



MEMORANDUM

Missouri Department of Transportation

Saint Louis District – 1590 Woodlake Drive, Chesterfield, MO 63017

DATE: June 4, 2019

TO: Tom Blair, P.E.
District Engineer

FROM: Shirley Norris, P.E.
Project Manager

SUBJECT: SL District - Design
Route U.S. Route 50, Franklin County
Intersection Safety Improvement Project
Job No. J6P2350
Conceptual Study Report

LOCATION

Improvements for this project will be performed in and around the U.S. Route 50 and Route AT/North Outer 44 intersection in Franklin County, MO. This intersection is located in the eastern region of the City of Union. The intersection is located at Log Mile 221.76 for U.S. Route 50, and is approximately 650 feet west of the I-44 interchange.

See Appendix 01 for Location Sketch.

PURPOSE AND NEED

The purpose of this project is to increase overall safety by providing long-term geometric improvements that reduce intersection conflict points and/or lower the speed of vehicles entering the intersection. Such improvements are needed to improve safety by reducing the number of rear end and right-angle crashes.

DESIGN TRAFFIC

U.S. Route 50

ADT (2020)	= 16,225
ADT (2040)	= 17,925
DHV	= 1,595
D	= 51/49 (WB/EB)
% Trucks	= 10%
Operational (Posted) Speed	= 55mph

Route AT

ADT (2020)	= 3,835
ADT (2040)	= 4,235
DHV	= 260
D	= 51/49
% Trucks	= 5%
Operational (Posted) Speed	= 55mph

North Outer 44

ADT (2020) = 1,730
 ADT (2040) = 1,915
 DHV = 240
 D = 52/48
 % Trucks = 6%
 Operational (Posted) Speed = 55mph

EXISTING FACILITIES

☒ Major Route ☐ Minor Route

U.S. Route 50 is functionally classified as Principal Arterial with a posted speed limit of 55 mph within the project limits. Route AT is functionally classified as Minor Arterial with a posted speed of 55 mph and North Outer 44 is functionally classified as a Major Collector with a posted speed limit of 55 mph within the project limits.

Principal Arterial: U.S. Route 50

Beginning Log Mile	Pavement		Year Built	Roadbed Width	Min. R/W Width	Access Control
	Width	Type				
221.76	42'	Asphalt surface over concrete pavement	1926; widened in 1970	62'	175'	Limited

Minor Arterial: Route AT

Beginning Log Mile	Pavement		Year Built	Roadbed Width	Min. R/W Width	Access Control
	Width	Type				
0.000	24'	Asphalt	1970	40'	Varies	Limited

Major Collector: North Outer 44

Beginning Log Mile	Pavement		Year Built	Roadbed Width	Min. R/W Width	Access Control
	Width	Type				
0.000	22'	Asphalt	Pre-1970	38'	Varies	Limited

EXISTING BRIDGES

Bridge No.	Location	Type	Length	Width	Year Built	Condition Ratings		
						Deck	Super	Sub
N/A	N/A	N/A	-	-	-	N/A	N/A	N/A

There are no existing bridges in the proposed project limits.

CRASH DATA

Project Crash Rate – 1.86 (5-Yr Average)

Statewide rate for a similar class of roadway - 0.158 (5-Yr Average)

Locations within or adjacent to the project limits which are on the “High Severity Location Lists” in the TMS database – **U.S. Route 50 @ Route AT/AH Intersection**

Crash rates at this intersection are 11 times higher than the statewide average rate for a similar class of intersection. Five-year crash history shows 53 total crashes occurred from 2013 to 2017, including 1 disabling injury and 12 minor injury incidents. Of the 53 total crashes, 23 (or 43%) were rear-end type incidents, and 18 (34%) were right angle collisions (either through, right or left turns). A review of the crash reports indicated that high speeds on U.S. Route 50 contribute significantly to the intersection crashes by limiting appropriate gaps for traffic turning and merging into a single lane on U.S. Route 50 and by making it difficult to judge the timing of approaching vehicles. The geometric improvements included within this project are expected to reduce the crash rates at this intersection.

See Appendix 02 for a summary of crash data at the intersection from 2013-2017.

ALTERNATIVES ANALYSIS

The intersection of U.S. Route 50 with Route AT/ North Outer 44 experienced significant safety concerns in recent years. The current safety issues at the intersection stem from three root causes: the number of conflict points associated with the intersection, the speed of the vehicles entering the intersection, and the lack of critical gaps in traffic (associated with the volume of traffic). This Conceptual Study Report documents the Franklin/Jefferson County Area Team’s efforts in determining the best safety improvement strategy at the subject intersection.

Over the last several years, various improvements have been investigated at this location. Some early alternatives, ranging from small improvements to sprawling geometric additions, were removed from further consideration. On the small improvements side, the concept of **Additional Signs, Striping and Traffic Calming Measures** on the I-44 WB exit ramp was abandoned when, in 2017, the Safety Improvements Design-Build (D-B) project (Job No. J6P3194) installed a suite of improvements at and around the subject intersection, which included installation of an Intersection Conflict Warning system to warn drivers on U.S. 50 and I-44 WB Exit ramp about vehicles waiting to turn from the minor roads. The Safety Improvements D-B project also constructed right turn angle changes to the right turn bays on the minor roads. These angle changes make the turning motion more severe, forcing motorists to significantly slow or stop before pulling out into traffic.

Additionally, **Converting the Intersection to Right-In/Right-Out** was considered. This option proposed removal of the existing left turns, thereby detouring traffic to another route that could replace the left turn movement. However, due to the amount of adverse travel needed by drivers

to make those left turns, this option was removed from serious consideration. Finally, an I-44 companion bridge option dubbed **Route AT/AH Connector** proposed to convert the existing intersection to right-in/right-out and connect Route AT and North Outer 44 with a bridge parallel to the existing I-44 bridges. A conceptual Request for Environmental Services (RES) was completed for this proposed design, but revealed significant environmental impacts. The maintenance and construction cost of this option were also of concern. Due to these factors, the concept was not analyzed further.

The improvements made as a part of the Safety Improvement D-B project are not considered a long-term solution for the intersection, and therefore further engineering was needed. A consultant-led traffic study submitted in July 2018 analyzed both a **Single-lane Roundabout** and a **Traffic Signal** at this intersection. However, both of these options were discarded. The Single-lane Roundabout yielded long queue lengths on westbound U.S. 50 during the PM peak hour in Year 2040 (40.9 Vehicles), creating a safety hazard on westbound I-44 as the queues extended toward the mainline traffic. The Traffic Signal failed to provide quantifiable safety benefit and yielded LOS E and long delays on the minor road approaches in during the PM peak hour in Year 2040. The final early alternative of note is the **Westbound US 50 Bridge** over the intersection. Using the higher elevation of the westbound I-44 exit ramp, that grade was maintained by using MSE walls to retain fill necessary to take the westbound U.S. Route 50 lane over the intersection. Ramps to and from the elevated westbound U.S. 50 section provided access to the subject intersection. The lack of adequate vehicle storage on Route AT and the difficulty in providing sufficient sight distance within the MSE wall layout led to this option being dropped from further consideration.

Building from the findings of the earlier report, an additional traffic study was completed in late 2018. This version examined options that could benefit safety while still maintaining acceptable movement of traffic through the facility. The results of the newer study yielded five (5) viable alternatives the Area Team was able to analyze for maximizing the safety benefit at the intersection. An in-depth analysis of each option will be presented in the following section.

FINAL STUDY ALTERNATIVES:

Option #1: Roundabout with Dual Westbound Lanes (AKA “Dual Lane Roundabout”)

The roundabout design uses a 198-ft inscribed circle diameter. The circulatory roadway is generally 25.5 feet wide, except in the westbound direction where two 15-ft wide through lanes provide a 30-ft wide roadway. The larger diameter roundabout and wider circulation lane, combined with generally wider approach and exit lanes, allow for efficient movement through the roundabout. A southbound right-turn bypass lane is included in the design. At 500 feet in length, the bypass lane allows drivers to merge into the westbound U.S. Route 50 traffic without entering the roundabout. The second lane for westbound U.S. Route 50 continues for 1,050 feet past the roundabout, ending before the bridge over Birch Creek.

