Benefit Cost Narrative

Bridging The Gap: Multimodal Connections On I-35 Over the Oklahoma River

Oklahoma Department of Transportation

Multimodal Project Discretionary Grant Application

November 14, 2024

Table of Contents

TABLES

FIGURES

Resubmittal Supplement

During the October 31, 2024 debrief with FHWA, the following general comments were received:

1. An overly aggressive traffic growth rate was used to predict future traffic.
2. A better crash modification factor for lane additions is available.
3. Travel time savings were overstated and needed additional justification as the analysis used a project area greater than the construction area, and no traffic analysis for this assumption was provided.

This section is intended to address the above comments by either identifying changes made to analysis and/or providing additional reinforcement and justification for assumptions that were not adjusted.

Traffic Growth Rate

The traffic growth rate was adjusted (cell B59) from the NBI default value (ODOT's reported value) of 2.38% to the recommended 1.6% census value. This subsequently updated all forecasted AADT values used in the analysis. This change dropped the BCR from 1.97 to 1.82.

Crash Modification Factor Selection

Crash modification factor 8335 was removed from the analysis as it was rated 3-stars on the CMF Clearinghouse. It was also noted that the CMF Clearinghouse had 4-star rated CMFs for going from 5 to 6 lanes with values between 1.03 and 1.07 (CMFs 7, 8, 9). Upon further investigation, these CMFs do provide the following additional text:

> *HSM lists this CMF in bold font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less. However, it also includes an asterisk (*) to indicate that the CMF value itself is within the range 0.90 to 1.10, but that the confidence interval defined by the CMF ± two times the standard error may contain the value 1.0.* ***This is important to note since a treatment with such an CMF could potentially result in (a) a reduction in crashes (safety benefit), (b) no change, or (c) an increase in crashes (safety disbenefit). HSM recommends that this CMF should be used with caution.***

For this reason, no CMF was applied for the additional lane. However, CMF 8342 was applied to capture benefits of the additional shoulder width. This change dropped the BCA from 1.82 to 1.73.

Travel Time Savings

The debrief noted that a project area of 2.0 miles was used which was four times the size of the 0.5 mile construction area. Adjusting the analysis to only use the 0.5 mile construction area and keeping the 50% of benefits conservative assumption used previously, changes the BCR from

1.73 to -0.10. If the assumption of only using 50% of the benefits is removed, this increases the BCR up to 0.51.

However, the resubmitted analysis still assumes the 2.0-mile assumption for queued traffic based on the following justifications:

USDOT BCA Guidance

USDOT's BCA guidance has several references that indicate that analyses are not restricted to only capturing benefits within the construction area, including step two of the most crucial components of a high-quality benefit-cost analysis:

> *A clear understanding of the problem the project is intended to solve (i.e., baseline conditions)* ***[page 7,*** *Benefit-Cost Analysis Guidance for Discretionary Grant Programs****, USDOT]***

Further, the guidance references the use of corridor-level and regional travel demand model with larger geographic areas:

> *Where traffic forecasts are developed from models (such as corridor-level models or regional travel demand models) that cover areas beyond the improved facility itself, the geographic scope of those models should be clearly defined and justified. Other assumptions used to translate the usage forecasts into estimates of travel time and delay (such as gate-down times at grade crossings) should also be described and documented. Forecasts should be provided under both the baseline and the improvement alternative. Applicants should take care to ensure that the differences between the two reflect only the proposed project being analyzed in the BCA and not any impacts from other planned improvements. Forecasts should incorporate indirect effects (e.g., induced demand) to the extent possible.* ***[page 10-11,*** *Benefit-Cost Analysis Guidance for Discretionary Grant Programs****, USDOT]***

The use of regional travel demand models in BCA as described above (e.g. using a cordoned section of the model to develop delta VMT and VHT values, if reasonable as prescribed in section 4.1 of the guidance) would certainly exceed analyzing areas outside of a project construction area. This methodology is consistent with the guidance provided in "User Benefit Analysis for Highways", AASHTO, 2003 and should provide our project with the opportunity to also realize such benefits.

Finally, under Section 5. Benefits:

> *Benefits measure the economic value of* ***outcomes that are reasonably expected to result from the implementation of a project****. Benefits typically accrue to the users of the transportation system because of changes to the characteristics of the trips they make and can also be experienced by the public at large. To the extent possible,* ***all of the benefits reasonably expected to result from the implementation of the project or program***

> ***should be monetized** and included in a BCA. **[page 15,** Benefit-Cost Analysis Guidance for Discretionary Grant Programs**, USDOT]***

In pointing out these references to the guidance, our analysis is not explicitly limited to computing benefits occurring from the project that are isolated to the construction area.

Traffic Characteristics

While no regional travel demand model or detailed traffic analysis exists, our assumptions try and capture local area benefits by specifically analyzing volumes and speeds in traffic queues that start within the construction area and extend beyond it. The analysis recognized that induced demand is not counted. Nor are any benefits that pulling vehicles off local streets (the induced demand) would have on improving other adjacent facilities.

To help justify the continued use of the 2.0-mile assumption Appendices A and B has been added to the document. These appendices include:

- Screen captures from ODOT's traffic cameras demonstrating the queue starting within the construction area and quickly extending back across the river to Harrison Avenue (2 miles upstream of the south end of the construction area). Images include the capture of an accident during observation outside of the construction area, but directly related to queuing from the bottleneck within the construction area!

- Findings from the I-35/I-40/I-235 Dallas Junction OKC Preliminary Lane Capacity Analysis

It is ODOT's belief that the implementation of the interchange project over the 0.5 mile construction impact will have wider local benefits to users upstream of the I-35 facility.

Based on this additional reinforcement of assumptions the resubmitted analysis keeps the 2.0 mile assumption, but still only takes credit for 50% of these benefits given the uncertainty and unavailability of macro- and microsimulation modeling of the project. With this assumption, the resubmitted BCR is 1.73.

The remainder of the document was updated reflect changes to the assumptions and analysis results.

Executive Summary

This Benefit Cost Analysis (BCA) supports Oklahoma Department of Transportation (ODOT) request of $87 million in Bridge Investment Program (BIP) funds to replace the I-35 NB and SB bridges, construct a new I-35 ramp NB bridge, and rehabilitate the I-35 bridge over the Stillwater Railroad (the Project). The new I-35 bridges would provide six 12-foot lanes in each direction, and a minimum of 12-foot inside and outside shoulders. Currently, the I-35 bridges have five lanes in each direction, but the shoulder widths are inadequate, causing both bridges to be considered functionally obsolete. The Project will provide new, safer, and geometrically improved bridges over the Oklahoma River. The main vehicular bridge replacement will deliver major safety benefits to a high crash-prone river crossing, while adding vehicular capacity through travel lane expansion and the provision of safety lanes in both directions, which are currently functionally obsolete on the existing bridge.

