of Wakarusa and I-70 ramp terminals.

Overall, the existing models indicate that most roadway segments are running at acceptable conditions but have enough problematic areas along eastbound and westbound SLT to indicate needed improvements.

4.3 Safety

This project represents a unique situation safety wise with the opening of a new portion of roadway during the study period. With the completion of the East Leg of SLT in 2016, traffic patterns and therefor safety were impacted. In an effort to account for this, the safety analysis was broken up into before and after the opening of the East Leg.

Since the completion of the SLT East Section in 2016, local Lawrence arterial streets are no longer used as the primary route for the SLT through Lawrence; this traffic has shifted to the SLT East and West Sections. The focus on safety remains and now includes the West Section two-lane expressway facility. An analysis of crash rates within the SLT's West Section (N 1800 Road to Iowa Street) of the SLT before and after the opening of the East Section (Iowa Street to E 23rd Street/SLT Interchange) in November 2016, shows that crash rates increased across much of the corridor after the opening of the East Section.

Table 9 shows the breakdown of crash rates before and after the opening of the SLT East Section. Crash rates for the period before opening of the East Section covers January 2012 through October 2016, four years and ten months in length. Crash rates for the period after the opening of the East Section covers December 2016 through December 2019, three years and one month in length.

Table 9: SLT Corridor Pre and Post East Section Opening Crash Rates

Analysis Segments (SLT)	SLT Pre-East Section Opening January 2012-October 2016		SLT Post-East Section Opening December 2016- December 2019	
	Crash Rate (MVMT)	Fatal Crash Rate (HMVMT)	Crash Rate (MVMT)	Fatal Crash Rate (HMVMT)
N 1800 Rd to I-70 NB Ramp Terminal	0.99	0.00	2.55*	0.00
Between I-70 Ramps	1.60*	0.00	3.38*	0.00
I-70 to W 6th St	0.26	0.00	0.55	0.00
W 6th St Interchange	0.85	0.00	0.30	0.00
W 6th St to Bob Billings Pkwy	0.46	0.00	0.40	0.00
Bob Billings Pkwy Interchange	0.46	0.00	2.85*	0.00
Bob Billings Pkwy to Clinton Pkwy	0.42	0.00	2.13*	0.00
Clinton Pkwy Interchange	0.96	0.00	1.45*	9.68*

Analysis Segments (SLT)	SLT Pre-East Section Opening January 2012-October 2016		SLT Post-East Section Opening December 2016- December 2019	
	Crash Rate (MVMT)	Fatal Crash Rate (HMVMT)	Crash Rate (MVMT)	Fatal Crash Rate (HMVMT)
Clinton Pkwy to W 27th St	0.49	0.00	0.97	0.00
W 27th St to Kasold Dr (E1200)	0.65	1.91*	1.91*	0.00
Kasold Dr (E1200) to Iowa St	0.71	4.74*	1.04*	6.49*
Corridor Total	0.59	0.85	1.35*	1.19
Two Lane Undivided Rural Highway with Partial Access Control - Statewide Average Crash Rates	1.054	2.120	0.997	1.312

MVMT - Million Vehicle Miles Traveled
HMVMT - Hundred Million Vehicle Miles Traveled
* indicates exceeds statewide average crash rate.
Pre-East Section Opening Statewide Crash Rates 2012-2016
Post East Section Opening Statewide Crash Rates 2014-2018

After the opening of the East Section in 2016, there were seven segments on the West Section with crash rates that exceeded the statewide average for similar facilities: N 1800 Road to I-70 WB Ramp Terminal, between the I-70 Ramp Terminals, Bob Billings Parkway Interchange, Bob Billings Parkway to Clinton Parkway, Clinton Parkway Interchange, W 27th Street to Kasold Drive, and Kasold Drive to Iowa Street. Before the opening of the East Section, only one segment experienced crash rates above the statewide average. This indicates that crash rates have worsened in comparison to the statewide average crash rate for similar facilities since the opening of the East Section.

Table 10 shows the crashes by severity of crashes for the SLT corridor before and after the opening of the East Section. The crashes are subdivided into three severity categories – Property Damage Only (PDO), Injury Crashes and Fatal Crashes.

Table 10: SLT Corridor Pre and Post East Section Opening Crashes by Severity Category

Analysis Segments (SLT)	Pre-East Leg Opening January 2012-October 2016				Post-East Leg Opening December 2016-December 2019			
	Fatal Crashes	Injury Crashes	Property Damage Only	Total Crashes	Fatal Crashes	Injury Crashes	Property Damage Only	Total Crashes
N 1800th Rd to E 850 Rd	0	1	3	4	0	0	2	2
E 850 Rd - Between I-70 Ramps	0	3	4	7	0	1	5	6
I-70 to W 6th St	0	3	8	11	0	1	17	18
6th St Interchange	0	0	16	16	0	1	2	3
6th St to Bob Billings	0	0	3	3	0	0	2	2
Bob Billings Interchange	0	1	8	9	0	4	33	37
Bob Billings to Clinton Pkwy	0	2	6	8	0	3	20	23
Clinton Pkwy Interchange	0	2	13	15	1	3	11	15
Clinton Pkwy to W 27th St	0	2	16	18	0	4	22	26
W 27th St to Kasold (E1200)	1	9	24	34	0	16	62	78
Kasold (E1200) to Iowa St	1	1	13	15	1	4	11	16
Total	**2**	**24**	**114**	**140**	**2**	**37**	**187**	**226**

Source: KDOT Crash Records

Two fatal crashes occurred during the almost five-year period before the opening of the East Section, one between W 27th Street and Kasold Drive and another between Kasold Drive and Iowa Street. Crash severity is a concern in this portion of the corridor due to the at-grade, signalized intersection at W 27th Street and SLT. Two fatal crashes occurred after the opening of the East Section, one fatality was at the Clinton Parkway curve and the other was between US-59/Iowa Street and Kasold Drive.

Table 11 shows the crashes by type for the SLT corridor before and after the opening of the East Section.

Table 11: SLT Corridor Pre and Post East Section Opening Crashes by Type

Accident Type (K-10)	Pre-East Leg Opening January 2012 - October 2016	Post-East Leg Opening December 2016 - December 2019
Head On	4	4
Rear End	42	88
Angle	19	39
Sideswipe	20	30
Single Vehicle	163	159
Other	3	5
Total Accidents	**251**	**325**

Source: KDOT Crash Records

The most common types of crashes on the SLT corridor during the pre-East Section opening period outside of single vehicle crashes include rear end and sideswipe crashes with 42 and 20 crashes respectively, followed by angle with 19 crashes. After the opening of the East Section rear end crashes remained the single highest crash type outside of single vehicle with 88 crashes. Angle and sideswipe crashes followed with 39 and 30 crashes respectively.

Local Arterials

Crash frequency in crashes per year for select arterials within the city of Lawrence were calculated for a period before and after the opening of the East Section in November 2016. The portion of Haskell Avenue at the SLT Highway Ramp Terminals was not constructed before the completion of the East Section, therefore it is shown as “Not Built” in the table below.
12 below shows the crash frequency by year for select arterials within the City of Lawrence that connect to the SLT.

Table 12: Local Arterial Street Pre and Post SLT East Section Opening Crashes Per Year

Street	Analysis Segments (SLT)	January 2012-October 2016		December 2016-December 2019	
		All Crashes	Fatal Crashes	All Crashes	Fatal Crashes
Iowa St	N 1100 Rd to N 1250 Rd	5.38	0.00	13.30	0.00
Iowa St	N 1250 Rd to K-10 EB Ramp Terminal	0.41	0.00	0.32	0.00
Iowa St	K-10 Interchange	1.86	0.00	0.00	0.00
Iowa St	K-10 WB Ramp Terminal to W 34th St	2.28	0.00	3.57	0.00
Iowa St	W 34th St to W 33rd St	5.59	0.00	6.81	0.00
Iowa St	W 33rd St to W 31st St	13.66	0.00	29.84	0.00

Street	Analysis Segments (SLT)	January 2012-October 2016		December 2016-December 2019	
		All Crashes	Fatal Crashes	All Crashes	Fatal Crashes
Iowa St	W 31st St to Clinton Pkwy	78.67	0.00	107.36	0.00
Iowa St	Clinton Pkwy to Bob Billings Pkwy	62.32	0.00	53.52	0.00
Iowa St	Bob Billings Pkwy to W 6th St	60.25	0.00	51.57	3.08
Iowa St	I-70 to south of Princeton Blvd	2.28	0.00	2.59	0.00
Iowa St	I-70 to N 1800 Rd	1.66	0.00	2.27	0.00
McDonald Dr	W 6th St to I-70 Ramps	15.94	0.00	22.71	0.00
McDonald Dr	Between I-70 Ramps	0.41	0.00	0.00	0.00
E 1200 Rd	K-10 to W 31st St	1.04	0.00	0.32	0.00
Kasold Dr	W 31st St to Clinton Pkwy	12.63	0.00	6.81	3.08
Kasold Dr	Clinton Pkwy to Bob Billings	13.04	0.00	12.97	0.00
Kasold Dr	Bob Billings Pkwy to W 6th St	22.77	0.00	12.65	0.00
Kasold Dr	W 6th St to N 1800 Rd	6.00	0.00	4.54	0.00
Wakarusa Dr	K-10 to Clinton Pkwy	4.14	0.00	3.57	0.00
Wakarusa Dr	Clinton Pkwy to Bob Billings	10.56	0.00	12.65	0.00
Wakarusa Dr	Bob Billings Pkwy to W 6th St	15.94	0.00	17.19	0.00
6th St	Between K-10 Ramp Terminals to Wakarusa Dr	0.62	0.00	0.00	0.00
6th St	6th St Interchange NB Ramp Terminal to Wakarusa Dr	16.77	0.00	19.14	0.00
6th St	Wakarusa Dr to Kasold Dr	45.34	0.21	64.22	0.00
6th St	Kasold Dr to Iowa St	70.39	0.00	68.44	0.00
Bob Billings	Between K-10 Ramps	0.00	0.00	0.32	0.00
Bob Billings	K-10 Interchange to Wakarusa	3.93	0.00	9.41	0.00
Bob Billings	Wakarusa Dr to Kasold Dr	18.01	0.00	24.98	0.00
Bob Billings	Kasold Dr to Iowa St	16.77	0.00	13.95	0.00
Clinton Pkwy	Between K-10 Ramps	0.00	0.00	0.00	0.00
Clinton Pkwy	K-10 Interchange to Wakarusa	0.00	0.00	7.78	0.00
Clinton Pkwy	Wakarusa Dr to Kasold Dr	22.57	0.00	34.38	0.00
Clinton Pkwy	Kasold Dr to Iowa St	36.44	0.00	24.33	0.00
W 23rd St	Iowa St to Massachusetts St	139.54	0.21	127.15	0.00
W 23rd St	Massachusetts St to Haskell	51.76	0.00	33.08	0.00
W 23rd St	Haskell Ave to E Hills Dr	81.99	0.00	46.38	0.00
N 1800 Rd	Iowa St to E 1200 Rd	1.24	0.00	0.97	0.00

Street	Analysis Segments (SLT)	January 2012-October 2016		December 2016-December 2019	
		All Crashes	Fatal Crashes	All Crashes	Fatal Crashes
N 1800 Rd	E 1200 Rd to E 850 Rd (K-10)	0.83	0.00	8.11	0.32
N 1800 Rd	E 850 Rd (K-10) to E 800 Rd	1.04	0.21	0.65	0.00
N 1800 Rd	E 800 Rd to E 600 Rd	2.48	0.00	3.24	0.00
Mass. St	W 23rd St to W 6th St	77.23	0.00	88.87	0.00
Haskell Ave	Between K-10 Ramp Terminals	Not Built	Not Built	0.00	0.00
Haskell Ave	K-10 to W 23rd St	7.25	0.00	9.41	0.32
E 800 Rd	W 6th St to N 1800 Rd	0.21	0.00	0.65	0.00
All Arterial Crashes		**912.24**	**0.62**	**927.34**	**1.30**

Source: KDOT Crash Records

Post SLT East Leg opening, 22 of the 44 segments experienced a higher frequency of all crashes while four experienced an increase in fatal crash frequency. Overall, all studied arterials combined experienced a greater frequency of all crashes and fatal crashes after the opening of the East Section.