Option #2: Intersection Shift (relocating North Outer 44 to the west)

This design creates two three-leg intersections. It eliminates the southern portion of the existing intersection by continuing North Outer 44 approximately 700 feet to the west, terminating at U.S. Route 50 at a 90° angle. Since the left turn lane for the southbound movement is removed from the existing intersection, it allows the striping to be reworked to offset the westbound right-turn lane 6 feet from mainline traffic. The existing U.S. Route 50 right-turn and left-turn lane lengths and tapers are used for the intersection with Route AT. The southbound right-turn lane improvements recently installed at the intersection are also left in place.

Option #3: Minor Road Underpass (U.S. Route 50 bridge)

The underpass design features a new bridge on U.S. Route 50 over a new connecting road alignment placed approximately 350 feet west of the study intersection to serve through movements for both minor roads. The single span bridge is 51-ft long x 57'-8" wide on MSE retaining wall abutments. To minimize superstructure depth, six (6) 21" x 48" x 51'-0" prestressed precast concrete box beams were selected. Coupled with an 8.5-inch thick deck, the total superstructure depth is 3'-4". The minimum vertical clearance was set at 16'-6". The new connecting road has 14-ft lanes with 6-ft shoulders. Tight 140-ft radii curves minimize the footprint of the new connecting roadway while serving as a traffic calming measure. The left-turn lanes on U.S. Route 50 are eliminated, creating a right-in/right-out intersection with U.S. Route 50.

Option #4: Route AT bridge over U.S. Route 50

This option uses a new bridge over U.S. Route 50 on a new connecting road alignment placed approximately 350 feet west of the study intersection to serve through movements for both minor roads. The single span bridge is 100-ft long x 40-ft wide on MSE retaining wall abutments. Using pre-stressed NU 35 girders, the total superstructure depth is 4'-3". The minimum vertical clearance was set at 16'-6". The new connecting road has 14-ft lanes with 6-ft shoulders. Tight 140-ft radii curves minimize the footprint of the new connecting roadway while serving as a traffic calming measure. The left-turn lanes on U.S. Route 50 are eliminated, creating a right-in/right-out intersection with U.S. Route 50.

Option #5: No Build

This option proposes no improvements to the subject intersection. It is used as a baseline to compare the alternatives.

See Appendix 03 for Conceptual Layouts and Typical Sections for each alternative.

HIGHWAY SAFETY MANUAL (HSM) ANALYSIS

AASHTO's Highway Safety Manual (HSM) details a crash prediction procedure for rural two-lane roads, and has provided a spreadsheet to analyze the predictive models based on various user inputs. The Rural two lane, intersection tab on the HSM spreadsheet was used, and inputs for existing and proposed geometry, traffic volumes, stop conditions, and any proposed Crash Modification Factors were used to generate a predictive crash rate for each option.

See Appendix 04 for HSM predictive crash rate output for each alternative.

COST ESTIMATES

Option #1: Roundabout with Dual Westbound Lanes

Conceptual Cost: \$1,920,000
Right of Way: \$0
Construction: \$1,920,000

Option #2: Intersection Shift

Conceptual Cost: \$2,010,000
Right of Way: \$624,000
Construction: \$1,386,000

Option #3: Minor Road Underpass

Conceptual Cost: \$5,030,000
Right of Way: \$1,730,000
Construction: \$3,300,000

Option #4: Route AT bridge over U.S. Route 50

Conceptual Cost: \$5,220,000
Right of Way: \$1,725,000
Construction: \$3,495,000

Option #5: No Build

Conceptual Cost: \$0
Right of Way: \$0
Construction: \$0

See Appendix 05 for the Conceptual cost estimates.

BENEFIT/COST RATIO ANALYSIS

Option #1: Roundabout with Dual Westbound Lanes

Average Annual Cost: \$85,700
Estimated Average Annual Net Savings: \$643,600
Before Benefit / Cost Ratio: 8.5

Option #2: Intersection Shift

Average Annual Cost: \$89,700
Estimated Average Annual Net Savings: \$167,200
Before Benefit / Cost Ratio: 2.9

Option #3: Minor Road Underpass

Average Annual Cost: \$224,600
Estimated Average Annual Net Savings: \$206,900
Before Benefit / Cost Ratio: 1.9

Option #4: Route AT bridge over U.S. Route 50

Average Annual Cost: \$223,100
Estimated Average Annual Net Savings: \$198,400
Before Benefit / Cost Ratio: 1.9

Option #5: No Build

Average Annual Cost: \$0
Estimated Average Annual Net Savings: \$0
Before Benefit / Cost Ratio: 0

See Appendix 06 for Benefit/Cost Ratio output for each alternative.

LEVEL OF SERVICE & TRAFFIC MOBILITY

The 2018 existing operational characteristics of the intersection of US Route 50 with Route AT / N Outer 44 were evaluated utilizing Synchro and SIDRA software packages. These are considered the baseline year for comparison purposes. Levels of Service (LOS) are measures of traffic flow that consider such factors as speed, delay time, traffic interruptions, safety, driving comfort, and convenience. LOS C or higher is considered acceptable for peak conditions for highway design. However, LOS D or higher is often considered acceptable for peak operating conditions in urban areas.

LOS is not reported for unsignalized intersections with partial (side street) stop control since vehicles on the main road are not required to stop or yield. In this case, LOS is only provided for the secondary movements (main road left-turns and minor street movements). Since drivers are not guaranteed service at regular intervals, LOS thresholds for unsignalized intersections are lower than those for signalized intersections.

For comparison to Option #1 Dual Lane Roundabout, the existing intersection was evaluated using SIDRA Intersection 8. This software is typically used to evaluate roundabouts and could give the best evaluation between existing and future conditions. The existing intersection was modeled as a two-way stop-controlled condition with no improvements. The results of the SIDRA baseline operational analyses determined the minor leg approaches currently operate with an unacceptable Level of Service during the peak hours. These results are summarized in Appendix 07, Table 1.

Options #2, #3, & #4 were analyzed using Synchro 10, software by Trafficware. This software is typically used to evaluate signalized & unsignalized intersections, providing the best comparison between existing and future conditions for these options. No improvements were included for the

baseline traffic analysis, the results of which are summarized in Appendix 07, Table 2. The baseline Synchro analysis also determined the minor leg approaches currently operate with an unacceptable Level of Service during the peak hours.

For Option#1 Dual Lane Roundabout, all approaches currently operate at a Level of Service B or better during the peak hours throughout the 20-year design year 2040.

Option #2 Intersection Shift is operating at failing levels of service for the minor leg approaches as early as the construction year 2020.

Options #3 & #4 Grade-Separated (Minor Road Underpass & Route AT bridge) operate at acceptable levels of service through year 2040 with the exception of the southbound approach. The minor legs experience failing levels of service for the southbound and northbound approaches as traffic waiting to enter US Route 50 experiences lengthy delays due to the increasing volume of background traffic along US Route 50. Due to the fact that a relatively small volume of traffic utilizes the minor legs, a higher delay per vehicle should be considered an acceptable operating condition. Throughout the 2040 AM and PM peak hours, the eastbound left and westbound left traffic entering the minor legs experiences minimal delays.

See Appendix 07 for the Level of Service Tables.

CONSTRUCTION IMPACTS

Option #1: Roundabout with Dual Westbound Lanes

Construction of the roundabout can be performed with minimal disruption to existing traffic. Split into four stages to reduce Maintenance of Traffic impacts, the proposed stages are as follows:

Stage 1 – Construct sections of roundabout outside of existing traffic lanes in the NW / SW / SE quadrant

Stage 2 – Construct pavement and roundabout in the NE quadrant, and portions in the North Outer Rd.

Stage 3 – Construct center of roundabout and U.S. Route 50 concrete median islands

Stage 4 – Final paving, striping and cleanup

MOT impacts to the minor roads and U.S. Route 50 would be mitigated by detouring traffic via I-44 to the Route 100 interchange or to the U.S. Route 50 and Denmark Road intersection.