The BCA captures and monetizes three categories of benefits arising from the vehicular bridge project: maintenance cost savings, travel time savings, and crash reduction benefits. Other benefits that have not been monetized (but are discussed below) include resilience, emissions, and other environmental benefits. Economic benefits such as enhanced labor and business productivity (over and above those embodied in travel time savings) are also not included. However, the overall improvements in regional accessibility may generate benefits.

Results: The Project yields an overall Benefit-Cost Ratio (BCR) of **1.73** and a Net Present Value of $97.8 million. The preponderance of benefits is from vehicular travel time savings, with smaller but still significant shares due to maintenance savings arising from the Project.

Overview

The BCA has been conducted following the USDOT's Benefit-Cost Analysis Guidance for Discretionary Grant Programs and the Bridge Investment Program (BIP) BCA tool. The general parameters and assumptions used in the BCA are described in the sections **Project Description** and **BCA Methodology**.

Project Description

For the purposes of this analysis, a No-Build and Build Alternative were under consideration.

No-Build Alternative

The No-Build Alternative included leaving the existing bridges and their geometry as is with no modifications or restrictions to current access.

Build Alternative

The Project, centrally located in downtown Oklahoma City, will provide a new, safer, and geometrically improved bridge over the Oklahoma River. The Project includes replacing two mainline bridges on I-35 (National Bridge Inventory (NBI) 21356 and 21723), rehabilitating the two I-35 ramp bridges over the BNSF Railway (NBI 21335 and 21708), constructing a new I-35 ramp bridge spanning the Oklahoma River, and lengthening an existing box structure (NBI 14239) that traverses underneath the I-35. The bridge width will be approximately 96 feet for I-35 SB to accommodate six lanes with 12-foot shoulders. I-35 NB will be approximately 72 feet wide (four-lanes with shoulders) and the two-lane ramp bridge approximately 42 feet wide. The three bridges will be approximately 820 feet long with a primary span extending at least 360 feet. The Project will deliver major safety benefits to a high crash-prone crossing while adding vehicular capacity through travel lane expansion and the provision of safety lanes in both directions, which are currently functionally obsolete on the existing bridge. The bridge is an essential connecting link along I-35, a major north-south interstate route that provides passenger and truck freight connectivity from the Texas-Mexico border through the Dallas metro area, to Oklahoma City, and on to points north.

BCA Methodology

Methodology and assumptions largely followed the processes outlined by FHWA and USDOT for using the BIP BCA Tool and standard BCA assumptions. Specific details regarding the values used in the accompanying BCA Tool are outlined in the sections below:

Main Components

The main components analyzed included:

- Initial capital costs
- Maintenance and costs
- Traving time/delay (vehicle hours traveled – VHT)
- Crashes by severity

Analysis Years

This analysis assumed that the Build Alternative would be constructed over a four-year period, starting in 2026 with completion in 2030. Therefore, the year 2031 was assumed to be the first full year that benefits will be accrued from the Project. The Project costs also account for costs already incurred in 2024. The annual cost burden for each bridge was based on the payout schedule in **Table 1**.

Table 1: Payout Schedule

Year	2024	2025	2026	2027	2028	2029	2030	Total
Construction Expenditure	4%	4%	6%	15%	30%	28%	15%	**100%**

The analysis focused on the estimated daily benefits. For the two river crossing bridges an analysis period of 20 years was used as the bridges are being reconstructed, but the improvement is to expand capacity. For the railroad crossing bridges and box culvert extension, an analysis period of 20 years was used as these are rehabilitation projects. The present value of all benefits and costs was calculated using 2022 as the year of current dollars.

Economic Assumptions

The value of time, occupancy, and cost of crashes were obtained from the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated January 2023 and are consistent with the default values provided in the BIP BCA Tool. A user value was provided for average bus occupancy by EMBARK who operates the lone route crossing the bridges in the Project area. This is based on 2023 ridership to date, and for purposes of this analysis was not expected to grow over time, which should be considered a conservative estimate.

Construction Costs

ODOT estimated costs based on estimated quantities and recent similar projects. The costs developed by ODOT were originally estimated in 2024. The estimates for both the roadway and bridge portions of the Project included a 30 percent contingency. For purposes of this analysis these were converted to 2022 dollars using the GDP price deflator. Costs were not developed in year of expenditure dollars.

As the BIP BCA Tool was set up to conduct the analysis by bridge and it was anticipated that there will be contingency costs and additional roadway and traffic costs associated with the Project, these costs were distributed to each bridge based on the bridges proportion of the total bridge costs. Original costs, 2022 converted costs for the analysis, and distribution of additional non-bridge costs are provided in **Table 2**. This table also contains the proportional breakout of bridge versus roadway costs for the purpose of calculating the remaining capital value of the Project. **Table 3** shows the distribution of roadway and contingency costs to each individual vehicular bridge based on the cost proportion in **Table 2**.

Table 2: Project Cost and Bridge Cost Proportion

Item and Component	Total Cost	Total Cost in 2022 $
Roadway		
Construction	$30,600,000	$29,017,500
Other Items (Traffic Control, Striping, etc.)	$4,500,000	$4,267,279
30% Contingency	$10,530,000	$9,985,434
Roadway Total	$45,630,000	$43,270,213
I-35 Bridges		
I-35 SB over Oklahoma River	$43,320,000	$41,079,677
I-35 NB over Oklahoma River	$31,000,000	$29,396,814
I-35 Ramp over Oklahoma River	$18,910,000	$17,932,056
Double 10'x10' RCB Extension	$290,000	$275,002
I-35 over Stillwater RR Bridge Rehab	$2,800,000	$2,655,196
30% Contingency	$28,896,000	$27,401,624
Mainline Bridge Aesthetics	$4,500,000	$4,267,279
Bridge Total	$129,716,000	$123,007,648
Total	**$175,346,000**	**$166,277,862**

Source: ODOT (Q1 2024 Dollars)

Table 3: Cost Distribution to Individual Vehicular Bridges (2022 Dollars)

Item and component (NBI #)	Cost	Proportion	Bridge Contingency and Aesthetics	Total Bridge	Roadway	Bridge and Roadway
I-35 SB over River (21723)	$41.08M	.450	$14.24M	$55.32M	$19.46M	$74.78M
I-35 NB over River (21356)	$29.40M	.322	$10.19M	$39.59M	$13.93M	$53.52M
I-35 NB New Ramp (# TBD)	$17.93M	.196	$6.22M	$24.15M	$8.50M	$32.64M
Box Culvert Extension (14239)	$0.28M	.003	$0.09M	$0.37M	$0.13M	$0.50M
I-35 over RR Bridge (21708 and 21335)	$2.66M	.029	$0.92M	$3.58M	$1.26M	$4.83M
Bridge Total	**$91.34M**		**$31.67M**	**$123.01M**	**$43.27M**	**$166.28M**

Operating and Maintenance (O&M) Costs

It is expected that reconstructing the Project bridges will reduce the required future rehabilitation and maintenance activities to keep the roadway serviceable. Future maintenance activities were obtained for the No-Build and Build scenarios from project planning staff. The provided rehabilitation and maintenance schedules for each scenario are listed below in **Table 4**. All dollar amounts are provided in 2021 dollars.