4.4 Conclusions

In summary, approximately 70 percent of the corridor is currently operating at an acceptable level of service with approximately 30% of the corridor not operating at an acceptable level of service. Poor operations primarily occur at the at grade intersections of Wakarusa and I-70 ramp terminals.

Crashes along the SLT were primarily single vehicle crashes with rear end, angle and sideswipe comprising the top four crash types. One primary area of concern was identified in the analysis, the portion of SLT between Wakarusa Dr and Iowa Street. This area had a higher rate of crashes and contains an at-grade signalized intersection on SLT.

The existing safety analysis looked at the impact of the opening of the East Leg of SLT on the arterial network and the West Leg of SLT. After the opening of the East Leg of SLT crash rates along the West Leg increased above the statewide average for similar facilities in eight segments. Prior to the opening of the East Leg only one segment exceeded the statewide average.

Crash frequency expressed as crashes per year was determined for major arterials within the City of Lawrence. After the opening of the SLT East Leg, 22 of 44 segments across 13 separate arterials saw an increase in crash frequency. This equates to roughly even split of segments experiencing increases and segments experiencing decreases in crashes. The summation of crashes across all segments indicates a slight increase in crashes along all arterial segments after the SLT East Leg opening.

The increase in crash rates on segments along SLT shows the negative safety impact of the opening of the East Leg and the increase in traffic volumes had on the roadway system.

5.0 Future No-Build Conditions

5.1 Description

Future No-Build SLT traffic and safety conditions were analyzed based on the geometric conditions as of 2018. This includes a four-lane fully access controlled freeway from US 59 east to K-10 and a two-lane expressway with at-grade intersections at Farmers Turnpike, I-70 and Wakarusa. Future 2045 design year traffic demand was assumed.

5.2 Operations

Future No-Build 2045 peak hour traffic analysis was performed using the VISSIM simulation model. Tables 13 and 14 show the existing AM and PM peak hour level of service for each of the SLT corridor functional areas. Level of service is also shown graphically in Appendix B. Minor traffic signal improvements were assumed at existing stop-controlled intersections where they were warranted in the future using MUTCD peak hour signal warrant methodology.

Table 13: Future No-Build 2045 Number of Segments at each Level of Service – AM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound		1			4	6
SLT Eastbound		3		1	3	4
SLT Intersections	5	4	6	5	1	3
I-70 Westbound		5				
I-70 Eastbound	2	3				
Total Number	**7**	**16**	**6**	**6**	**8**	**13**

Source: SLT VISSIM Model
Note: minor traffic signal improvements were assumed

Table 14: Future No-Build 2045 Number of Segments at each Level of Service – PM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound				1	3	7
SLT Eastbound	2	1			4	4
SLT Intersections	4	5	3	4	3	5
I-70 Westbound		4	1			
I-70 Eastbound	2	2		1		
Total Number	**8**	**12**	**4**	**6**	**10**	**16**

Source: SLT VISSIM Model
Note: minor traffic signal improvements were assumed

As shown in the tables above, both AM and PM future No-Build models contain segments in all levels of service categories. Both the AM and PM have a majority of segments in the acceptable levels of service A, B, C, and D. This indicates that those segments contain traffic that is free flowing, has minimal delay, is in stable condition, or has congestion to which travel speeds are slightly decreased during the peak hours. Out of the 56 segments accounted for, 35 (63%) of those segments were in the acceptable range in the AM and 30 (54%) segments were in the acceptable range in the PM.

There were 21 (37%) segments in the AM and 26 (46%) segments in the PM that fell into unacceptable levels of service conditions E and F along the westbound direction on I-70 and SLT. Levels of service E and F indicate high congestion and closely spaced vehicles resulting in problematic breakdowns in traffic flow. LOS E and F locations are primarily along K-10 between Iowa and I-70 and at the at grade intersections of Wakarusa and I-70 ramp terminals. Overall, the Future No-Build models have most segments running at acceptable conditions but have enough problematic areas along the freeway to indicate needed improvements before the year 2045.

5.3 Safety

A Highway Safety Manual (HSM) analysis was not performed for the Future No-Build scenario for this project, a qualitative assessment was conducted instead. Future traffic volumes are anticipated to increase throughout the SLT corridor, both on SLT and the local arterial network, as population increases, and new land use and development occurs within the Lawrence metro area and throughout Douglas County. This increase in traffic could strain already stressed roadways in the study area, especially if no improvements are made to the SLT West Section as local and regional traffic continues to shift to the SLT corridor. This could contribute to an increase in crash frequency and severity if no improvements are made.

There are two conditions under the No-Build scenario that have a high potential to contribute to an increase in crashes when combined with increasing traffic volumes along the SLT corridor. The two-lane cross-section of the West Leg of SLT and the at-grade intersections at I-70 and

Wakarusa. These conditions currently contribute to numerous crashes along the corridor and increasing traffic volumes without addressing these issues are expected to continue to lead to higher rates of crashes along the corridor.

5.4 Conclusions

In summary, as traffic continues to increase through 2045, nearly 40 percent of the corridor in the AM and more than 45 percent of the corridor in the PM is expected to experience unacceptable levels of service conditions E and F. LOS E and F locations are primarily at the at-grade intersections of Wakarusa and I-70 ramp terminals but would spill over into most of the remainder of the corridor.

Under the No-Build scenario crashes are expected to continue to increase along the corridor and arterial network as traffic volumes increase. Two conditions of particular safety concern under the No-Build are the two-lane cross-section of the West Leg of SLT and the at-grade intersections at I-70 and Wakarusa. Not addressing these conditions has the highest potential to impact future crashes.

6.0 Future Build Toll-Free Conditions

6.1 Description

Future Build SLT traffic and safety conditions were analyzed for the existing four-lane freeway on SLT between US 59 and K-10 and a new four-lane fully access controlled toll-free freeway on SLT between Farmers Turnpike and US 59 in the 2045 design year. An interim two-lane freeway which is fully access controlled was also analyzed. Chapter 2 of the SEIS provides a full detailed description of the Future Build Toll-Free Alternative and for each of the three Build Alternatives for the K-10 and I-70 Interchange.

6.2 Operations

SLT and I-70 North Interchange

Build toll-free 2045 peak hour traffic analysis was performed using the VISSIM simulation model for the SLT and I-70 north interchange. Table 15 and Table 16 show the future build AM and PM peak hour level of service for each of the SLT functional areas for K-10 & I-70 Interchange Alternatives 1 through 3. Level of service is also shown graphically in the Appendix B.

Table 15: Future Build – Toll-Free 2045 Number of Segments at each Level of Service by K-10 & I-70 Interchange Alternative – AM Peak

	Level of Service					
	A	B	C	D	E	F
K-10 & I-70 Interchange Alt. 1						
SLT Westbound		1				
SLT Eastbound		1				
SLT Intersections	1	1	1			
I-70 Westbound		8	1			
I-70 Eastbound		8	1			
Total	**1**	**19**	**3**	**0**	**0**	**0**
K-10 & I-70 Interchange Alt. 2						
SLT Westbound		1				
SLT Eastbound		1				
SLT Intersections	1		3			
I-70 Westbound		8	1			
I-70 Eastbound		8	1			
Total	**1**	**18**	**5**	**0**	**0**	**0**
K-10 & I-70 Interchange Alt. 3						
SLT Westbound		1				
SLT Eastbound	1					
SLT Intersections	1	2				
I-70 Westbound		3	2			
I-70 Eastbound		6	1			
Total	**2**	**12**	**3**	**0**	**0**	**0**

Source: SLT VISSIM Model

Table 16: Future Build – Toll-Free 2045 Number of Segments at each Level of Service by K-10 & I-70 Interchange Alternative – PM Peak

	Level of Service					
	A	B	C	D	E	F
K-10 & I-70 Interchange Alt. 1						
SLT Westbound	1					
SLT Eastbound		1				
SLT Intersections	2		1			
I-70 Westbound		8	1			
I-70 Eastbound		9				
Total	**3**	**18**	**2**	**0**	**0**	**0**
K-10 & I-70 Interchange Alt. 2						
SLT Westbound	1					
SLT Eastbound		1				
SLT Intersections	2		1	1		
I-70 Westbound		8	1			
I-70 Eastbound		9				
Total	**3**	**18**	**2**	**1**	**0**	**0**
K-10 & I-70 Interchange Alt. 3						
SLT Westbound	1					
SLT Eastbound		1				
SLT Intersections	3					
I-70 Westbound		4	1			
I-70 Eastbound		7				
Total	**4**	**12**	**1**	**0**	**0**	**0**

Source: SLT VISSIM Model

As shown in the tables above, the Future Build Toll-Free 2045 AM and PM models contain segments only in the acceptable levels of service A, B, C, and D. This indicates that those segments contain traffic that is primarily free flowing with minimum delay. Out of the 23 segments in K-10 & I-70 Interchange Alternative 1, 23 (100%) of those segments were in the acceptable range in the AM and the PM. Out of the 24 segments in K-10 & I-70 Interchange Alternative 2, 24 (100%) of those segments were in the acceptable range in the AM and the PM.

Out of the 17 segments in K-10 & I-70 Interchange Alternative 3, 17 (100%) were in the acceptable range in the AM and the PM.

SLT West Corridor

Build toll-free 2045 peak hour traffic analysis was performed using the VISSIM simulation model for the SLT west corridor. Table 17 and Table 18 show the future build AM and PM peak hour level of service for each of the SLT functional areas for west corridor. Level of service is also shown graphically in the Appendix B.

Table 17: Future Build – Toll-Free 2045 Number of Segments at each Level of Service South of I-70 & K-10 Interchange – AM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound	1	17	1			
SLT Eastbound	1	15	3			
SLT Intersections	7	8	3			
Total	**9**	**40**	**7**	**0**	**0**	**0**

Source: SLT VISSIM Model

Table 18: Future Build – Toll-Free 2045 Number of Segments at each Level of Service South of I-70 & K-10 Interchange – PM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound	1	14	4			
SLT Eastbound	1	18				
SLT Intersections	6	8	4			
Total	**8**	**40**	**8**	**0**	**0**	**0**

Source: SLT VISSIM Model

As shown in the tables above, the Future Build Toll-Free 2045 AM and PM models contain segments only in the acceptable levels of service A, B, and C. This indicates that those segments contain traffic that is primarily free flowing with minimum delay. Out of the 58 segments in the SLT west corridor, 58 (100%) of those segments were in the acceptable range in the AM and the PM.

Overall, the Toll-Free Build Alternatives shows no problematic areas and running at acceptable levels throughout all the models during the AM and PM peak hours. Table 19 below shows a comparison between all three K-10 & I-70 Interchange alternatives.