Option #2: Intersection Shift

Extending North Outer 44 to the west can be done without major impacts to U.S. Route 50 and Route AT. The proposed stages are as follows:

Stage 1 – Construct new pavement on north side of U.S. Route 50

Stage 2 – Construct new pavement for North Outer 44, including right-turn bays to/from U.S. Route 50

Stage 3 – Resurface U.S. Route 50 and Route AT and restripe

Stage 4 – Remove old North Outer 44 connection to U.S. Route 50 and final cleanup

MOT impacts to U.S. Route 50 would be confined to long-term shoulder closures and nighttime lane closures for milling/paving/stripping operations. No closures of U.S. Route 50 are foreseen. Route AT and North Outer 44 would have little to no MOT impacts except during nighttime milling/paving/stripping operations.

Option #3: Minor Road Underpass

The underpass road pavement can be built without impacting U.S. Route 50. However, installation of the MSE walls, and structural components of the bridge, including curing time for the new bridge deck, will require a complete closure or a longer-term partial closure of U.S. Route 50. The proposed stages are as follows:

Stage 1 – Construct new minor road tie-in pavement north and south of U.S. Route 50. Begin construction of MSE walls.

Stage 2 – Complete MSE walls and construct single span bridge on U.S. Route 50 – requires major impact to U.S. Route 50. Build concrete islands at minor roads and mill/pave/stripe to tie into new pavement.

A complete closure of U.S. Route 50 could last up to 30 days while the retaining walls are completed, girders set, and bridge deck rebar and concrete placed. MOT impacts to the minor roads and U.S. Route 50 would be mitigated by detouring traffic via I-44 to the Route 100 interchange or to the U.S. Route 50 and Denmark Road intersection.

Option #4: Route AT bridge over U.S. Route 50

The connecting road pavement and MSE walls can be built without impacting U.S. Route 50. Complete closure time of U.S. Route 50 will be required when setting girders for the new bridge, and traffic may need to be restricted while placing bridge deck concrete. The proposed stages are as follows:

Stage 1 – Construct new minor road tie-in pavement and MSE walls, including backwalls and abutments for the bridge, north and south of U.S. Route 50

Stage 2 – Construct single span bridge over U.S. Route 50. Requires short closure to U.S. Route 50. Build concrete islands at minor roads and mill/pave/stripe to tie into new pavement.

A complete closure of U.S. Route 50 could last up to 24 hours while the girders are set. Traffic may need to be restricted on mainline while bridge deck concrete placed. MOT impacts to the minor roads and U.S. Route 50 would be mitigated by detouring traffic via I-44 to the Route 100 interchange or to the U.S. Route 50 and Denmark Road intersection.

UTILITIES

The topographic survey of the project area was used to check for impacts to existing utilities with the various design options. Overall, the utility impact appears to be minimal. What follows is a list of utilities and the anticipated effects on each:

Electrical Power: The closest Ameren power pole and power drop are located to the east of the commuter parking lot and will be unaffected by any of the concepts designed for this study.

Telephone/Water/Gas/Sanitary Sewer: Not found in project limits

Fiber: Fiber optic cables are located in and around the bridge carrying the I-44 Entrance and Exit ramps. This is outside of the construction limits for any of the concepts designed for this study. No anticipated impacts to this utility.

Storm sewer: There are three drainage structures within the study area: a 24" RCP cross-road pipe with concrete flared end sections just west of the existing intersection, an 18" CMP under the driveway to the south of U.S. Route 50, and a 5'x6' box culvert approximately 1000' west of the intersection that runs under U.S. Route 50.

Option #1 -Dual Lane Roundabout: the 24" RCP would either need to be lengthened or removed and replaced in a different location. Since curbing is needed with this option, an enclosed drainage network would need to be designed. The 24" RCP would be tied into the future drainage network. This can be cared for during design development while designing the storm water improvements.

Option #2 - Intersection Shift: The driveway would be removed and relocated to the south, tying in with the extended North Outer 44. The 18" CMP under the driveway would be replaced as part of that work. The 5'x6' box culvert would be extended due to the addition of the right-turn lane. There is no anticipated effect on the 24" RCP. In general, this option will use roadside ditches to capture and convey stormwater.

Options #3 & #4 - Minor Road Underpass & Route AT Bridge: Existing drainage structures used in place, possible lengthen the crossroad pipe to the west of the intersection. A combination of an enclosed drainage network (for the underpass), roadside ditches and possibly small detention basins would handle the stormwater for these options.

MoDOT ITS/Signals/Electrical Power: Existing MoDOT power runs underground on either side of U.S. Route 50 and powers the light poles at the intersection. In each of the concepts considered, at least one of the lighting poles would need to be relocated, along with some length of cable/conduit. Existing MoDOT lighting controllers are located to the east of the commuter parking lot and will be unaffected by this project, except to connect new or relocated light poles for the new intersection. The Intersection Conflict Warning System installed by the Safety Design-Build team would no longer be needed and would be removed. MoDOT can salvage the signs, beacons and controller cabinet.

PROPOSED DESIGN – PREFERRED ALTERNATIVE

The preferred alternative selected by the Area Team is ***Option #4 - Route AT bridge over U.S. Route 50***. This alternative provides a long-term improvement for a safe, grade-separated crossing of U.S. Route 50. The option also provides for future growth of U.S. Route 50 by offering a 100-foot long bridge, allowing more than 20 feet of greenspace along westbound and eastbound lanes for future lane additions. This option can be built with minimal impact to existing traffic, increasing safety for drivers and construction workers during construction.

The team acknowledges that the quantified safety benefit of this option is lower than the other options considered, especially the Dual Lane Roundabout. With direct knowledge of local driver behaviors, the Area Team noted that there are few roundabouts in the area and the unfamiliar geometry of a roundabout may be difficult for local drivers to navigate. Additionally, although the roundabout's second lane in the westbound direction prevented long queues in the traffic model, the team feared that the second lane would be under-utilized, possibly creating longer-than-anticipated queues in the westbound direction during the PM peak. It was also noted that the Dual Lane Roundabout and the Intersection Shift options did not leave sufficient space for future growth of U.S. Route 50, and did not honor the designation of the I-44 exit and entrance ramps as "High Speed" ramps as defined in the Major Transportation Investment Analysis (MTIA) performed by MoDOT in 1997.

Overall, ***Option #4 - Route AT bridge over U.S. Route 50*** as a safety countermeasure will reduce serious and fatal crashes at the existing intersection, allow for future growth along the U.S. Route 50 corridor, and will maintain the high-speed ramps to and from I-44.

PROPOSED DESIGN CRITERIA

U.S. Route 50

Functional Classification	Design Speed	No. & Width Of Lanes	Roadbed Width	Right of Way	
				Width	Control
Principal Arterial	60 mph	2 -12' lanes with turn lanes	Varies	Varies	Limited

Route AT

Functional Classification	Design Speed	No. & Width Of Lanes	Roadbed Width	Right of Way	
				Width	Control
Minor Arterial	55 mph	2 – 12' lanes	40'	Varies	Limited

North Outer 44

Functional Classification	Design Speed	No. & Width Of Lanes	Roadbed Width	Right of Way	
				Width	Control
Major Collector	55 mph	2 -12' lanes	38'	Varies	Limited

New Connector Road

Functional Classification	Design Speed	No. & Width Of Lanes	Roadbed Width	Right of Way	
				Width	Control
Minor Arterial	25 mph	2 -14' lanes	40'	Varies	Limited

SATISFACTION OF THE PURPOSE AND NEED

The preferred alternative satisfies the safety concerns by providing a long-term geometric improvement that reduce intersection conflict points through a grade-separated crossing of U.S. Route 50. Such improvements will improve safety by reducing the number of rear end and right-angle crashes at the intersection.

ENVIRONMENTAL SUMMARY

As previously noted, an initial RES had been prepared for this project. From the findings of that report, the single biggest environmental concern in the study area is likely the existing wetland in the northeast corner of the land bounded by Route AT and the westbound I-44 exit ramp. According to the National Wetlands Inventory managed by the U.S. Fish and Wildlife Services (www.fws.gov/wetlands/Data/Mapper.html), the Freshwater Emergent Wetland to the northeast of the intersection is 0.37 acres in size. However, based on the footprint of the five options considered, there will be no direct impacts to the wetland by the project. The wetland may need to be delineated in the design plans to avoid impacts by the storm water drainage design, and so that a contractor does not impact the wetlands with equipment storage or the like.