Table 4: Operations & Maintenance Cost Schedules

Bridge	No-Build Routine Costs	No-Build Large Maintenance Costs	Build Routine Costs	Build Large Maintenance Costs
I-35 SB over River (21723)	$1,000	$1.0M (2026) $1.5M (2040)	$1,000	None
I-35 NB over River (21356)	$1,000	$1.0M (2026) $1.5M (2040)	$1,000	None
I-35 NB New Ramp (# TBD)	None	None	$1,000	None

Box Culvert Extension (14239)	$1,000	None	$1,000	None
I-35 over RR Bridge (21708 and 21335)	$1,000	$0.5M (2040)	$1,000	$0.5M (2040)

The routine repair costs are expected to occur every other year for both the No-Build and Build and largely cancel out except for those occurring before the construction of the Build Alternative.

Development of AADT and Travel Time Savings

This analysis assumed the NBI AADT values for all bridges with only one small exception. All bridges assumed a bus AADT of 9 trips per day and subtracted this amount from the provided passenger AADT value. The bus trip count obtained by local transit provider EMBARK. No growth was assumed for this transit route into the future. All bridges in the BIP BCA Tool are directional (e.g., only northbound, or only southbound) except for the box culvert. For this reason, the box culvert assumes 18 bus trips per day as both inbound and outbound trips cross this structure.

Travel Time Savings

To compute travel time savings the BIP BCA Tool breaks out the travel time benefit and construction disbenefit by bridge. In actuality, the bridges included in the Project work as a system. That is, vehicles traveling across one bridge in each direction travel across all the bridges in that direction (e.g., southbound vehicles travel across the river bridge, the box culvert, and the railroad bridge). It is for this reason that all travel time savings for a given direction were assigned to the river crossing bridges. This methodology was selected as to not triple count the benefits by applying travel time savings to all bridges in each direction. It was selected to not have to break out the benefits for all bridges in each direction, which implies that a given bridge accounts for a certain proportion of the directional benefits. If one directional bridge is down, it does not matter if the other two bridges in that direction are in service, vehicles will not be able to access that bridge.

To compute the travel time savings, this analysis used assumed travel speeds through the 2-mile project area in each direction. The project capacity expansion is expected to resolve two bottlenecks that exist in the project area:

- *I-35 Southbound: There is currently a lane drop at SE 15th Street. This bottleneck routinely backs up to Harrison Avenue, which is two miles to the north.*
- *I-35 Northbound: There is currently a weave and dual lane drop entering the Dallas Junction interchange where I-35 splits to send traffic to the right (I-40/I-35) or continue north (I-235). Queues from this section of freeway can back up between SE Grand Boulevard and SE 44th St.*

Existing segment performance is documented in the I-35/I-40/I-235 Dallas Junction OKC Preliminary Lane Capacity Analysis developed by ODOT's Traffic Engineering Division. Figures below illustrate the existing and future expected LOS, and additional information is provided in Appendix B: Supplemental Traffic Studies.

Figure 1 - 2020 AM Peak LOS

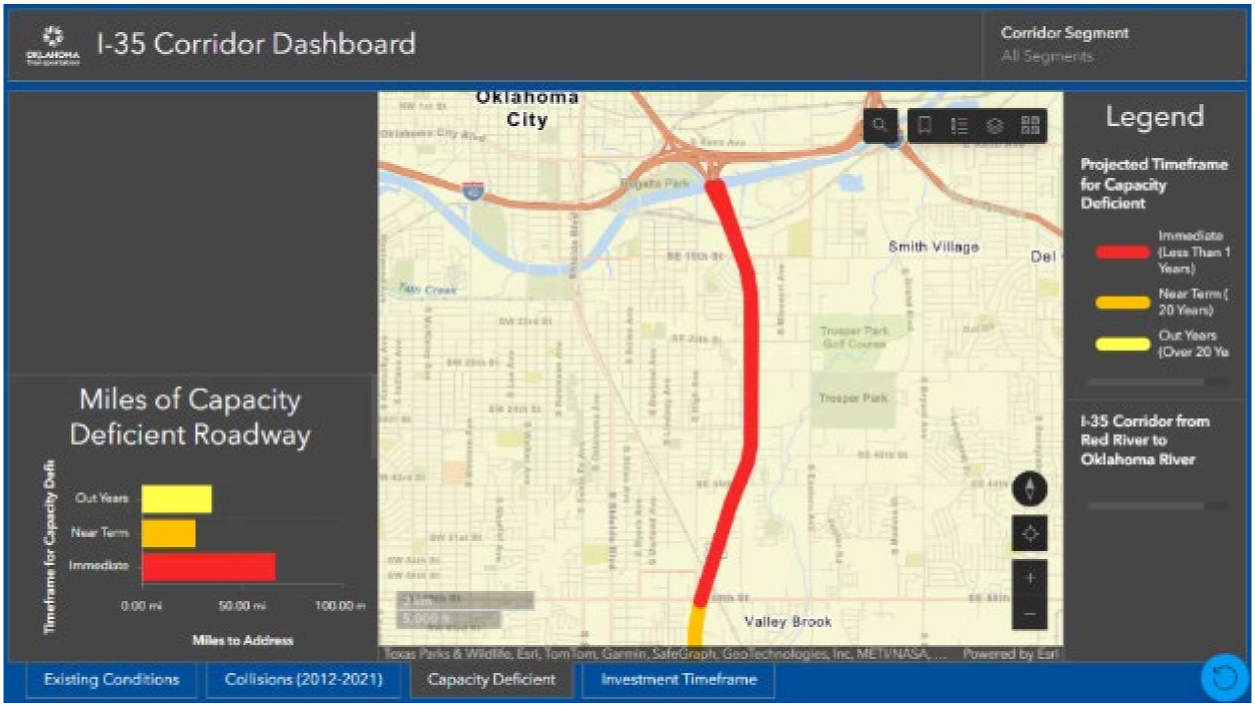
Figure 2 - 2020 PM Peak LOS

Figure 3 - 2035 AM Peak LOS

Figure 4 - 2035 PM Peak LOS

These deficiencies are also highlighted in [ODOT's Forward 35 Report and Dashboard]:

Figure 5 - I-35 Capacity Needs



These bottlenecks exist in the existing condition and are only expected to worsen as traffic continues to grow into the future. ODOT estimates that the future volume crossing need for this section of freeway will exceed 178,000 vehicles per day.

For these reasons, the analysis assumes that the benefit of the 0.5-mile project will extend to users of this facility who are required to travel through long and slow traffic queues caused by the existing mobility deficiencies that exist in this segment of roadway. A value of 2 miles was used in both the northbound and southbound directions to account for users' reduced travel speed in these queues under the No Build condition. These conditions exist today and are expected to worsen in the future with no treatment. This assumption also does not include any improvement in travel time to users of the I-40 ramps under the Build condition. This should be considered a conservative estimation of travel time benefits.