Table 19: Future K-10 & I-70 Interchange Alternatives Comparison

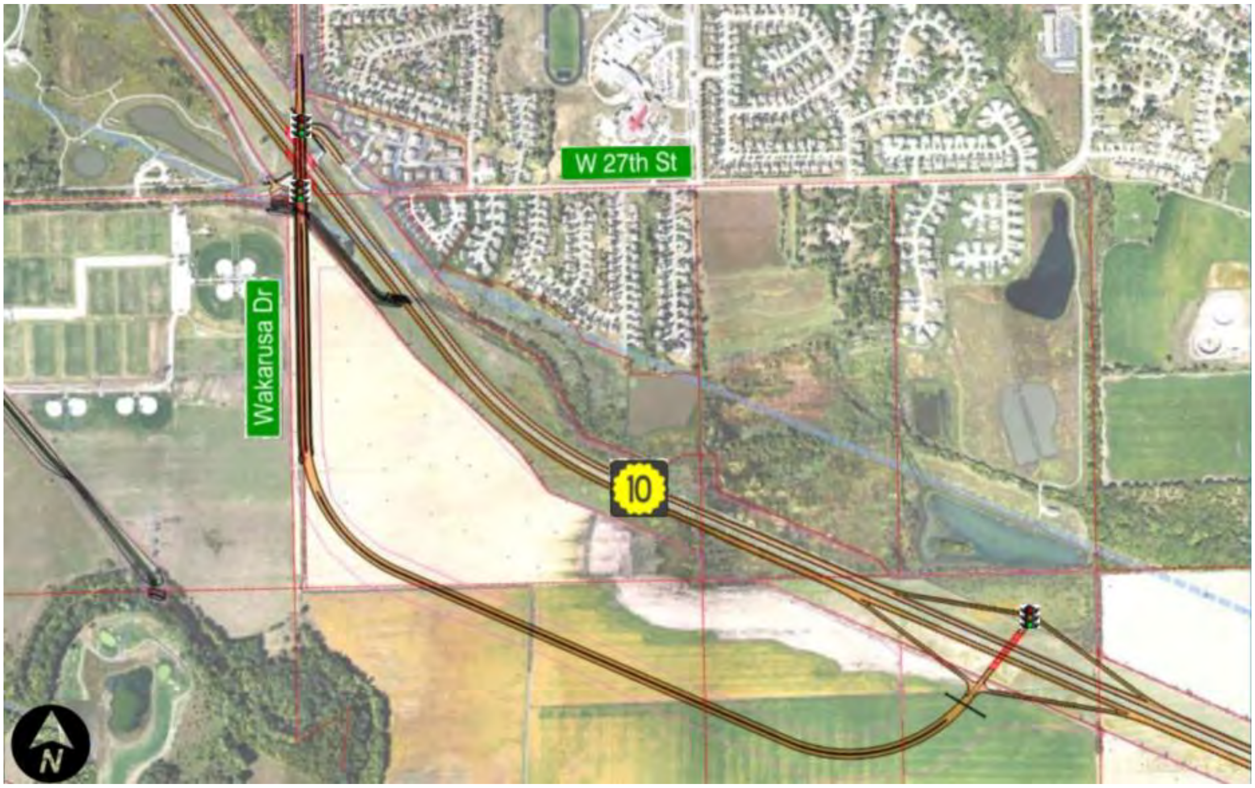
	Alt 1 **Relocated Farmer's** Turnpike Access	Alt 2 Partial Relocated **Farmer's** Turnpike Access	Alt 3 Non-Relocated **Farmer's Turnpike** Access
Intersections	All intersections operate at an acceptable level	Same	Same
Freeway	All segments operate at an acceptable level	Same	Same
Travel Times	Consistent between all alternatives	Same	Same
Travel Speeds	Consistent between all alternatives	Same	Same
Overall	Provides an efficient transformation system	Same	Same

Wakarusa Interchange Alternatives

In addition to the Build Alternatives studies at the K-10 & I-70 interchange, a series of Build interchange alternatives were also considered at the Wakarusa interchange. The analysis of alternatives was in response to input from the City of Lawrence, Douglas County, and the public gathered through the stakeholder engagement activities. The primary concern heard from these groups was with the location of the offset diamond Wakarusa interchange design, east of existing Wakarusa Drive and the out of direction travel that this location would necessitate for traffic with origins or destinations north of K-10.. As a result, two new interchange alternatives were developed and analyzed at SLT and Wakarusa Drive using the Toll-Free Build Alternative volumes and VISSIM simulation model in addition to the Offset Diamond Interchange Alternative. The three alternatives analyzed were:

- **Alternative 1, Offset Diamond Interchange** – Located approximately 1 mile east of existing Wakarusa Drive with a new connector road to provide access from the new interchange to existing Wakarusa Drive. See **Figure 1**.

Figure 1: Alternative 1, Offset Diamond Interchange



- **Alternative 2, Folded Diamond Interchange** – New ramp terminals would be located along existing Wakarusa Drive. Wakarusa Drive would be extended south approximately 0.5 mile to a new eastbound K-10 ramp terminal. See **Figure 2**.

Figure 2: Alternative 2, Folded Diamond Interchange

Note: The analysis for the Folded Diamond Interchange evaluated the use of both signalized and roundabout intersection control at both ramp terminals.

- **Alternative 3, Partial Folded Diamond Interchange** – Utilizing a folded diamond configuration for the eastbound K-10 ramps and a diamond configuration for the westbound K-10 ramps. The westbound ramps would provide intersections at existing 27th street and at Wakarusa Drive. See **Figure 3**.

Figure 3 Alternative 3, Partial Folded Diamond Interchange

Note: The analysis for the Partial Folded Diamond Interchange evaluated the use of both signalized and roundabout intersection control at both ramp terminals.

The analysis for the Folded Diamond Interchange and Partial Folded Diamond Interchange evaluated the use of both signalized and roundabout intersection control at the ramp terminals. The Offset Diamond analysis assumed a stop-controlled intersection for the eastbound ramp terminal and signalized intersection for the westbound ramp terminal. All alternatives provided intersection and local street operations at Level-of-Service C or better in the design year 2045 and there were no appreciable differences in intersection delay or queueing between the alternatives. Level of Service tables can be seen in Tables 20-22.

Table 20: Wakarusa Alternative 1 – Offset Diamond

Intersection	AM Delay	AM LOS	PM Delay	PM LOS
Wakarusa & Eastbound SLT Ramps[1]	7.9	A	9.5	A
Wakarusa & Westbound SLT Ramps[2]	8.4	A	7.7	A
Wakarusa & Wakarusa Connection[1]	15.9	C	10.8	B
Wakarusa & 27th St[2]	12.6	B	8.2	A
Wakarusa & Speicher[2]	8.5	A	3.6	A

[1]Stop-Controlled, [2]Traffic Signal
Source: HNTB VISSIM Model

Table 21: Wakarusa Alternative 2 – Folded Diamond Preferred Alternative

Intersection	AM Delay	AM LOS	PM Delay	PM LOS
Wakarusa & Eastbound SLT Ramps[1]	5.5	A	4.1	A
Wakarusa & Westbound SLT Ramps[1]	5.6	A	7.4	A
Wakarusa & 27th St.[2]	11.0	B	10.7	B
Wakarusa & Speicher[2]	6.4	A	6.0	A

[1]Roundabout, [2]Traffic Signal
Source: WSP VISSIM Model

Table 22: Wakarusa Alternative 3 – Partially Folded Diamond

Intersection	AM Delay	AM LOS	PM Delay	PM LOS
Wakarusa & Eastbound SLT Ramps[1]	5.2	A	2.4	A
27th St & Westbound SLT Exit Ramp[1]	2.9	A	6.7	A
Wakarusa & Westbound SLT Entrance Ramp[2]	15.2	B	14.9	B
Wakarusa & Speicher[2]	3.1	A	4.2	A

[1]Roundabout, [2]Traffic Signal
Source: HNTB VISSIM Model

As shown in the tables above, each intersection for all alternatives operate at acceptable levels of service.

In addition to level of service, a travel time analysis was performed between the three alternatives looking at travel times between the Clinton Parkway & Wakarusa Drive intersection and along K-10, east and west of the interchange in both directions. It's estimated that Alternatives 2 and 3 are anticipated to reduce the travel time provided by Alternative 1 by an average of 50% during the AM and PM peak hours.

Mainline operations for the basic, merge, and diverge freeway segments around the Wakarusa Drive interchange operate at acceptable levels of service in each alternative.

Each alternative includes a grade separated interchange at K-10 and Wakarusa Drive which provides a safer alternative to the existing at-grade intersection. To compare the three build alternatives, a conflict point analysis was performed and it is not anticipated that the alternatives would have a meaningful difference in safety performance.

In addition to the traffic and safety analysis summarized above, the study team also evaluated the environmental and engineering elements of each alternative, which is documented in the SEIS. Based on the comprehensive analysis and input from KDOT, the City of Lawrence, and Douglas County, the preferred alternative was identified to be Alternative 2 Folded Diamond. The decision was made to move forward with the folded diamond to better accommodate bike and pedestrian access and safety, maintain traffic diversion off of 27th Street, and meet the traffic operations and safety standards through the 2045 design year.

Interim Build

The transportation needs in Kansas are currently far exceeding the available funding for transportation improvements, subsequently KDOT faces the difficult challenge of prioritizing the investment of available statewide funding to ensure that the maximum benefit is derived from the transportation investments. One of the many tools that KDOT employs to ensure that the greatest benefit is delivered to the transportation system is through practical design or "right-sizing" of improvements to ensure that every state dollar spent on a project is delivering benefit to the traveling public and that projects are not over-built.

The SLT West Leg Draft Preferred Alternative in the ongoing SEIS is a four-lane freeway (setup for a future 6-lane freeway), fully access controlled with grade separated interchanges. Traffic and safety analysis of the corridor indicates that full implementation of the preferred alternative is needed by the 2045 design year in order to maintain KDOT's acceptable levels of service and achieve the purpose and need identified for the project. However, current project cost estimates anticipate the construction cost of the preferred alternative to be $175 million (2020 construction dollars), which represents a substantial portion of KDOT's available funds for expansion and modernization projects. Thus, the SLT Project team has investigated multiple strategies for breaking the SLT preferred alternative improvements into a series of projects that could be implemented over time, referred to as *Project Breakout Strategies*.

The project breakout strategies investigated different scenarios for implementing the full improvements by focusing on corridor priorities identified in the SEIS Purpose and Need and in the SEIS. All of the project breakout strategies involve utilization of a two-lane freeway for some period of time until the preferred alternative improvements are fully implemented. Thus, the team determined it was important to understand the level of service and safety that would be provided by a two-lane freeway and how that level of service and safety would change as traffic volumes continue to grow in the corridor.

The team tested the operation of a two-lane freeway with the following assumed improvements to be in place:

- I-70 System Interchange (no at grade intersections remain)
- Wakarusa Interchange grade separation
- K-10 alignment improvements near Clinton Pkwy
- Assumed K-10 design speed of 65 mph

The operations were evaluated under four K-10 traffic volume scenarios; 20k ADT (existing average ADT volume), 25k ADT, 30k ADT, and 40k ADT. The corridor operations for the AM and PM peak hours were evaluated using a combination of the VISSIM project traffic model and Highway Capacity Software (Car Following Density Level of Service) to obtain Levels of Service (LOS) for the 16 segments of the corridor.

Interim Build Traffic Operations

The peak hour level of service results are summarized in Table 23 below for the various volume scenarios.

Table 23: Highway Capacity Software Two-Lane Highway Level of Service Summary

ADT	AM Two-Way	PM Two-Way
20k ADT Level (Existing)[a]	**11**/14 segments – LOS E **0**/14 segments – LOS F	**11**/14 segments – LOS E **0**/14 segments – LOS F
25k ADT Level	**8**/16 segments – LOS E **0**/16 segments – LOS F	**9**/16 segments – LOS E **0**/16 segments – LOS F
30k ADT Level	**10**/16 segments – LOS E **2**/16 segments – LOS F	**9**/16 segments – LOS E **4**/16 segments – LOS F
35k ADT Level	**9**/16 segments – LOS E **6**/16 segments – LOS F	**8**/16 segments – LOS E **7**/16 segments – LOS F

[a] These values are from the pre-2018 older version of the HCS/ HCM methodology. The old methodology uses percent time spent following, while the new methodology uses car following density. The updated HCM methodology with speeds of 65 mph provide 3/14 LOS E and 0/14 LOS F segments in both AM and PM

Levels of service begin to degrade from D to E as volumes approach 25k ADT and from E to F as volumes pass 30k ADT.