The FEMA Map for the project area depicts a 500-year and 100-year floodplain in proximity to the project location. The overall location of the new connecting road to bridge over U.S. Route 50 minimizes the building of new pavement in the floodplain. Completing the necessary tie-in work to Route AT may require additional environmental clearances (i.e. SEMA Floodplain Development Permit). Based on the location of the floodway, a No-Rise Certificate will not be required for this project.


Please see Appendix 08 for FEMA Flood Plain Map of the project area.

Requests for Environmental Services will be submitted at all project milestones. Any additional environmental concerns identified by those requests will be addressed in the design. Overall, it is anticipated that building any of the concepts considered will not have significant social, economic, or environmental impacts. Therefore, it is expected that the NEPA process will yield a Categorical Exclusion (CE) for the project.

COMMENTS AND RECOMMENDATIONS

It is recommended to move forward with constructing a new Route AT bridge over U.S. Route 50 and converting the existing intersection to a right-in/right-out intersection.

 7/1/19
Shirley Norris, P.E. Date
MoDOT Project Manager

 6/4/2019
Heather Copeland, P.E. Date
Consultant Project Manager


Recommendations or Comments:

PLEASE MAKE SURE THESE ALTERNATIVES ARE
REVIEWED AS WE FUND IMPROVEMENTS.

PLEASE ENSURE WE SEEK THE BEST DELIVERY
METHOD THAT WILL PRODUCE THE GREATEST RESULTS.

Attachments:

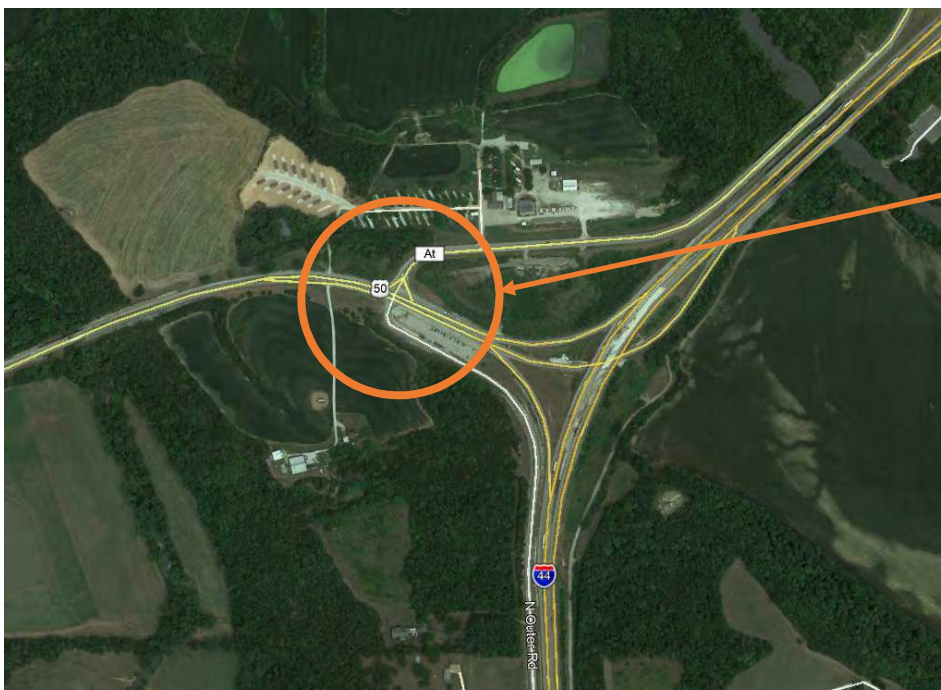
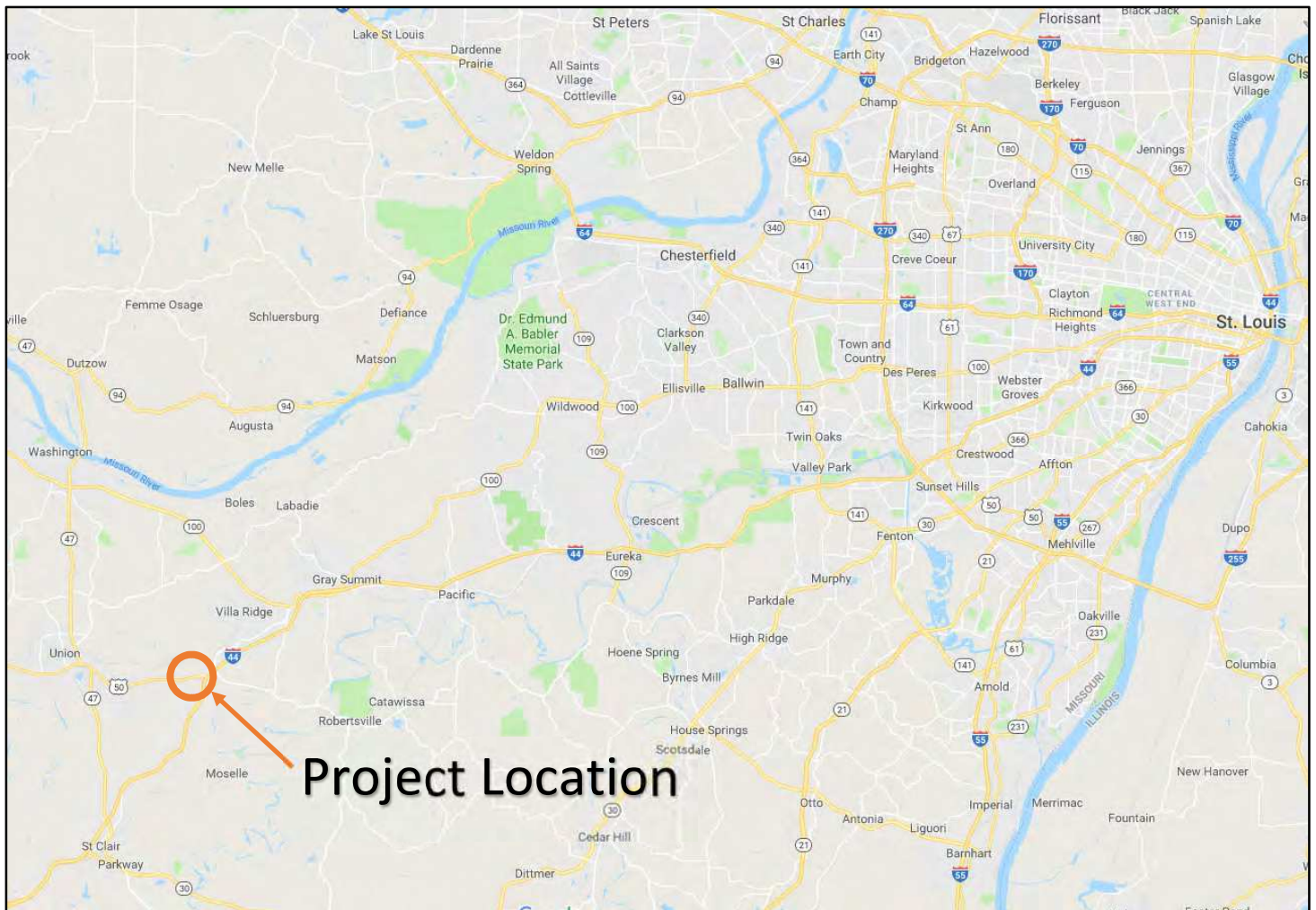
- Appendix 01 – Location Map
- Appendix 02 – Crash Data Summary
- Appendix 03 – Conceptual Layouts
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- Appendix 05 – Conceptual Cost Estimates
- Appendix 06 – Benefit/Cost Ratio Spreadsheets
- Appendix 07 – Level of Service Tables
- Appendix 08 – FEMA Flood Plain Map