The assumed travel speeds and resultant travel times, and travel time savings are included in **Table 5**.

Table 5: Travel Speed, Travel Time, and Travel Time Savings Assumptions

Year	No-Build Speed (mph)	No-Build Travel Time (min.)	Build Travel Speed (mph)	Build Travel Time (min.)	Travel Time Savings (min.)	Travel Time Savings Used (min.)
2030	35	3.43	55	2.18	1.25	0.623
2040	30	4.00	55	2.18	1.82	0.910
2059	23.6	5.09	55	2.18	2.90	1.452

The No-Build speed in 2059 was based off the trend in travel time between 2030 and 2040. The travel speeds are assumptions based on existing peak period data from the NPMRDS. While 35 and 30 miles per hour were assumed. The queues stemming from the bottleneck routinely experience speeds much slower.

Although ODOT also recognizes that although the Project includes an increase in capacity, no induced demand is included. This has to do with where the Project is in the planning process and when future year forecasts are developed using traditional travel demand forecasting techniques. Often the influence of induced demand as it relates to travel time savings 'cancels out'. That is, the additional traffic added to the facility under an induced demand scenario, which reduces the facility speeds for existing users, is offset by the travel time savings observed by those users transferring to the facility, and the improvement to travel times of users on adjacent facilities that now have lower volumes. Without any additional information regarding induced demand, the analysis used this as a reasonable and conservative assumption.

Additionally, the assumed travel time savings were reduced by 50 percent (**Table 5** 'Travel Time Savings Used' column). This assumption was made since it is not expected that all vehicles will realize this benefit. Only those traveling during peak periods when speeds are depressed will realize improved travel time benefits. Further, the annualization factor for these benefits was set to 260 days, so that benefits were realized only on weekdays (commute days).

For the I-35 northbound river crossing bridges (mainline and new ramp bridge), the travel time benefits were split 60 percent to the mainline bridge and 40 percent to the new ramp bridge based on the proportion of total travel lanes.

It should also be noted that the free flow speed assumed for the build condition is lower than the posted speed limit and free flow speed and should also be considered conservative.

Construction Disbenefits

Similar assumptions were used to calculate construction disbenefits. All disbenefits were attributed to the river bridges, and NBI AADT values were used with adjustments for bus trips. For the construction of the I-35 NB and SB river bridges it is expected that two lanes in each direction will be always maintained during construction. It was also assumed that this condition will be in place for all 365 days for all four years for the purpose of the BCA analysis.

The analysis assumed a delay of 1 minute per vehicle. This is equivalent to a reduction in speed from 60 mph to 30 mph for 1 mile of the construction zone. This would also be equivalent to 20 percent of vehicles (e.g., those at the peaks) experiencing a 5-minute delay, or traveling at 10 mph.

The crash increase was based on CMF ID: 520 (active work zone with temporary lane closure compared to no work zone – all areas and severities) which is associated with a 66 percent increase in crashes during construction.

Safety Analysis

Project Area Crash Data

ODOT uses crash data from the Oklahoma Highway Safety Office (OHSO) because it provides in-depth crash data for specific project locations. OSHO produces publications and problem identification data including in-depth analysis of crash numbers, rates, and locations. The OHSO crash data is used by highway safety professionals across Oklahoma to evaluate traffic safety priority areas and propose potential solutions.

Crash data were obtained from the OHSO to determine the nature and frequency of collisions along the interstates and ramps. Collision history was for the northbound and southbound segments of I-35 between SE 15th Ave and the Dallas Interchange. As shown in **Table 6**, a total of 463 collisions were recorded. Of those, 105 were of injury crashes, and 3 were fatal.

Table 6: Crashes on I-35 between SE 15th Ave and the Dallas Interchange

Type of Collision	Fatality	Injury	Property Damage	Total
Rear-End	1	61	167	229
Head-On	1	1		2
Right Angle		1		1
Angle Turning				
Other Angle				
Sideswipe Same Direction		13	128	141
Sideswipe Opposite Direction		1		1
Fixed Object	1	12	44	57
Pedestrian				
Pedal Cycle				
Animal				
Overturn/Rollover		14	6	20
Other Single Vehicle Crash		1		1
Other		1	10	11
Total	3	105	355	463

SOURCE: OKLAHOMA HIGHWAY SAFETY OFFICE

The most prevalent collision type within the interchange was rear-end (front to rear) collisions, accounting for nearly half of all collisions. These types of crashes are commonly observed with congested roadways where stopped traffic occurs in the driving lanes and sudden deceleration from vehicles traveling at higher rates of speed is required. The limited bridge travel lane capacity, reduced shoulders, and merging of travel lanes directly south lead to conditions that cause traffic stopping and weaving. It has been demonstrated that the queues caused by deficiencies from this segment extend well outside of the project area. The area of crash history included in this analysis does not extend beyond the project limits and should be considered a conservative estimate as there are likely many more similar crashes occurring in the queues caused by these bottle necks that are not included in this crash history.

The replacement bridges for I-35 NB and SB would have six lanes each as well as adequate shoulder widths. This would allow for the I-35 NB bridge to have a dedicated lane for I-40 WB and the I-35 SB bridge to have an additional lane from I-40 WB. South of the I-35 SB bridge, the proposed roadway would narrow to four lanes instead of three; this is an additional lane from the current configuration. The additional lane should help reduce the number of rear-end collisions by reducing the backup at the interchange during peak hours which, in turn, increases the capacity of the interchange. The addition of a SB through-lane would lessen the weave movements which occur today.

The next most common collision type found was sideswipe same direction at nearly 30 percent. The reduction of the five-lane bridge to three lanes south of the bridge causes a weaving movement on both sides of the roadway for I-35 SB and causes a considerable number of sideswipe collisions as drivers seek to merge. The I-35 bridge replacement would provide an additional lane and would eliminate the weaving movement on the inside of the roadway and help reduce the number of sideswipe collisions.

Additionally, the I-35 bridge replacement would restore the inside and outside shoulders to adequate widths. Full shoulders are important for the safety of a bridge because they allow for broken-down cars to pull off to the shoulder rather than blocking a lane of traffic. The shoulders also permit emergency vehicles to bypass stopped traffic to access the scene of a crash or incident more quickly, allowing injured persons to receive medical attention sooner.

For this analysis and to facilitate use of the BIP BCA Tool, the interchange crashes were distributed to each of the individual project bridges proportional to the construction cost relative to the total bridge costs.

Crash Reduction Factors

To compute the expected crash reduction associated with the infrastructure improvements, this analysis leverages CMFs from the CMF Clearing house.