KDOT typically designs to a LOS D when identifying 20-year design improvements. If KDOT wishes to stay with the LOS D design year threshold then improvement from two to four lanes is warranted by the existing traffic volumes. LOS E conditions occur in multiple locations along the corridor when traffic volumes reach 25k ADT and LOS F conditions begin to emerge at 30k ADT. Tables 24 and 25 show the Level of Service for the 25k, 30k and 35k demand scenarios analyzed.

Table 24: Future Interim Build –Number of Segments at each Level of Service – AM Peak

	Segment	Existing	25k	30k	35k
Eastbound	6th Exit - 6th Ent	C	C	D	D
Eastbound	6th Ent - Bob Billings Exit	D	E	E	E
Eastbound	Bob Billings Exit - Bob Billings Ent	C	D	E	E
Eastbound	Bob Billings Ent - Clinton Exit	D	E	E	E
Eastbound	Clinton Exit - Clinton Ent	C	D	D	E
Eastbound	Clinton Ent - Wakarusa Exit	C	D	E	E
Eastbound	Wakarusa - 1200 Rd	D			
Eastbound	Wakarusa Exit - Wakarusa Ent		C	D	E
Eastbound	1200 Rd - Iowa	D			
Eastbound	Wakarusa Ent - Iowa		E	E	F
Westbound	Iowa - Wakarusa Exit		E	E	F
Westbound	Iowa - 1200 Rd	E			
Westbound	Wakarusa Exit - Wakarusa Ent		D	D	E
Westbound	1200 Rd - Wakarusa	D			
Westbound	Wakarusa Ent- Clinton Exit	D	D	E	E
Westbound	Clinton Exit - Clinton Ent	C	D	E	E
Westbound	Clinton Ent - Bob Billings Exit	E	E	F	F
Westbound	Bob Billings Exit - Bob Billings Ent	D	E	E	F
Westbound	Bob Billings Ent - 6th Exit	E	E	F	F
Westbound	6th Exit - 6th Ent	D	E	E	F
	LOS E	3	8	10	9
	LOS F	0	0	2	6
	LOS E or F	**3**	**8**	**12**	**15**
	Total	**16**	**16**	**16**	**16**

Source: HCS Two-Lane Version 7.8.5, LOS based on Follower Density. In our Ex & FNB results presentation we had one LOS reported between Iowa & Wakarusa and did not split the segment at 1200 Rd. Totals exclude segments between 6th St & I-70

Table 25: Future Interim Build –Number of Segments at each Level of Service – PM Peak

	Segment	Existing	25k	30k	35k
Eastbound	6th Exit - 6th Ent	D	E	E	F
Eastbound	6th Ent - Bob Billings Exit	E	E	F	F
Eastbound	Bob Billings Exit - Bob Billings Ent	D	E	F	F
Eastbound	Bob Billings Ent - Clinton Exit	E	E	F	F
Eastbound	Clinton Exit - Clinton Ent	D	E	E	E
Eastbound	Clinton Ent - Wakarusa Exit	D	E	E	F
Eastbound	Wakarusa - 1200 Rd	D			
Eastbound	Wakarusa Exit - Wakarusa Ent		D	E	E
Eastbound	1200 Rd - Iowa	D			
Eastbound	Wakarusa Ent - Iowa		E	E	F
Westbound	Iowa - Wakarusa Exit		E	F	F
Westbound	Iowa - 1200 Rd	E			
Westbound	Wakarusa Exit - Wakarusa Ent		D	D	E
Westbound	1200 Rd - Wakarusa	D			
Westbound	Wakarusa Ent- Clinton Exit	C	D	E	E
Westbound	Clinton Exit - Clinton Ent	C	D	E	E
Westbound	Clinton Ent - Bob Billings Exit	D	D	E	E
Westbound	Bob Billings Exit - Bob Billings Ent	C	D	D	E
Westbound	Bob Billings Ent - 6th Exit	D	E	E	E
Westbound	6th Exit - 6th Ent	C	C	D	D
	LOS E	3	9	9	8
	LOS F	0	0	4	7
	LOS E or F	**3**	**9**	**13**	**15**
	Total	**16**	**16**	**16**	**16**

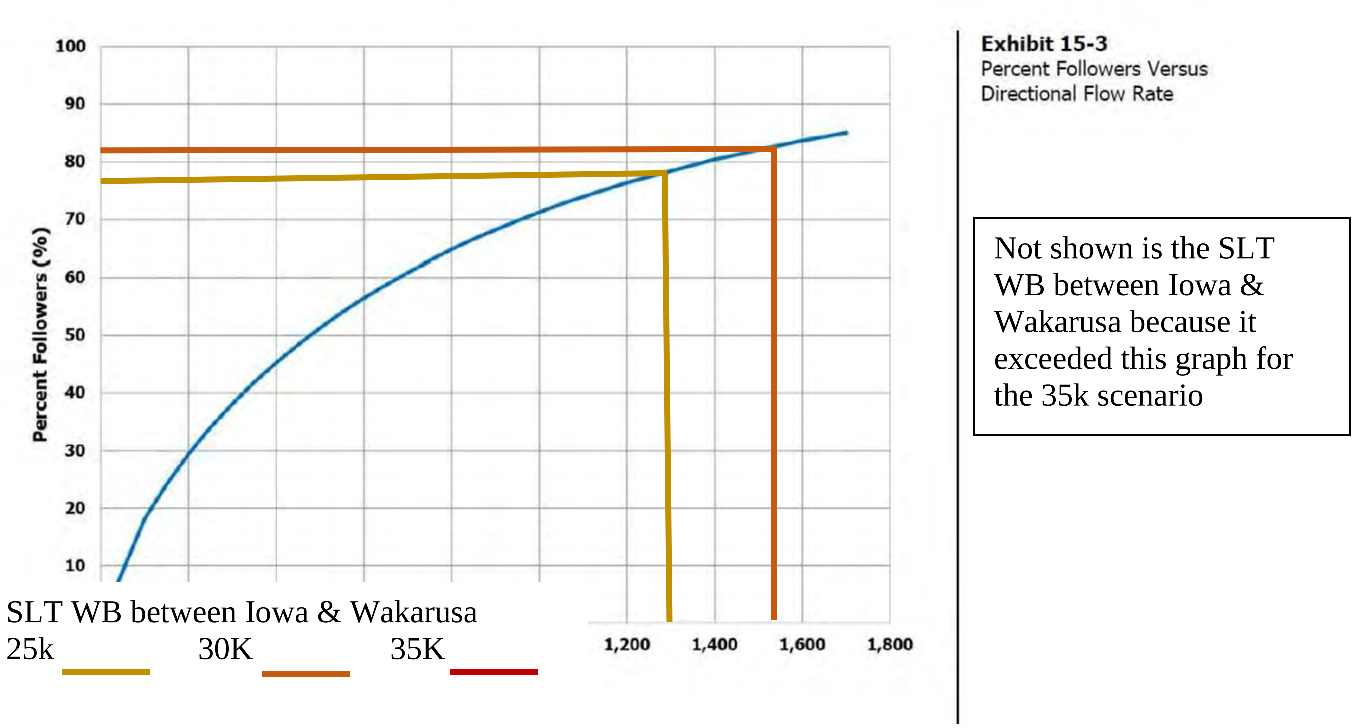
Source: HCS Two-Lane Version 7.8.5, LOS based on Follower Density. In our Ex & FNB results presentation we had one LOS reported between Iowa & Wakarusa and did not split the segment at 1200 Rd. Totals exclude segments between 6th St & I-70

The tables above show the number of segments that reach LOS E or LOS F in each of the AM and PM ADT thresholds. As shown in the tables, the number of E or F levels increase as the vehicles increase while the network geometry doesn't change from the Existing network.

During the AM peak hour LOS drops from E to F between 25k and 30k ADT between the Clinton Parkway Interchange and 6th Street Interchange. During the PM peak hour, LOS drops from E to F between 25k and 30k ADT between the 6th Street Interchange and Clinton Parkway Interchange as well as between the Iowa Interchange and Wakarusa Interchange.

The HCM provides graphics which show how the directional flow rates correlate to the percent followers and follower densities. Figures 4 and 5 below illustrate these HCM graphs with examples of where the SLT volumes fall on these graphs at a couple locations in the PM peak hour.

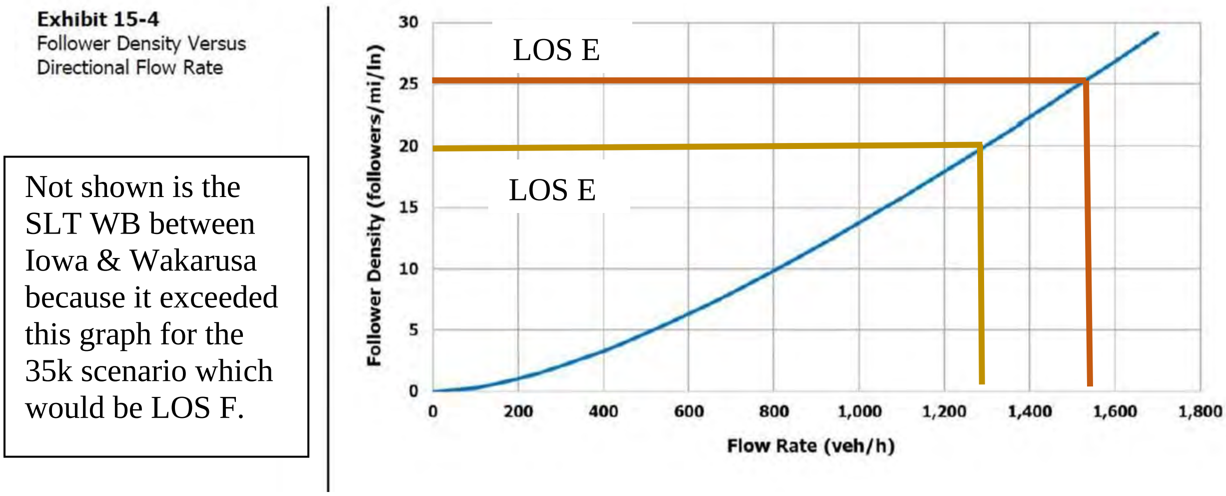
Figure 4: Percent Followers Versus Direction Flow Rate HCM Exhibit 15-3 Westbound PM Peak Hour



Source: Highway Capacity Manual, 6th Edition

Figure 1 above shows that in the westbound direction of the PM peak hour between Iowa and Wakarusa, the 25,000 ADT scenario estimates percent followers in the high 70's. In the 30,000 ADT scenario the percent followers are estimated above 80 percent, but by 35,000 ADT scenario, the volume exceeds the capacity of a two-lane highway.

Figure 5: Follower Density Versus Direction Flow Rate HCM Exhibit 15-4
Westbound PM Peak Hour



SLT WB Between Iowa & Wakarusa
25k 30K 35K

Source: Highway Capacity Manual, 6th Edition

Figure 2 above shows that in the westbound direction of the PM peak hour between Iowa and Wakarusa, the 25,000 ADT scenario estimates a follower density of approximately 20 which is in the LOS E range. In the 30,000 ADT scenario this follower density is estimated to be about 25 which is in the LOS E range, but by 35,000 ADT the volume exceeds the capacity of a two-lane highway which would be LOS F.

6.3 Safety

With several segments along the K-10 corridor currently experiencing crashes at rates higher than statewide averages for similar highway facilities, one of the primary focuses of the SLT improvement was to address potential safety concerns identified in the existing analysis. To assess the potential impact of these improvements Crash Modification Factors (CMFs) were employed.

A CMF is a multiplicative factor used to compute the expected number of crashes due to the implementation of a countermeasure at a specific site. CMFs are based on real world empirical studies where countermeasures were deployed. The Federal Highway Administration compiles CMFs and publishes them through the CMF Clearinghouse website, other resources exist that compile CMFs, but this is the primary source.