Approved by:  7/3/19
Tom Blair, P.E. Date
District Engineer

cc: Design Division
Construction and Materials Division
Traffic Division

Appendix 01 – Location Map

J6P2350 – U.S. Route 50 at Route AT Intersection



Project Location

U.S. Route 50 @ Route AT,
East of Union, MO

APPENDIX 02 - CRASH DATA SUMMARY

OFFSET	TRAVEL WAY ID	DESIGN ATION	TRAVEL WAY NAME	DIRECTI ON	BEGIN LOG	END LOG	BEGIN DISTRIC T	END DISTRIC T	BEGIN COUNTY	END COUNTY	COUNTY BEGIN LOG	COUNTY END LOG	BEGIN DESCRIP TION	END DESCRIP TION
	3507	US	50	E	221.76	221.76	5	5	FRANKLI N	FRANKLI N	26.765	26.765	RT AT E	RT AT E

TYPE	2013	2014	2015	2016	2017	TOTAL
FATAL	0	0	0	0	0	0
DISABLING INJURY	0	0	0	0	1	1
MINOR INJURY	2	3	5	2	0	12
PROPERTY DAMAGE ONLY	7	9	8	8	8	40
TOTAL	9	12	13	10	9	53
AADT	14219	14247	16268	16612	16966	

1 Year Statewide Rate

TYPE	2013	2014	2015	2016	2017	Rate Level
CRASH RATE	1.73	2.31	2.19	1.65	1.45	
STATE RATE	0	0.28	0.27	0.24	0	

TYPE	2013	2014	2015	2016	2017	TOTAL
ANIMAL DRAWN VEH OR RIDDEN ANIMAL	0	0	0	0	0	0
ANIMAL NOT DEER/DOG/FARM ANIMAL	0	0	0	0	0	0
ANIMAL OTHER THAN DEER	0	0	0	0	0	0
AVOIDING	0	0	0	0	0	0
BACKING	0	0	0	0	0	0
CHANGING LANE	0	0	0	0	0	0
CROSS MEDIAN	0	0	0	0	0	0
DEBRIS	0	0	0	0	0	0
DEER	0	0	0	0	0	0
DOG	0	0	0	0	0	0
DUAL LEFTS COLLIDE	0	0	1	0	0	1
DUAL RIGHTS COLLIDE	0	0	0	0	0	0
FARM ANIMAL	0	0	0	0	0	0
FIXED OBJECT	0	0	0	0	0	0
HEAD ON	1	0	0	0	0	1
JACKKNIFE	0	0	0	0	0	0
LEFT TURN	2	2	1	0	1	6
LEFT TURN RIGHT ANGLE COLLISION	1	2	1	2	1	7
OTHER	0	0	0	0	0	0
OUT OF CONTROL	1	0	0	0	0	1
PARKING OR PARKED CAR	0	0	0	0	0	0
PASSING	0	1	0	0	0	1
PEDALCYCLE	0	0	0	0	0	0
PEDESTRIAN	0	0	0	0	0	0
REAR END	4	5	5	5	4	23
RIGHT ANGLE	0	1	4	3	2	10
RIGHT TURN	0	0	0	0	1	1
RIGHT TURN RIGHT ANGLE COLLISION	0	0	1	0	0	1
SIDESWIPE	0	1	0	0	0	1
TOWED UNIT DISCONNECTS	0	0	0	0	0	0
U - TURN	0	0	0	0	0	0
WRONG WAY ON DIVIDED HIGHWAY	0	0	0	0	0	0
TOTAL	9	12	13	10	9	53

This report contains information that is protected from disclosure by federal law, 23 USC Section 409 and the Missouri Open Records Law (Sunshine Act), Section 610.021 RSMo. Please review MoDOT's policy and procedure manual on the Sunshine Act before releasing any of the information contained herein.