Lane Increase: The analysis uses CMF ID: 8335 to estimate the expected crash reduction associated with the additional lane. The CMF is .75 for an additional lane in an urban area, which indicates an expected crash decrease of 25 percent. This reduction is applicable to all crash types and for all severities except for property damage only (PDO) crashes. Given the amount of PDO crashes on these facilities, and the nature of the crashes, this should be considered a conservative estimate for included no benefit is applied to 74 percent of the crashes.

Factors Not Quantified

Additional Safety Benefits

The Project includes additional shoulder widening to be consistent with modern design practice. For this improvement, the CRF Desktop Reference Manual has a crash reduction factor (CRF) of .20 (or a CMF of .80) for upgrading facilities with less than 4-foot shoulder to over 8 foot. Traditional practice for combining CMFs as prescribed by the Highway Safety Manual is that CMFs be multiplied together. In this project’s case, which would equate to a combined CMF of (.75*.8) = 0.6 to account for both geometric improvements. This was not included in the BCA to ensure a conservative estimate of benefits. The BCA also does not include the safety benefits from the multimodal bridge, which is not part of this project.

Remaining Capital Value

The Project emphasizes roadway capacity improvement. However, the 20-year-old bridge structure will remain at the end of the analysis period. ODOT has no intention of shutting down this bridge at the end of the analysis period, and any future use of this bridge will have value and count toward project benefits.

Bridge Condition and Closures

The BIP BCA Tool leverages this section to calculate benefits for the bridge as closures are avoided. These include additional vehicle operating costs, emissions, and other environmental impacts associated with rerouted traffic. For all Project bridges except for the new NB I-35 ramp bridge, it was assumed that the detour would route vehicles on a similar facility (I-240 and I-44 to the west of I-35) to complete a similar NB/SB through trip that can currently be completed using I-35 through the Project area. This detour is 7.7 miles longer (18 miles compared to 10.3 miles) than a trip completed using the Project bridges. Based on Google Maps, this trip would take 17 minutes (travel speed of 63.5 mph) to complete, or an additional 7.3 minutes than using the Project bridges. The new I-35 NB ramp bridge has an equidistant but slower local route that could be used to make the movement. Based on Google Maps, this would take an additional .2 minutes, but this does not include any congestion that would be associated with the local road system handling freeway level volumes.

It was determined that while the Project will improve or preserve the bridges condition in a way that reduces the risk of closure and/or road posting (especially related to potential bridge scour impacts), there was no data or analysis available to complete this section of the BIP BCA Tool. Excluding these benefits is a conservative estimate, particularly because even a 10 percent reduction in future traffic starting in 2040, escalating to a 20 percent reduction in 2050 could result in another approximately $26M in benefits per direction.

Resiliency to Weather, Seismic or Other Extreme Events

Like the approach for bridge conditions and closures, the analysis does not account for these benefits as there was no data or analysis available to complete this section of the BIP BCA Tool. It is expected that there will be benefits from the Project for this category, and not including them should be considered a conservative estimate.

Wildlife, Noise, and Water Run Off

Like the approach for bridge conditions and closures, the analysis does not account for these benefits as there was no data or analysis available to complete this section of the BIP BCA Tool. It is expected that there will be benefits from the Project associated with noise and water run-off improvements, and not including them should be considered a conservative estimate.

BCA Results

The benefit-cost analysis provides an indication of the economic desirability of a scenario, but results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.0. The larger the ratio number, the greater the benefits per unit cost. Results of the benefit-cost analysis for the Project in provided in **Table 7**.