The preferred tolled-free Alternative provides the following improvements that are anticipated to positively influence safety along the corridor:

1. Upgrading the corridor from a two-lane undivided facility to a four-lane divided facility.
2. Providing auxiliary lanes between Clinton Pkwy, Bob Billings, and 6th Street interchanges.
3. Providing auxiliary lanes on Iowa Street at the interchange
4. Implementing full access control (at-grade intersection replaced by interchange) at the Wakarusa/K-10 interchange
5. Reconfigure interchanges at Clinton Pkwy and 6th Street.
   a. Clinton Parkway ramp terminals converted from stop-controlled intersections to roundabouts
   b. 6th Street interchange converted to a Diverging Diamond Interchange (DDI)
6. Addressing horizontal deficiencies in the existing K-10 alignment (through the Clinton Pkwy area).

Table 26 below shows the improvements with their associated CMFs. The table notes the CMF Number. This number is an ID used on the FHWA Crash Modification Factor website. The reduction percentages show the reduction in all crash severity and types. Note CMFs were not available for all improvements identified to have a positive impact on safety. Only those with CMFs are noted in the table.

Table 26: Crash Modification Factors for Improvements

Improvement	CMF ID	Reduction Percentage
SLT conversion from 2-lane undivided to 4-lane divided facility	7569	29%
Addition of auxiliary lanes between Clinton Pkwy, Bob Billings, and 6th Street interchanges on SLT	3898	20%
Implementing full access control (at-grade intersection to interchange) at Wakarusa/SLT intersection	459	42%
Converting Clinton Pkwy ramp terminals from stop-controlled intersections to roundabouts	9445	24%
Converting the 6th St Interchange from a Diamond to a Diverging Diamond Interchange	9104	41%

Source: Crash Modification Factors Clearinghouse www.cmfclearinghouse.com

The improvements identified as part of this study will have a positive impact on safety within the corridor as seen by the magnitude of the reduction percentages in Table 26.

Two improvements identified as having positive impacts but where CMFs were not available include the addition of auxiliary lanes along Iowa Street at the interchange and addressing horizontal deficiencies along the SLT corridor near Clinton Parkway. While specific CMFs were not available for these situations, these are types of improvements that improve driver sight distance and expectations and thus improve safety.

Additionally, under the interim conditions discussed previously, SLT would be converted to a fully access-controlled facility with the conversion of the Wakarusa intersection to an interchange. However, SLT itself would remain a two-lane facility. This interim condition would reduce crashes around the Wakarusa interchange, but would not address crashes along the rest of the corridor.

6.4 Conclusions

The Toll-Free Alternative maintains a high level of operations with almost all segments operating in the KDOT desirable LOS range. Overall, there were very few problematic areas and running at acceptable levels throughout all the models.

The improvements proposed as part of the Toll-Free Build Alternative would reduce crashes along the corridor, the greatest impacts will be seen from the conversion from a two-lane undivided to a four-lane divided facility and the conversion of the Wakarusa intersection to an interchange.

A potential interim scenario was also analyzed that assumed the SLT was upgraded from a two-lane partial access-controlled facility to a two-lane fully access-controlled facility. This interim scenario would include replacing the existing at-grade intersections at Wakarusa and at I-70 with new grade-separated interchanges. It is anticipated that traffic operations would be improved throughout the corridor with this set of improvements but as traffic continues to grow in the corridor, operations would degrade and eventually the full four-lane access-controlled facility would be needed. It is also anticipated that safety would be improved by this set of interim improvements, however the interim scenario would leave the head-to-head traffic condition that leads to some of the most severe accidents in the corridor today. This condition will not be resolved until the full four-lane divided freeway is implemented.

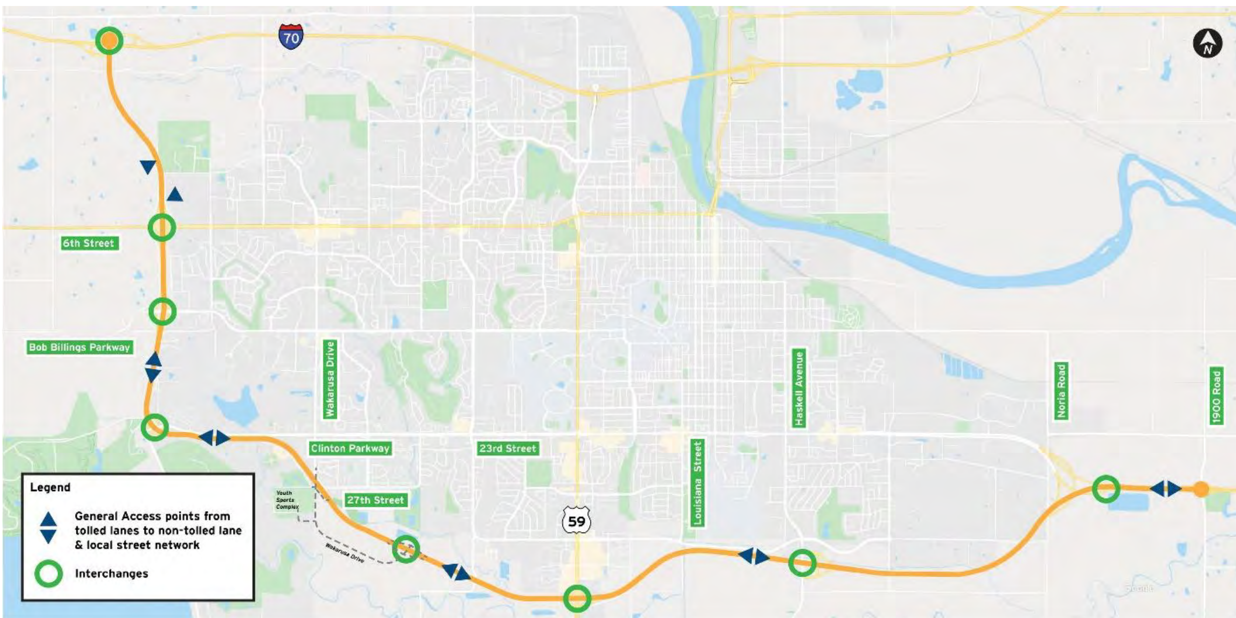
The interim scenario evaluated is just one interim scenario of many potential options for phasing the construction of the Preferred Alternative improvements over time. No decisions have been made about how or if the Preferred Alternative would be segmented into multiple construction projects. KDOT will continue to evaluate options for implementing the full improvements of the Preferred Alternative as the design of the project progresses and weigh options for funding the project in context of the other transportation needs in Kansas.

7.0 Future Build Toll Conditions

7.1 Description

Future Build Express Toll Lanes traffic and safety conditions were analyzed for a single general-purpose lane and single express toll lane in each direction between I-70 and US 59 (the SLT West Leg). Between K-10 east of US 59 (the SLT East Leg), two general purpose lanes and a single express toll lane were analyzed in each direction. This alternative was analyzed using traffic demand from a 2045 design year. Access is maintained between all of the local service interchanges identified in the Build Freeway alternative and shown in Figure 6 with the green circles. Access between the general-purpose lane and express toll lane would be accommodated in a weaving section shown in Figure 3 with the blue triangles. Chapter 2 of the SEIS provides a full detailed description of the Build Toll Alternative.

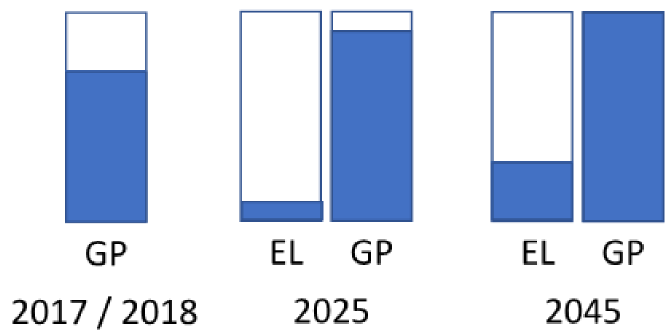
Figure 6: Future Build – Express Toll Lanes Access



7.2 Traffic Demand

Initial travel demand model results indicated that the express toll lane would produce low utilization in the opening year of 2025 and 2045 design year as illustrated in Figure 7. In the design year, the express toll lane would primarily have peak period utilization only with minimal diversion to alternate routes. Toll rates and travel speed differentials between the general-purpose lane and express lane were tested and found to have a significant impact on the results. Ultimately, due to the low demand utilization in the express toll lane from the travel demand model, more detailed lane balancing was performed between the express toll lane and general-purpose lane. The lane balancing methodology is described in Section 3.0.

Figure 7: SLT Peak Hour Traffic Volume to Capacity (Illustrative)



7.3 Operations

After volume balancing between the express toll lane and general-purpose lanes, traffic operational analysis was performed using the VISSIM simulation model. The K-10 & I-70 Interchange Alternative 3 was used as the initial tolled alternative. Tables 27 and 28 shows the Future Build Toll AM and PM peak hour level of service for each of the SLT functional areas. Level of service is also shown graphically in Appendix B.

Table 27: Future Build – Express Toll Lanes 2045 Number of Segments at each Level of Service – AM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound	6	14	7	1		
SLT Eastbound	7	16	4	1		
SLT Intersections	11	8	4			
I-70 Westbound		6	1			
I-70 Eastbound		3	2			
Total	**24**	**47**	**18**	**2**	**0**	**0**

Source: SLT VISSIM Model

Table 28: Future Build – Express Toll Lanes 2045 Number of Segments at each Level of Service – PM Peak

	Level of Service					
	A	B	C	D	E	F
SLT Westbound	7	12	7	2		
SLT Eastbound	6	13	7	2		
SLT Intersections	19	10	4			
I-70 Westbound		7				
I-70 Eastbound		4	1			
Total	**22**	**46**	**19**	**4**	**0**	**0**