Appendix 03 – Conceptual Layouts

Option #1: Dual Lane Roundabout

Geometric Layout

Typical Section

Option #2: Intersection Shift

Geometric Layout

Typical Section

Sight Distance Triangles – 4 Sheets

Option #3: Minor Road Underpass

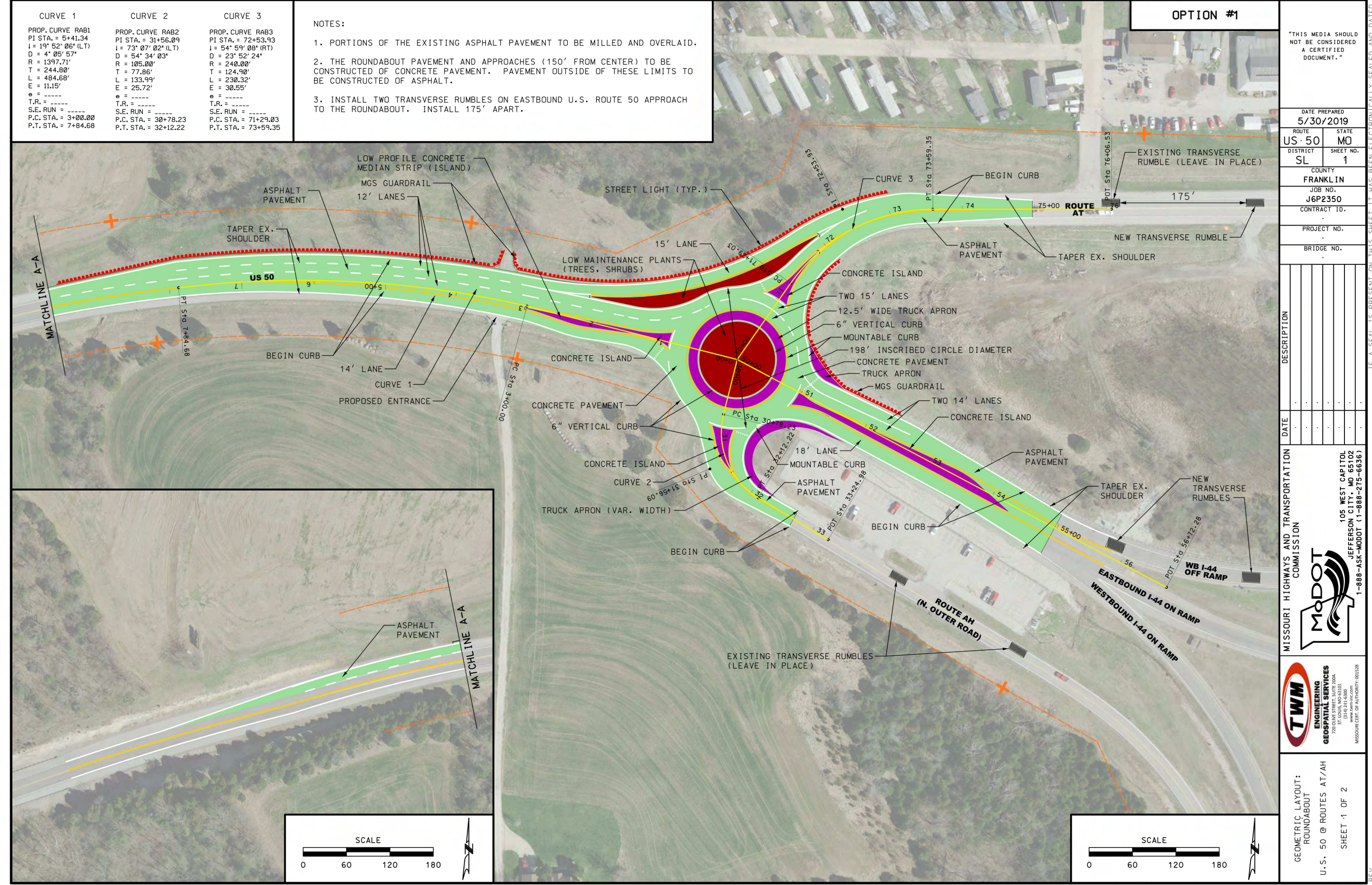
Geometric Layout

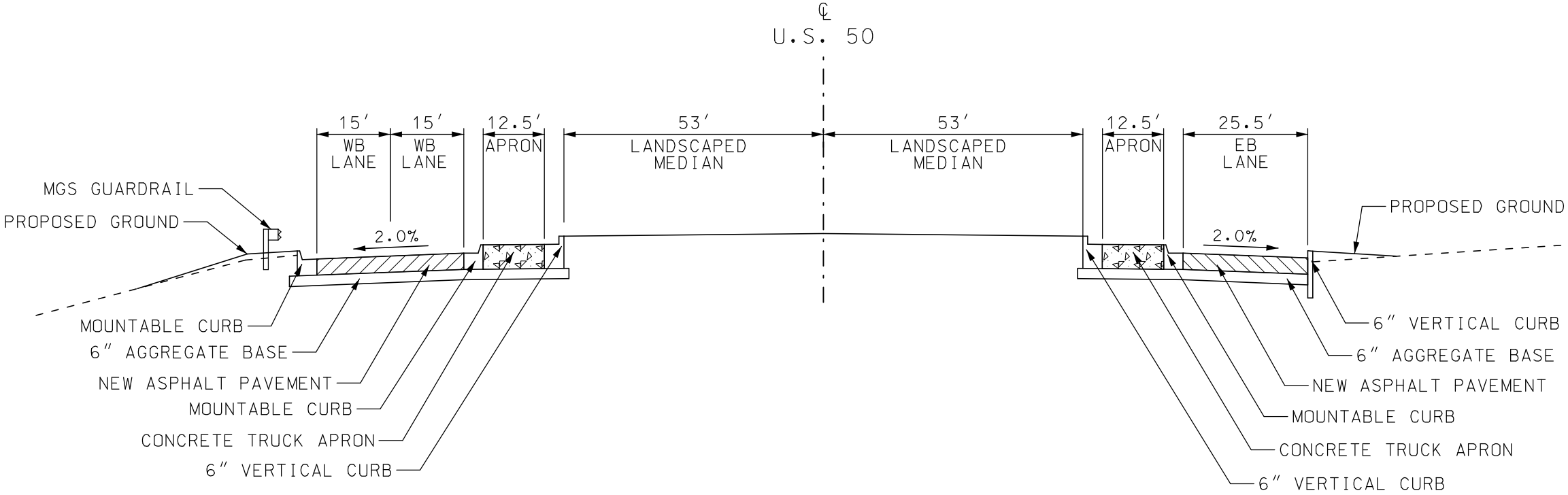
Typical Section

Option #4: Route AT bridge over U.S. Route 50

Geometric Layout

Typical Section





OPTION #1
ROUNABOUT TYPICAL SECTION


NOT TO SCALE -
FOLLOW DIMENSIONS

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DISTRICT SL	SHEET NO. 2
COUNTY FRANKLIN	
JOB NO. J6P2350	
CONTRACT ID. .	
PROJECT NO. .	
BRIDGE NO. .	

DESCRIPTION	DATE
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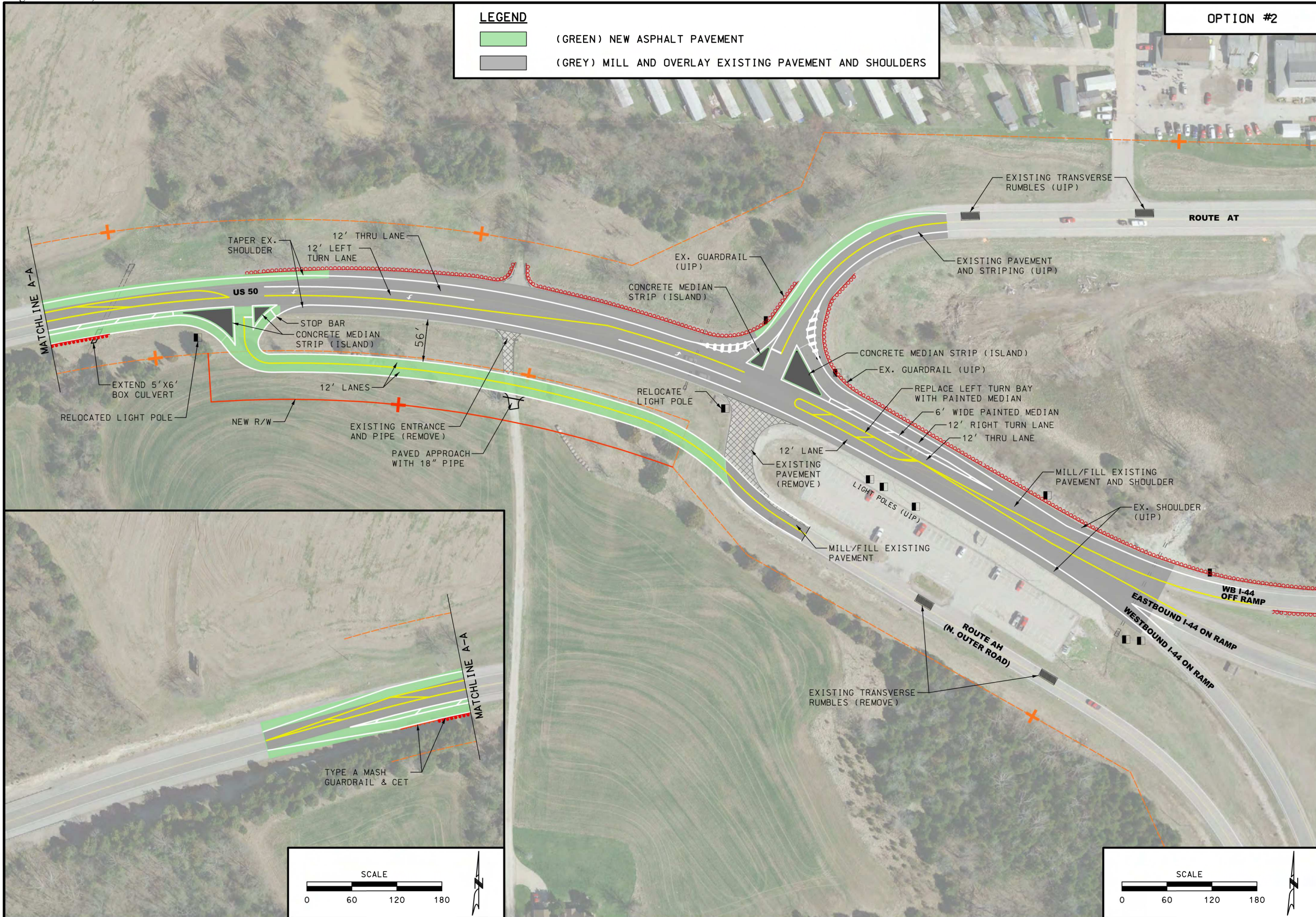


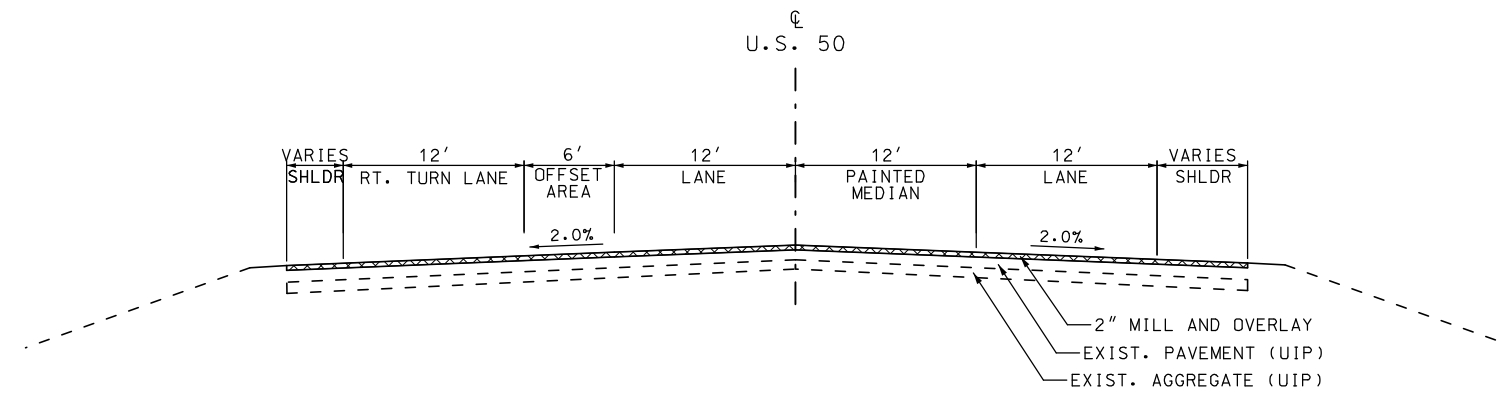
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TYPICAL SECTION:
ROUNABOUT