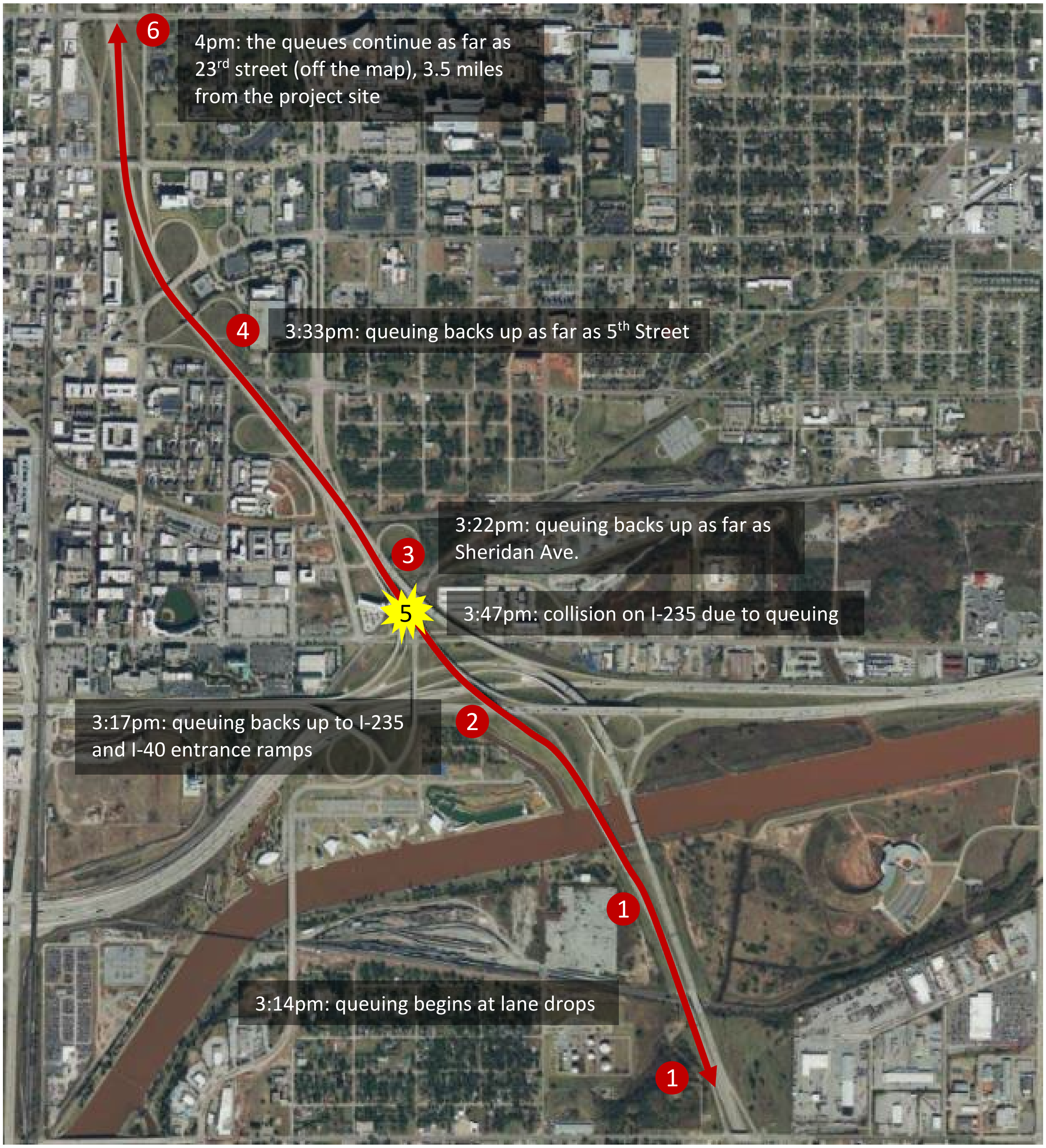
Table 7: BCA Results

Category	New I-35 Ramp	I-35 Box Culvert	I-35 NB RR	I-35 SB RR	I-35 SB	I-35 NB	Total
Safety	$1.28M	$0.02M	$0.08M	$0.08M	($2.25M)	($1.61M)	**($2.40M)**
Travel Time	$65.28M				$115.84M	$49.80M	**$230.92M**
Maintenance	($0.01M)	$0.00M	$0.28M	$0.28M	$1.50M	$1.50M	**$3.56M**
Total Benefits	$66.55M	$0.02M	$0.37M	$0.37M	$115.08M	$49.69M	**$232.08M**
Total Discounted Costs	$26.35M	$0.40M	$1.95M	$1.95M	$60.37M	$43.20M	**$134.22M**
BCR	**2.53**	**0.06**	**0.19**	**0.19**	**1.91**	**1.15**	**1.73**
Net Present Value	**$40.20M**	**($0.38M)**	**($1.58M)**	**($1.58M)**	**$54.71M**	**$6.49M**	**$97.86M**

Appendix A: Traffic Camera Documentation of Problem Understanding

The following photos from November 5, 2024, show that the bottlenecks caused by the lane drop at the I-35 bridges over the Oklahoma River directly cause queues which extend far beyond the project area and will be remedied by this project. Figure 6 shows an overview of a typical queue buildup beyond the project area.

Figure 6. Map of over 3.5 miles of backup during rush hour on November 5, 2024



At 3:14pm, queuing has already started on I-35 at the two lane drops, as shown in Figure 7 below, represented by (1) in Figure 6 above.

Figure 7. Queuing on I-35, looking north from SE 15th Street, November 5, 2024, at 3:14pm

As Figure 8 below shows, the fourth lane of I-35 turns into an Exit 125D for SE 15th Street. However, most of the total volume continues on I-35, causing a bottleneck.

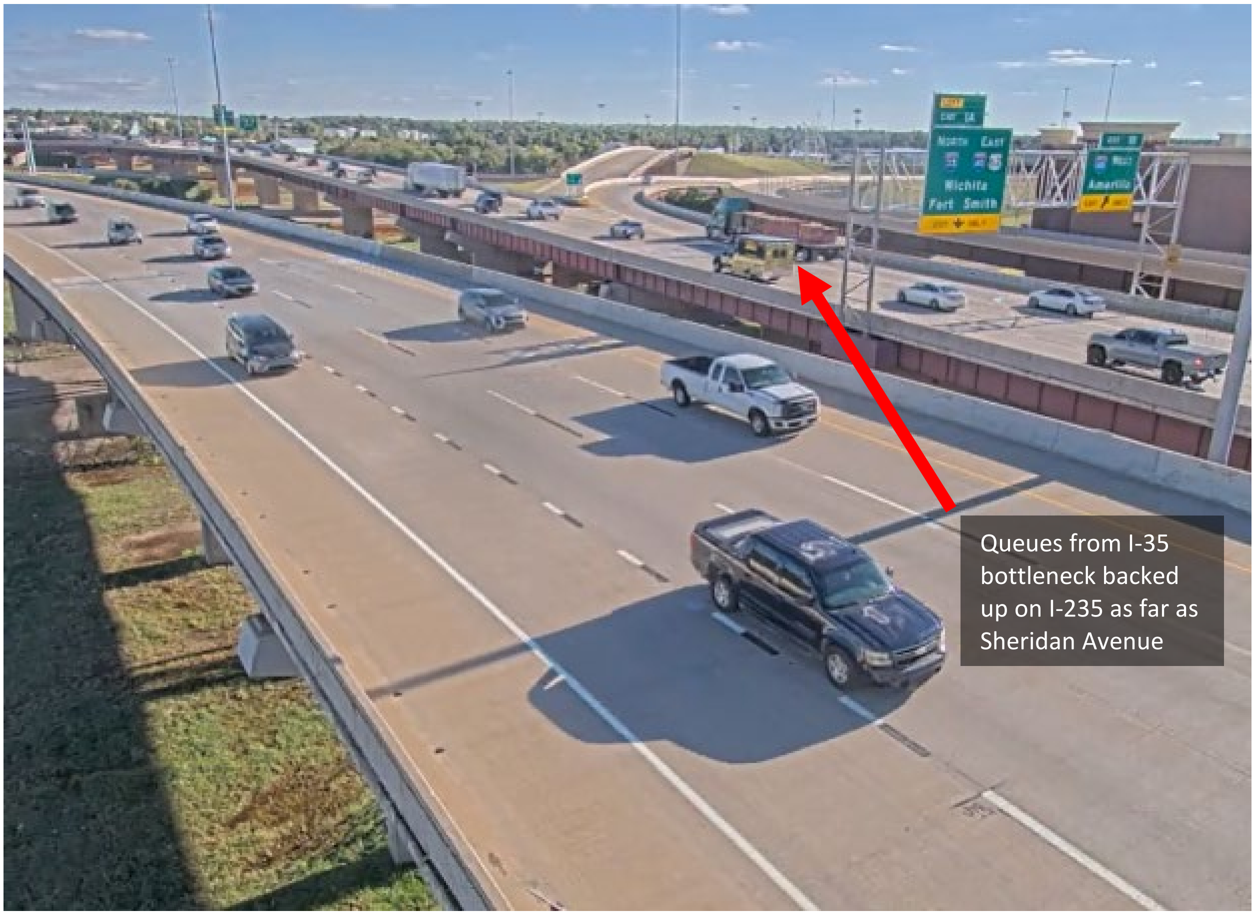
Figure 8. Aerial view of I-35 south of the railroad bridge

As shown in Figure 9 below, by 3:17pm the queue from the lane drop on the other side of the river has already spilled over onto the entrance ramps from I-40 and the I-235 mainline. The is represented by (2) in Figure 6 above.