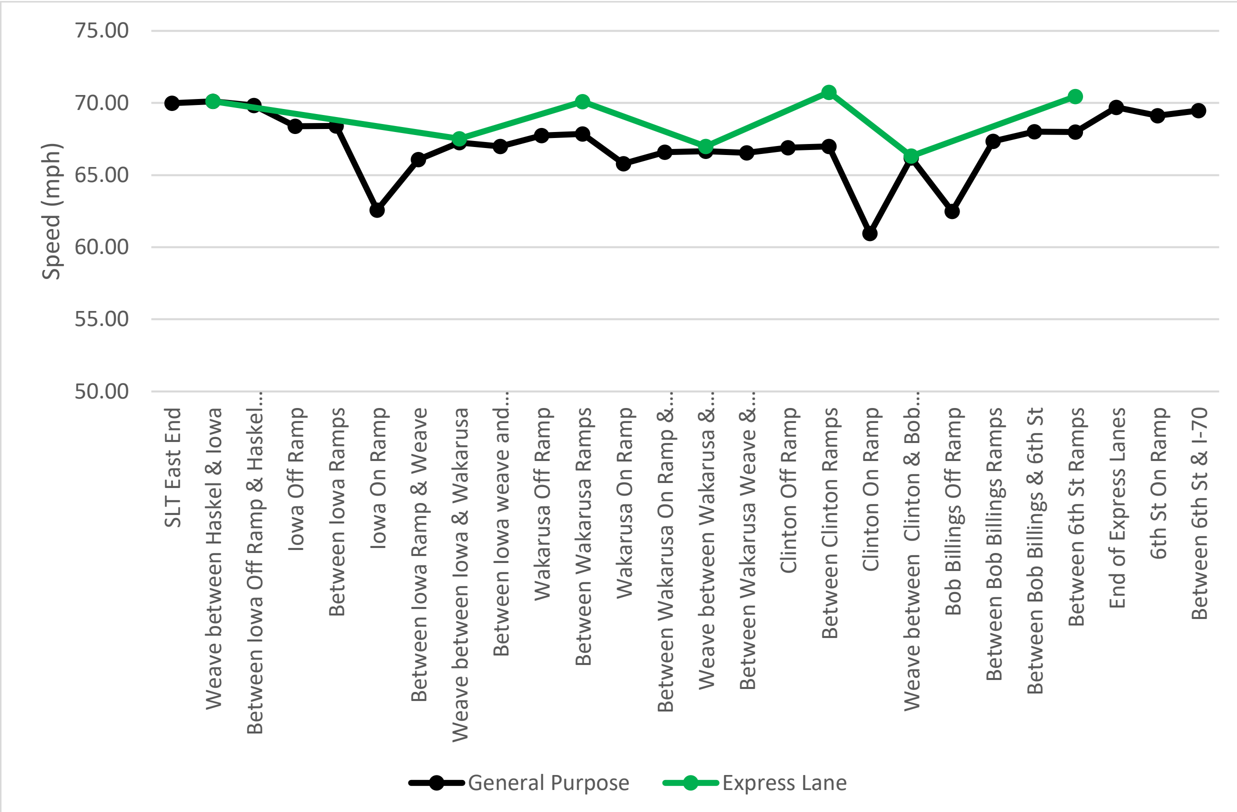
Source: SLT VISSIM Model

As shown in the tables above, the Future Build Tolled Alternative during the AM and PM models contain segments in all acceptable levels of service. Both the AM and PM have most segments in levels of service A, B, and C. This indicates that those segments contain traffic that is free flowing with minimum delay. Out of the 91 segments in the alternative, none of the segments were in the level of service E or F. In the AM, the segments at the level of service D are located on SLT between Wakarusa Drive and Iowa Street. In both the eastbound and westbound direction, this is the most congested area. The PM has a level of service D between Wakarusa Drive and Clinton Parkway, as well as between Wakarusa Drive and Iowa Street. Overall, the Tolled Build Alternatives show little to no problematic areas and is running at acceptable levels throughout the models.

Speed Profiles

Speed profiles were developed to show the anticipated future 2045 operating speeds for both the general-purpose lane and express toll lane. Figure 8 shows that general purpose lane speeds are above 60 mph for the entire corridor and mostly above 65 mph in the AM peak hour westbound direction. With travel speeds this high in the general-purpose lane in the design year, there is little incentive to use the express toll lane.

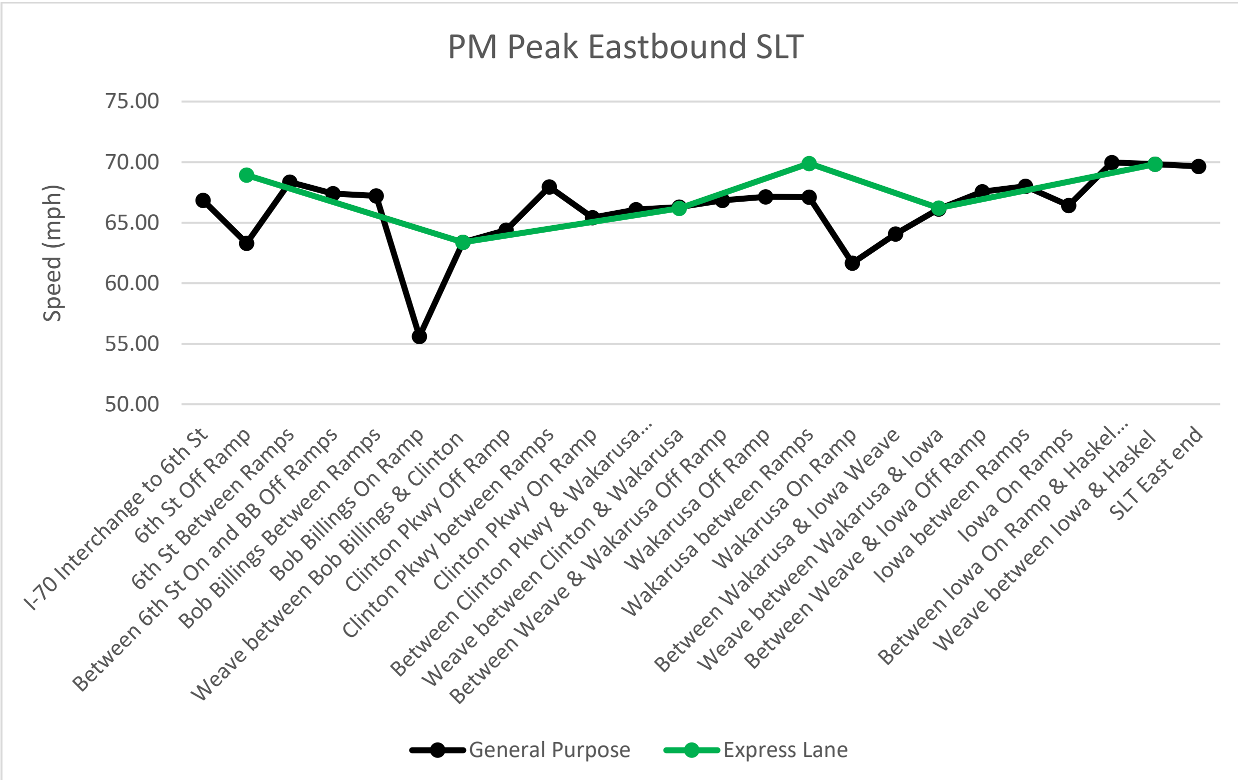
**Figure 8: AM Peak Westbound SLT
2045 Design Year**



Source: SLT VISSIM Model

Figure 9 shows that general purpose lane speeds are above 55 mph for the entire corridor and mostly above 65 mph in the PM peak hour east direction. With travel speeds this high in the general-purpose lane in the design year, there is little incentive to use the express toll lane.

Figure 9: PM Peak Westbound SLT
2045 Design Year



Source: SLT VISSIM Model

Table 29 provides a summary of the operational results during the AM and PM peak hours. As shown in the table, traffic operations are expected to be good in the design year with high travel speeds in the general purpose and express toll lanes.

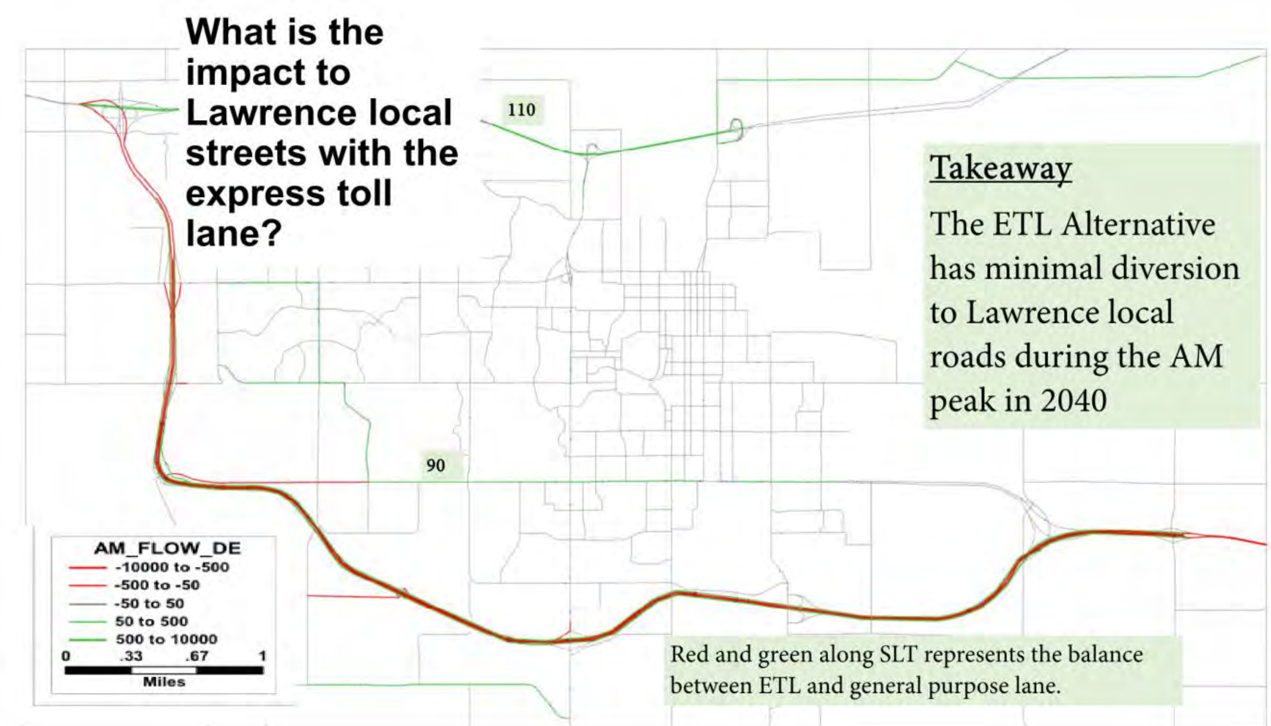
Table 29: 2045 LOS Results for Tolled Alternative

	AM	PM
Traffic Operations	• LOS C or better for all intersections • LOS D or better for all mainline merge, diverge and weave locations (between Wakarusa and Iowa)	• LOS C or better for all intersections • LOS D or better for all mainline merge, diverge and weave locations (between Clinton and Iowa)
Speed Graphs	• General purpose lane speeds greater than 60 mph on all segments • Tolled lane speeds greater than 65 mph on all segments	• General purpose lane speeds greater than 55 mph on all segments • Tolled lane speeds greater than 60 mph on all segments

Toll Diversion

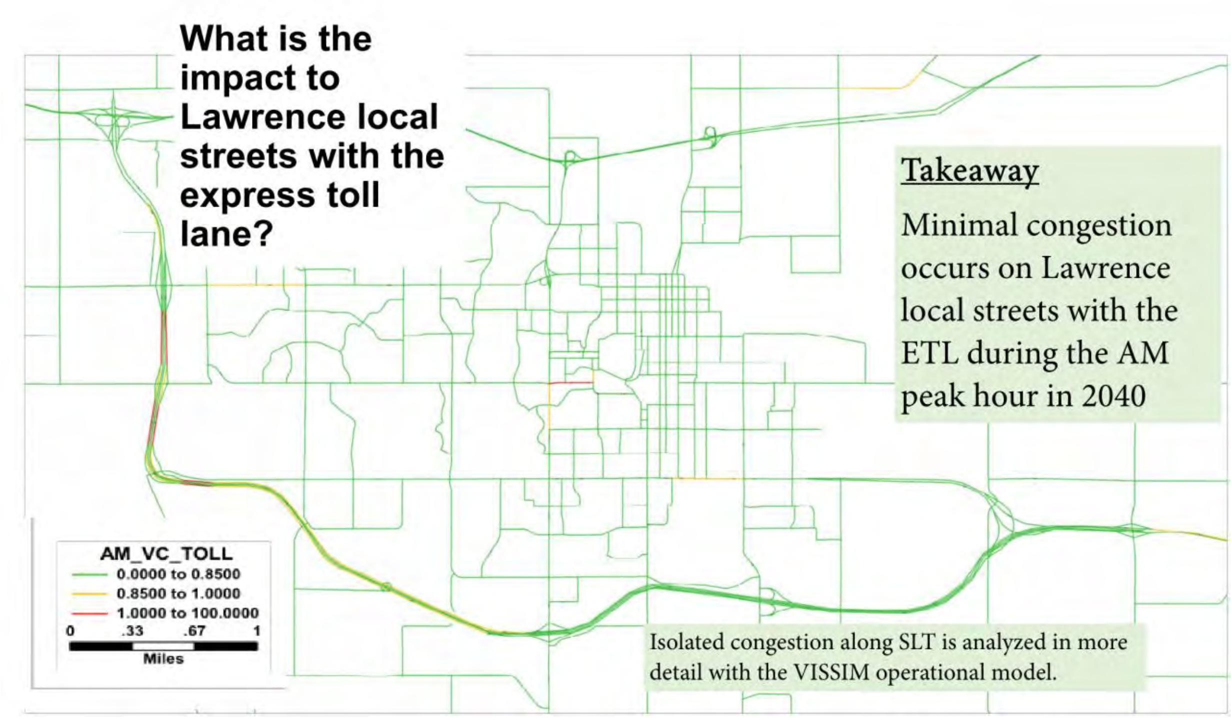
Toll projects can sometimes cause diversion of vehicle trips as a result of people that do not want to pay a toll. The 5-County model was used to analyze potential diversion either to I-70 for the longer regional trips or Lawrence for shorter/local trips. Figure 10 shows the AM peak hour change in traffic flow as a result of tolling and Figure 11 shows the AM volume to capacity on Lawrence local streets as a result of tolling. Figure 12 shows the PM peak hour change in traffic flow as a result of tolling and Figure 13 shows the PM volume to capacity on Lawrence local streets as a result of tolling.