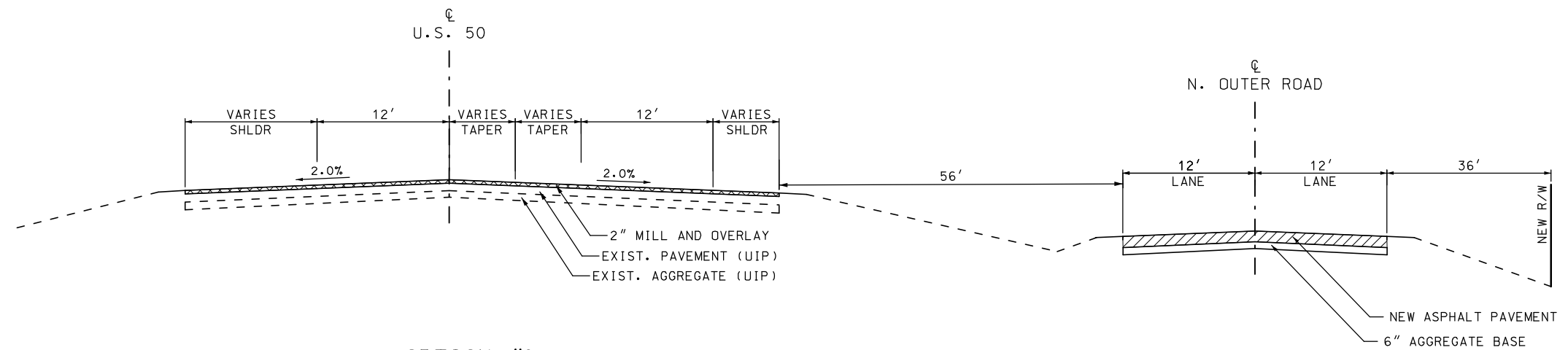
U.S. 50 @ ROUTES AT/AH

SHEET 2 OF 2

[illegible]



OPTION #2
U.S. 50 TYPICAL SECTION EAST OF ROUTE AT



OPTION #2
U.S. 50 TYPICAL SECTION WEST OF ROUTE AT

NOT TO SCALE –
FOLLOW DIMENSIONS

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DISTRICT SL	SHEET NO. 2
COUNTY FRANKLIN	
JOB NO. J6P2350	
CONTRACT ID. .	
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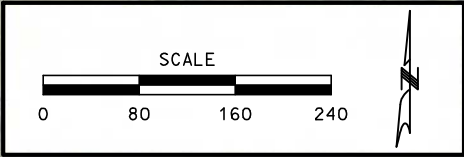
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TYPICAL SECTION:
INTERSECTION SHIFT

U.S. 50 @ ROUTES AT/AH

SHEET 2 OF 2



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ROUTE
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SHEET NO.
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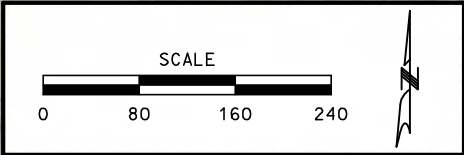
MISSOURI CERT. OF AUTHORITY: 001528

SIGHT DISTANCE:
INTERSECTION SHIFT

U.S. 50 @ ROUTES AT/AH

SHEET 1 OF 4

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.



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ROUTE
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COUNTY
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SIGHT DISTANCE:
INTERSECTION SHIFT

U.S. 50 @ ROUTES AT/AH

SHEET 2 OF 4

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DISTRICT SL	SHEET NO.
COUNTY FRANKLIN	
JOB NO. J6P2350	
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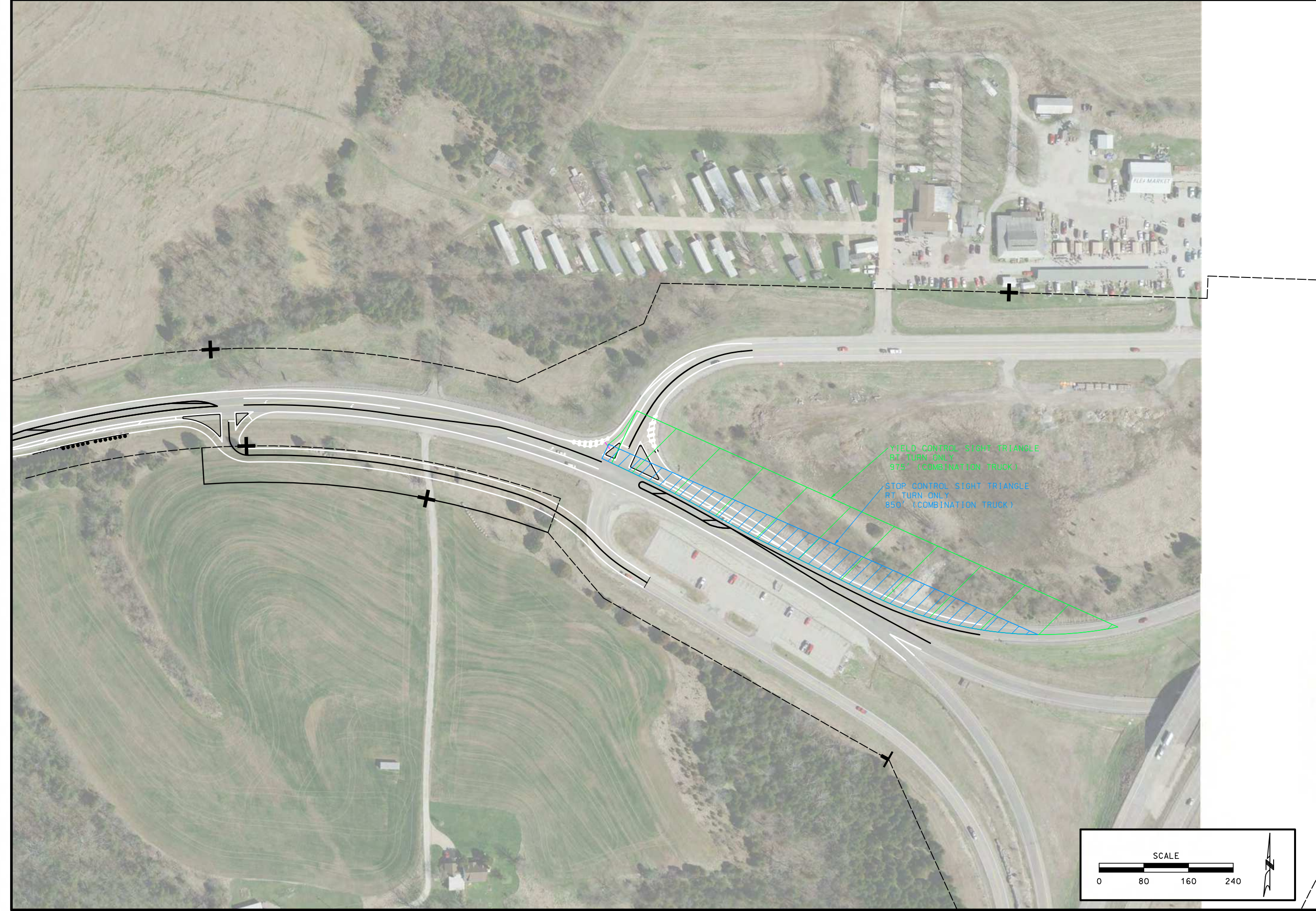
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SIGHT DISTANCE:
INTERSECTION SHIFT