Figure 9. Queues from I-35 spilling over to I-40 entrance ramps and I-235, November 5, 2024, at 3:17pm

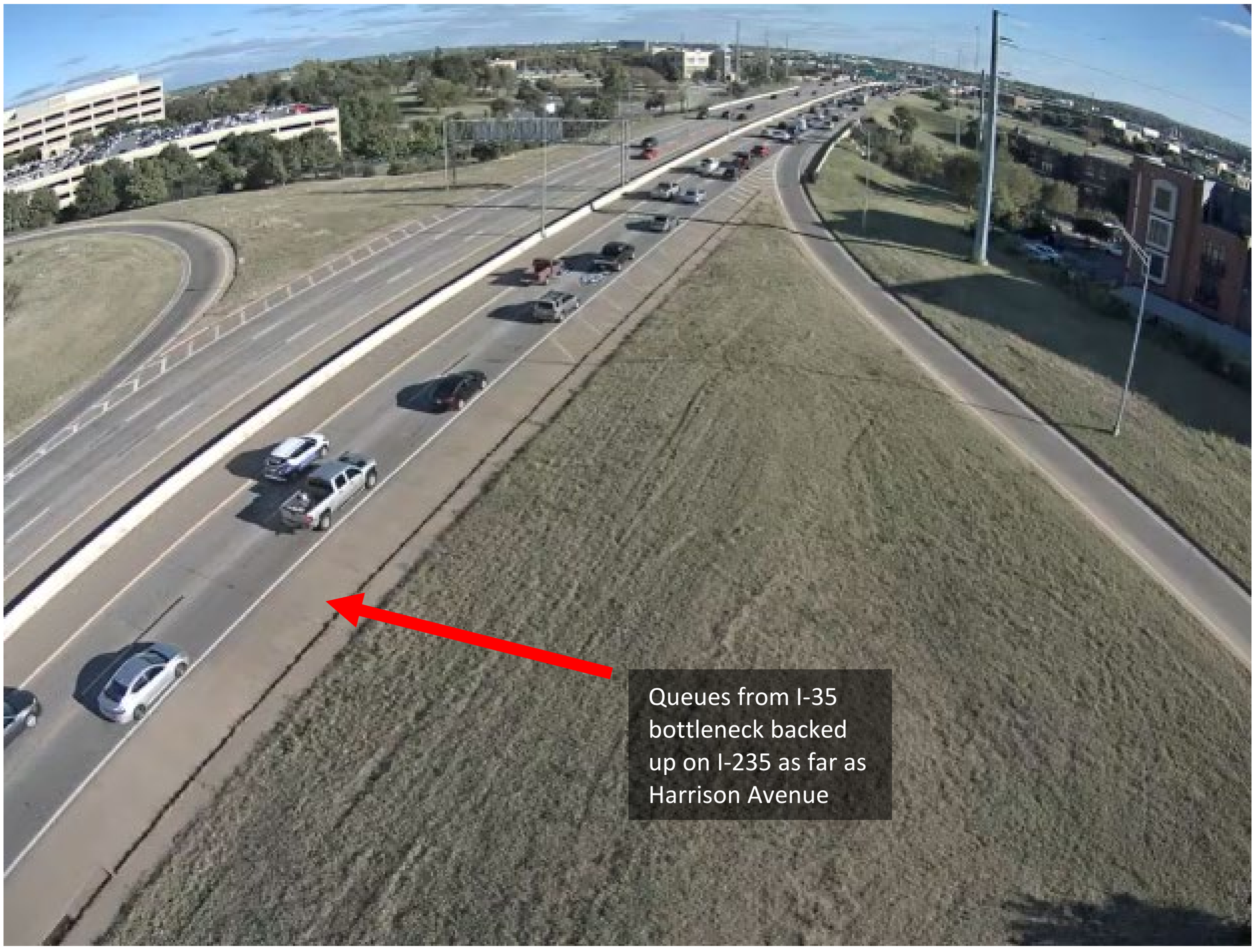
By 3:22pm, the queues have extended on I-235 as far as Sheridan Avenue, 1.3 miles from the bottleneck and far beyond the project construction area, as shown in Figure 10 below. This is shown by (3) in Figure 6 above.

Figure 10. Queues from I-35 spilling over to I-235 southbound at Sheridan Ave., November 5, 2024, at 3:22pm



By 3:22pm, the southbound queue on I-235 extends as far as 5th Street, shown in Figure 11 below and represented by (4) in Figure 6 above. This is 1.7 miles from the bottleneck.

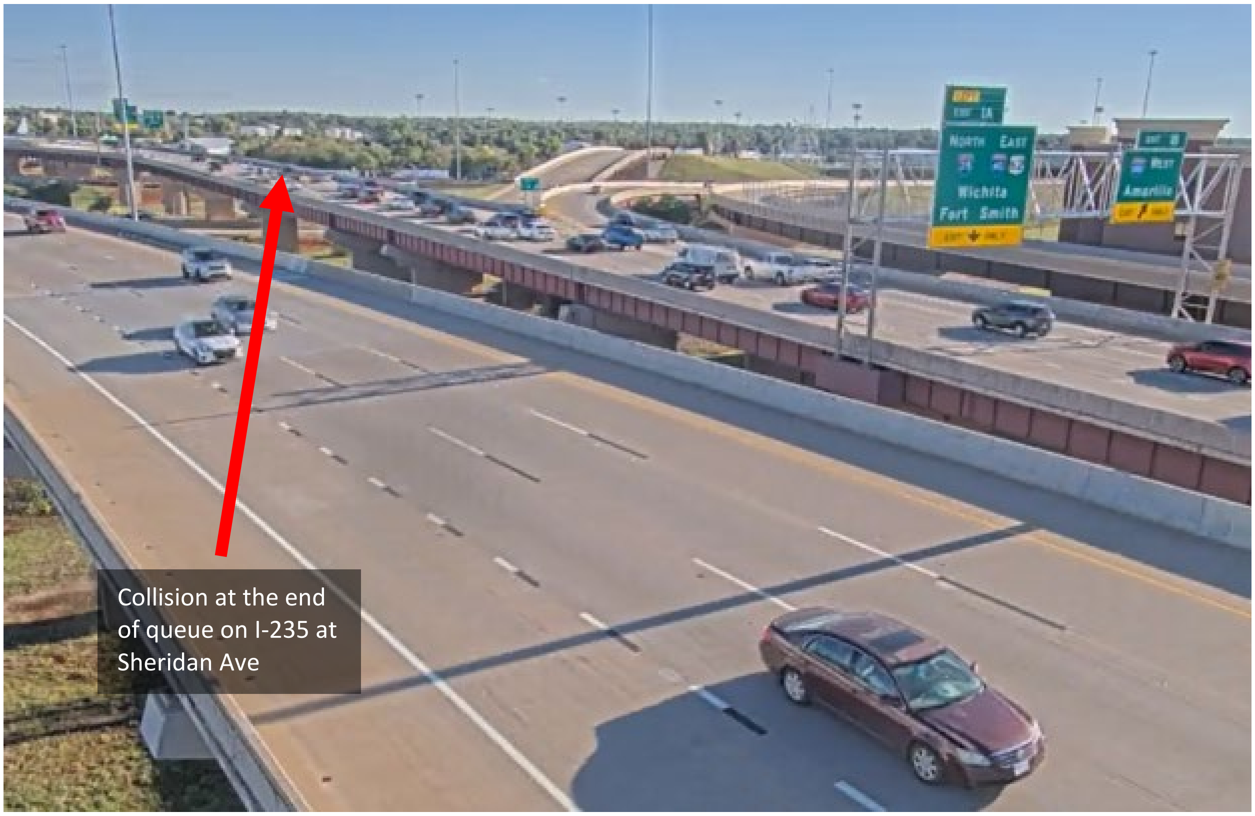
Figure 11. Queues from I-35 backing up on I-235 southbound at NE 5th Street, November 5, 2024, at 3:33pm



At 3:47pm, southbound traffic on I-235 becomes complete gridlocked at Sheridan Avenue, as shown in Figure 12 and Figure 13 below. The cause is a collision due to rapid change of speed at the end of the queue, represented by (5) in the map above.