Figure 10: AM Peak Hour Traffic Flow Difference with Express Toll Lanes



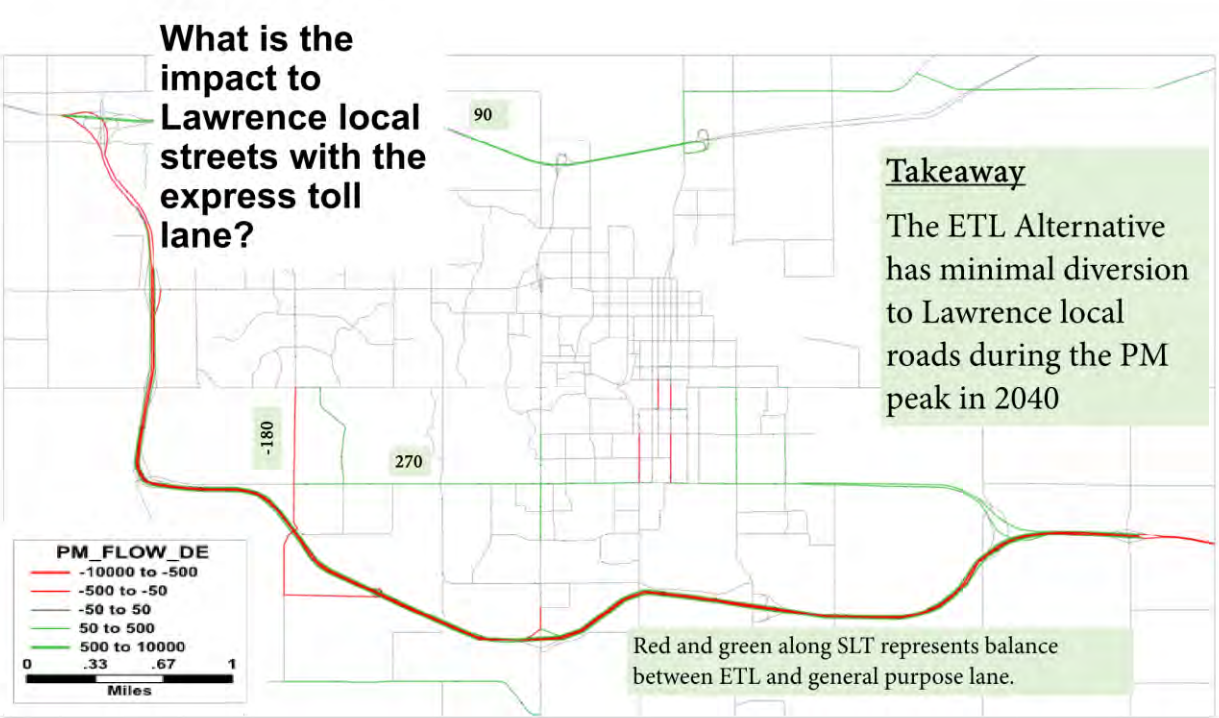
Source: 5-County Model

Figure 11: AM Peak Hour Volume to Capacity with Express Toll Lanes



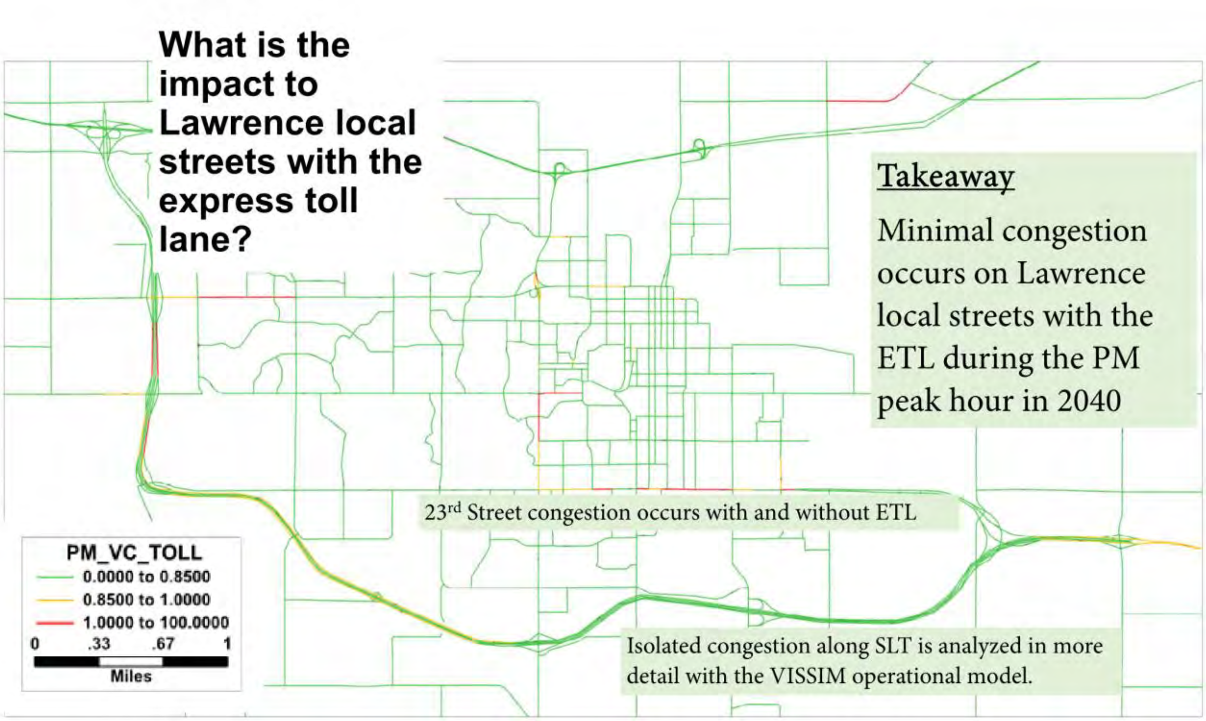
Source: 5-County Model

Figure 12: PM Peak Hour Traffic Flow Difference with Express Toll Lanes



Source: 5-County Model

Figure 13: AM Peak Hour Volume to Capacity with Express Toll Lanes



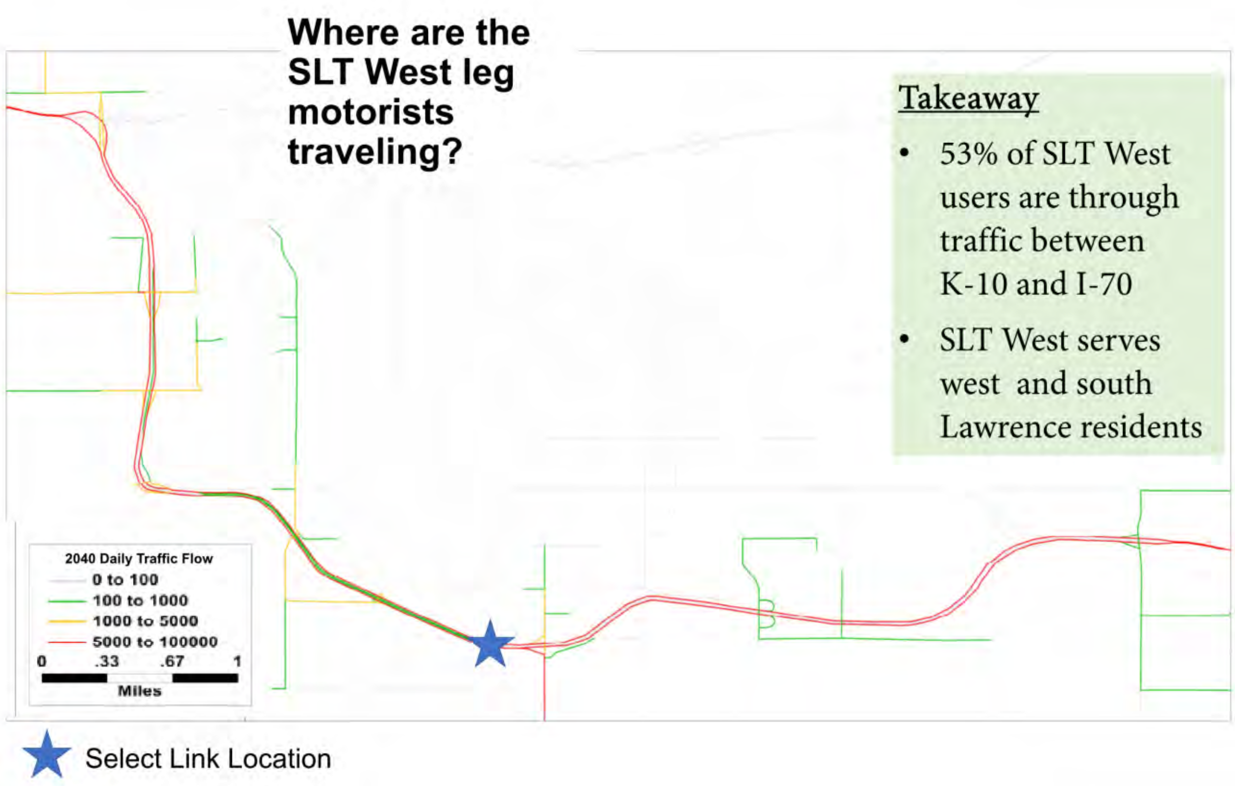
Kansas Department of Transportation

Source: 5-County Model

As the figures show, the express toll lane causes minimal diversion to Lawrence local streets during the AM and PM peak hours in the future. This is a direct result of the fact that the general-purpose lanes continue to operate at a high travel speed and low usage of the express lane is observed. The result of this is minimal diversion to local Lawrence streets in the AM and PM peak hours and shown in the Figures.

Figures 14 and 15 show the results of a select link analysis. A select link analysis picks a location (SLT west of Iowa in this case shown with a blue star) and then graphically displays the origins and destinations of all vehicle trips that pass through the select link (blue star). Figure 14 demonstrates that 53% of all trips passing through the select link started and ended their trip outside of Lawrence. The figure also shows that SLT west corridor serves primarily south and west Lawrence residents. Figure 15 shows a larger, regional perspective of the same select link. This figure demonstrates the regional impact that the SLT has on travel attracting trips from all over Douglas and Johnson Counties.

Figure 14: Lawrence Daily Select Link Analysis



Source: 5-County Model

Figure 15: Lawrence to Kansas City Daily Select Link Analysis

Source: 5-County Model

7.4 Safety

Similar to the toll-free build alterative, the tolled build alterative provides the same corridor improvements to SLT yielding similar safety benefits. The exception to this is an express lane and general-purpose lane in each direction along the corridor along with associated weaving sections and barriers. Although this alternative would benefit from the improvements noted in the toll-free alternative, in terms of safety the tolled express lanes would add more merge-diverge points along the K-10 corridor and the addition of roadside barriers, which ultimately makes the corridor susceptible to an increase in crashes.