Figure 12. Gridlocked traffic on I-235 southbound at Sheridan Ave., November 5, 2024, 3:47pm

Figure 13. Collision site on I-235 southbound at Sheridan Ave. due to queuing



By 4 pm the queue extended well north of 23rd St, as shown in Figure 14 below. This queue is at least 3.5 miles from the project area, beyond the view of the traffic camera. The site of the collision is represented by (5) on the map, and the end of the queue is represented by (6).

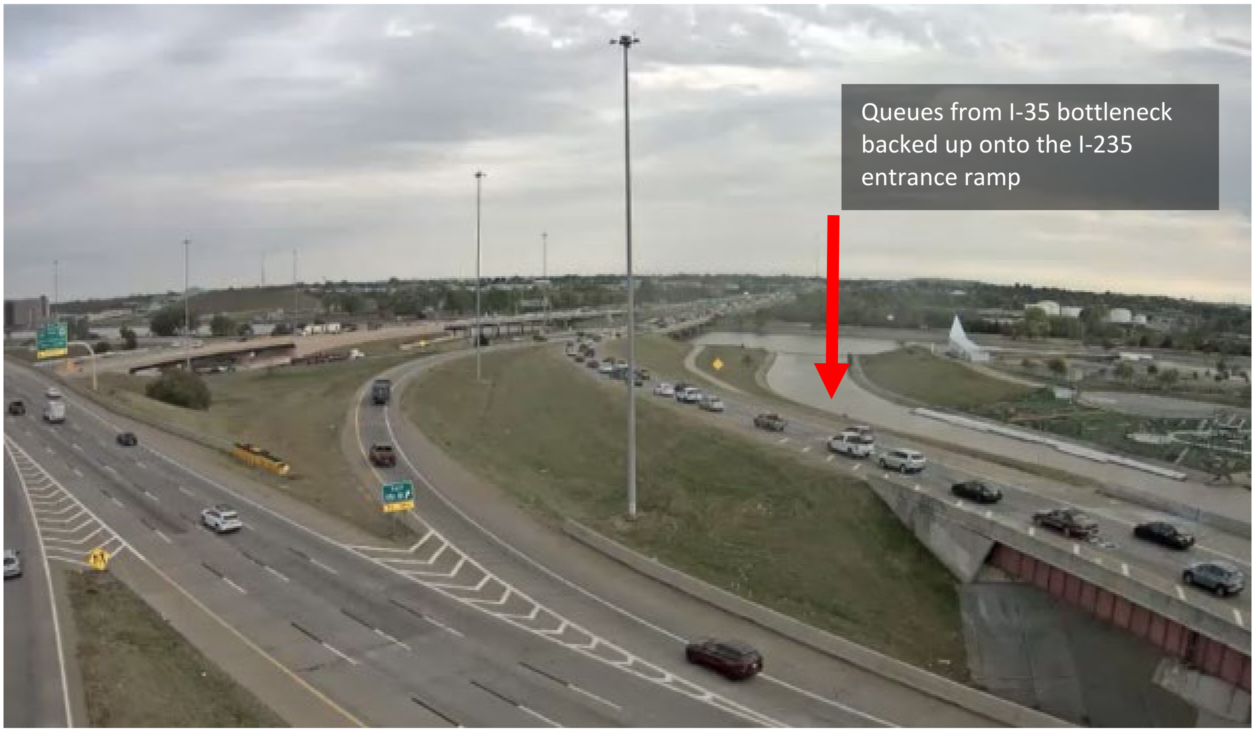
Figure 14. Traffic backup on I-235 to at least 23rd St, November 5, 2024, 4pm

Emergency services arrived at 4:01pm. The project area cleared because traffic was metered. Figure 15 below shows that the bottleneck is clear.

Figure 15. Project area bottleneck at 4:01pm

However, the next day the process repeats, with queues building from the 15th Street bottleneck again, as shown in Figure 17.

Figure 16. Queues from I-35 spilling over to I-40 entrance ramps and I-235, November 7, 2024, at 3:37pm



At the same time, the queue on I-235 quickly backs up to Sheridan Ave again, increasing the chance of a similar collision backing up traffic again, as shown in Figure 18 below.

Figure 17. Queues from I-35 spilling over to I-235 southbound at Sheridan Ave, November 7, 2024

Appendix B: Supplemental Traffic Studies

The 35/I-40/I-235 Dallas Junction OKC Preliminary Lane Capacity Analysis analyzed 33 points for lane capacity using equation 12-9 from the Highway Capacity Manual (HCM) and evaluated based on Level of Service (LOS) according to Exhibit 12-37 from the HCM during the AM and PM peak hours. The analysis used a 1.5% annual growth rate, slightly less than the 1.6% growth rate used in the BCA. The analysis found the following bottlenecks which will be alleviated by this project:

- Point A: I-235 SB Mainline north of the interchange
- Point B: I-235 SB Mainline immediately after the OKC Blvd. exit and before the I-40 WB exit
- Point D: I-235 SB Mainline after the I-40 WB exit and before the I-40 EB exit
- Point O: I-235 SB Mainline before the I-40 EB on ramp
- Point Q: I-235 SB Mainline after the I-40 EB on ramp and before the I-35 SB/I-40 WB ramp
- Point R: I-35 SB Mainline south of the interchange
- Point S: I-35 NB Mainline south of the interchange
- Point U: I-235 NB Mainline after the I-35 NB/I-40 EB exit
- Point AD: I-235 NB Mainline after the I-40 EB on ramp and before the I-40 WB exit
- Point AF: I-235 NB Mainline after the I-40 WB exit and before the I-40 WB on ramp
- Point AJ: I-235 NB Mainline north of the interchange

Table 8. Bottlenecks alleviated in this project

Point	Existing Lanes	2020 AM LOS	2020 PM LOS	2020 Lanes needed for LOS C or better	2050 AM LOS	2050 PM LOS	2050 Lanes needed for LOS E or better
A	4	C	E	6	D	F	6
B	4	C	E	6	D	F	6
D	3	C	E	5	D	F	5
O	2	C	F	4	E	F	4
Q	3	C	E	5	D	F	4
R	4	C	D	5	E	F	5
S	4	D	C	5	F	E	5
U	3	E	C	5	F	D	5
AD	4	E	B	6	F	D	6
AF	3	F	B	5	F	C	5
AJ	4	E	C	6	F	E	6

Figure 18 below shows the location of the points in Table 8. Bottlenecks alleviated in this project that will be alleviated by this project.

Figure 18. Reference map for Table 8