7.5 Traffic and Revenue Analysis

Traffic and revenue analysis was performed for the SLT tolled build alternative to derive an order of magnitude estimate of how much traffic and revenue an express lane would attract along the SLT corridor. A traffic and revenue analysis is not a toll feasibility assessment. If a comprehensive toll feasibility assessment is desired, the request would come from the local community.

Average Weekday Traffic Estimates

Tolled and toll-free traffic forecasts developed for the SLT corridor using the KDOT 5-County validated regional TransCAD travel demand model. Table 30 provides an estimate of average weekday vehicles at key mainline sections along the proposed ETL for opening year 2025 and horizon year 2065.

Table 30: Average Weekday Traffic Estimates at Key Locations on Proposed SLT Express Toll Lanes

	North End - Bob Billings/Clinton Pkwy	Bob Billings / Clinton Pkwy - Clinton Pkwy / Wakarusa Dr	Clinton Pkwy / Wakarusa Dr - Wakarusa Dr / US 59	Wakarusa Dr / US 59 - East End
2025	860	754	1039	547
2045	998	875	1205	635
Annual Growth Rate	0.7%	0.7%	0.7%	0.7%

Source: 5-County Model

As Table 30 illustrates, the average weekday traffic volumes are relatively modest. This is because the travel demand model runs indicate that the future anticipated travel time savings with the proposed ETL (compared to the GP lanes) are relatively modest. Therefore, the anticipated market share and average weekday traffic on the ETL are not expected to be significant enough to generate substantial revenue.

Traffic and Revenue Assumptions

A number of traffic and revenue assumptions were reviewed with KDOT and then used in the traffic and diversion analysis. These assumptions are summarized in Table 31.

Table 31: Traffic and Revenue Assumptions

Number of Lanes	One express toll lane in each direction
Permitted Users	• Passenger cars, transit vehicles, and emergency responders permitted • Trucks and cars with trailers permitted
Free/Tolled Usage	• All passenger vehicles pay the full toll rate • Trucks pay a rate that is assumed to be 3 times the passenger car rate • No discount for HOV
Toll Collection	• Tolls collected through electronic toll collection (ETC) only • All vehicles must have a K-Tag or similar transponder • Cash and video tolling not accepted
Toll Rates	• $0.15 / mile
Value of Time	• Value of time corresponding to median household income of ~$81,000 (Johnson County, KS). Sources: US Census
Revenue Adjustments	• Revenue projections assume uncollected revenue (leakage) of 7%
Annualization Factors	• Traffic and revenue annualized using 300 equivalent weekdays

Traffic and Revenue Estimates

This section describes the methodology involved in developing the annual traffic and revenue estimates for the proposed ETL's along the SLT corridor. It should be noted that the data and analysis used for the traffic and revenue estimation is preliminary in nature, and the estimates included herein are not suitable for use directly in project financing. A more comprehensive investment-grade study with more extensive data collection and analysis (including additional stated-preference surveys and an independent economic analysis of the region) should be undertaken for this purpose.

The traffic and revenue estimation process included the development of a high-level assessment of toll traffic volumes on the express lanes by time of day, and the estimation of the total revenue potential of the SLT ETLs.

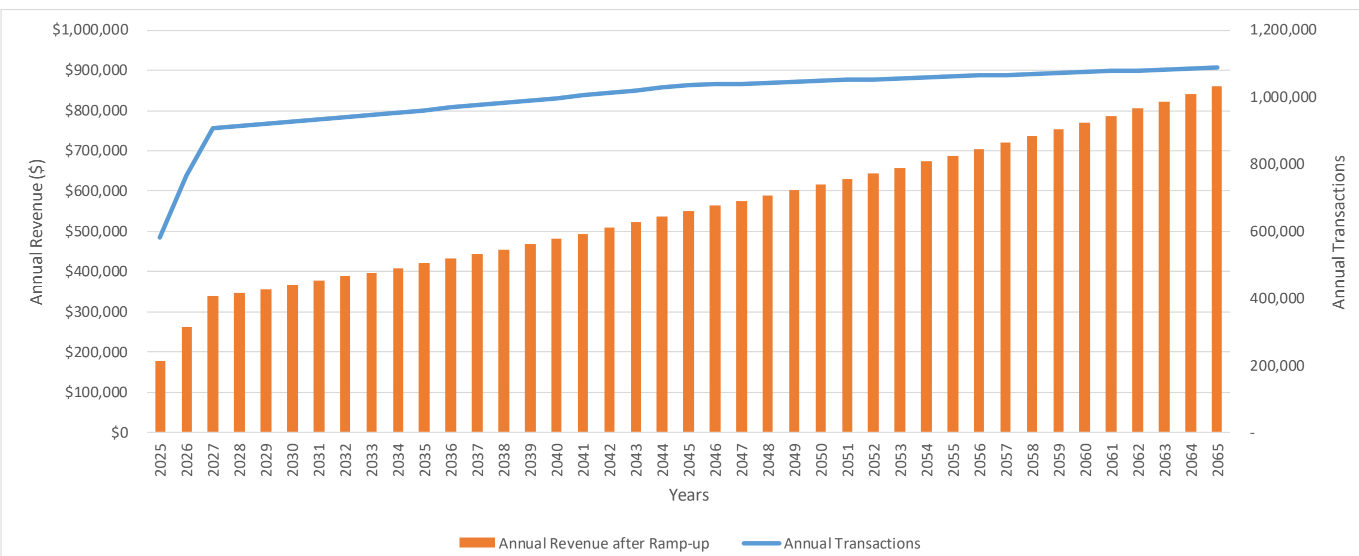
Gross Annual Traffic and Revenue Estimates

Gross annual toll traffic and revenue (T&R) estimates were developed for the two improvement scenarios. First, the share of the corridor global demand that is anticipated to use the proposed express lanes was estimated by time period and tolling segment for each scenario, and then aggregated to develop the average weekday tolled traffic and revenue forecasts. The average weekday revenue was estimated by multiplying the weekday traffic and the corresponding toll rate.

Average weekday tolled transactions and revenue were then annualized by applying an annualization factor of 300 to the average weekday traffic and revenue estimates. The first two years are expected to have slightly lower revenue due to ramp-up, with the subsequent years showing no-ramp up. For every forecast year, a revenue leakage of 7 percent was assumed. The annual transaction and revenue estimates for intermediate years (between 2025 and 2040) were developed by interpolating the annual transactions and revenue between these years. For all years beyond 2040, the growth rate was extrapolated. The forecasted annual gross revenue and total annual toll transactions are shown in graphically in Figure 16.

Based on this preliminary traffic and revenue analysis, the annual revenue is expected to be approximately $175k in year 2025 (after ramp-up), increasing to over $800k by year 2065.

Figure 16: Annual Transactions and Revenue



Source: HNTB Calculation

7.6 Conclusions

In summary, the Future Build Tolled Alternative operates at a very good LOS. The ETL is not expected to attract many vehicles in the opening year of 2025 but will increase usage as the general-purpose lane reaches capacity. As a result, revenue projections are relatively low for the ETL.

The tolled alternative is expected to provide a safety benefit over making no improvements to the corridor. However, with the addition of express lanes, additional merge/diverge points, and increased barrier separation the Tolled Build Alternative is not expected to perform better than the Tolled-Free Build Alternative.

8.0. Conclusions

8.1 Traffic

Below are peak AM and PM results from every alternative modeled using the VISSIM simulation model. Tables 32 and 33 below provide a summary of the levels of service for those segments along different locations throughout the corridors.

Table 32: Number of Segments at each Level of Service by Alternative – AM Peak

Functional Area	Existing	Future No-Build	Level of Service Toll-Free Future Build K-10 & I-70 Alt. 3	Tolled Future Build K-10 & I-70 Alt. 3
SLT Westbound				
A – C			19	33
D				2
E	9	4		
F		6		
SLT Eastbound				
A – C			19	32
D	4	1		1
E	5	3		
F		4		
I-70 Westbound				
A – C	5	5	7	5
D				
E				
F				
I-70 Eastbound				

Functional Area	Existing	Future No-Build	Level of Service Toll-Free Future Build K-10 & I-70 Alt. 3	Tolled Future Build K-10 & I-70 Alt. 3
A – C	5	5	7	7
D				
E				
F				

Source: SLT VISSIM Model

Table 33: Number of Segments at each Level of Service by Alternative – PM Peak

Functional Area	Existing	Future No-Build	Level of Service Toll-Free Future Build K-10 & I-70 Alt. 3	Tolled Future Build K-10 & I-70 Alt. 3
SLT Westbound				
A – C			19	32
D	3	1		3
E	6	3		
F		7		
SLT Eastbound				
A – C			19	30
D				3
E	9	4		
F		4		
I-70 Westbound				
A – C	5	5	7	5
D				
E				
F				
I-70 Eastbound				
A – C	5	4	7	7
D		1		
E				

		Level of Service		
			Toll-Free	Tolled
			Future Build	Future Build
Functional		Future	K-10 & I-70	K-10 & I-70
Area	Existing	No-Build	Alt. 3	Alt. 3
F				

Source: SLT VISSIM Model

During the AM Peak, the Existing and Future No-Build are the only scenarios that have levels of service D, E, or F demonstrating the need for improvement. The Toll-Free Build Alternative (incorporating Alternative 3 from the K-10 & I-70 interchange alternatives) model shows acceptable levels of service for all locations around the network. The Tolled Build Alternative (incorporating Alternative 3 from the K-10 & I-70 interchange alternatives) shows three level of service D locations and all other locations as level of service C or better.

During the PM Peak, the Existing and Future No-Build are the only scenarios that have levels of service E, and F demonstrating the need for improvement. The PM peak hour Toll-Free Build Alternative demonstrate traffic operational results in the level of service A-C range. In the Existing and Future No-Build alternatives, the segments with levels of service E and F are located along SLT in both eastbound and westbound directions. These problematic areas improve to levels of service A through D with all the Build alternatives. The Tolled Build Alternative shows six level of service D locations and all of other locations as level of service C or better.

8.2 Safety

Existing Conditions

The existing safety analysis analyzed the impact of the opening of the SLT East Leg. The analysis showed increases in the frequency of crashes along arterials and an increase in crash rates along the SLT West Leg. This impact shows the need for the completion of improvements along the SLT West Leg with a conversion to a full four-lane divided facility to match the SLT East Leg.

Future No Build

Under the future no build scenario crashes are expected to increase throughout the SLT corridor and on city arterials. This is due to increases in traffic volumes without appropriate improvements to the SLT West Leg to handle the increased volume.

Build

The two build alternatives (tolled and toll-free) share several similarities. Both are anticipated to improve safety along the SLT corridor and perform better than the No Build alternative. The conversion of the two-lane undivided SLT to a four-lane divided facility and the conversion of the Wakarusa intersection to an interchange will have positive impacts on safety within the corridor. Several other improvements are expected to have positive impacts to interchanges and associated arterials.

The toll-free alternative is expected to perform better from a safety standpoint than the tolled alternative. The addition of express lanes, additional weaving points and an increase in roadside barrier associated with the tolled alternative would have a negative impact over the toll-free alternative.

Attachments

A. Traffic Demand Maps
- 2018 Existing (AM & PM)
- 2045 Future No-Build (AM & PM)
- 2045 Future Build Toll-Free (AM & PM)
- 2045 Future Build Tolled (AM & PM)

B. Traffic Level of Service Maps
- 2018 Existing (AM & PM)
- 2045 Future No-Build (AM & PM)
- 2045 Future Build Toll-Free (AM & PM)
- 2045 Future Build Tolled (AM & PM)
- Interim Future Build Toll-Free (AM & PM)

C. US 40 Safety Analysis Memo

D. KTen Crossing