U.S. 50 @ ROUTES AT/AH

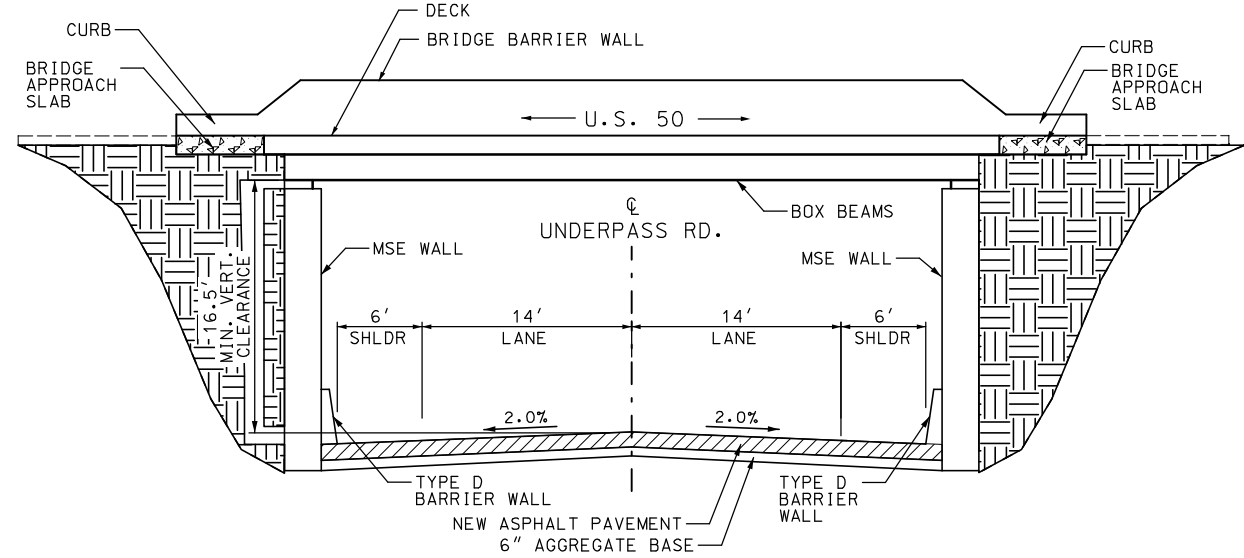
SHEET 3 OF 4

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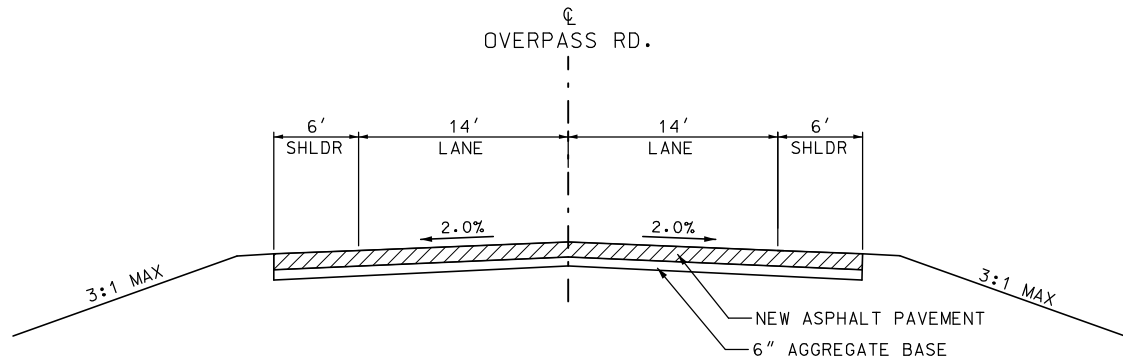


SIGHT DISTANCE: INTERSECTION SHIFT U.S. 50 @ ROUTES AT/AH SHEET 4 OF 4		 TWM ENGINEERING GEOSPATIAL SERVICES 720 OLIVE STREET, SUITE 200A ST. LOUIS, MO 63101 www.twm-inc.com MISSOURI CERT. OF AUTHORITY: 001528		MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION 105 WEST CAPITOL JEFFERSON CITY, MO 65102 1-888-ASK-MODOT (1-888-275-6636)		<table border="1"><thead><tr><th>DATE</th><th>DESCRIPTION</th></tr></thead><tbody><tr><td>.</td><td>.</td></tr><tr><td>.</td><td>.</td></tr><tr><td>.</td><td>.</td></tr><tr><td>.</td><td>.</td></tr><tr><td>.</td><td>.</td></tr></tbody></table>		DATE	DESCRIPTION	<table border="1"><tr><td colspan="2">DATE PREPARED 5/29/2019</td></tr><tr><td>ROUTE US 50</td><td>STATE MO</td></tr><tr><td>DISTRICT SL</td><td>SHEET NO. .</td></tr><tr><td colspan="2">COUNTY FRANKLIN</td></tr><tr><td colspan="2">JOB NO. J6P2350</td></tr><tr><td colspan="2">CONTRACT ID. .</td></tr><tr><td colspan="2">PROJECT NO. .</td></tr><tr><td colspan="2">BRIDGE NO. .</td></tr></table>		DATE PREPARED 5/29/2019		ROUTE US 50	STATE MO	DISTRICT SL	SHEET NO. .	COUNTY FRANKLIN		JOB NO. J6P2350		CONTRACT ID. .		PROJECT NO. .		BRIDGE NO. .		"THIS MEDIA SHOULD NOT BE CONSIDERED A CERTIFIED DOCUMENT."	
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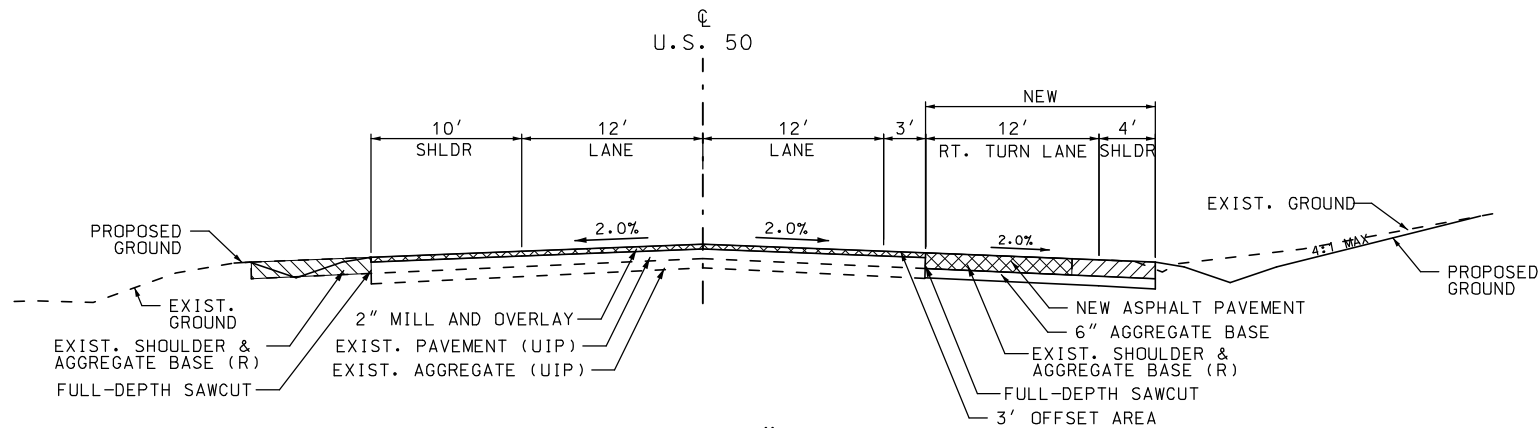
IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.



OPTION #3
UNDERPASS ROAD AT U.S. ROUTE 50
TYPICAL SECTION



OPTION #3
UNDERPASS ROAD TYPICAL SECTION



OPTION #3
U.S. 50 TYPICAL SECTION

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TYPICAL SECTION:
UNDERPASS OF U.S. 50

U.S. 50 @ ROUTES AT/AH

SHEET 2 OF 2

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NOTES:

1. 25MPH DESIGN SPEED FOR OVERPASS ROAD.
2. ROUTE AT BRIDGE IS SINGLE SPAN 100' LONG X 40' WIDE ON MSE RETAINING WALL ABUTMENTS. ASSUME CONCRETE NU-35 GIRDERS. TOTAL SUPERSTRUCTURE DEPTH = 51". MINIMUM 16'-6" VERTICAL CLEARANCE TO U.S. ROUTE 50.

OPTION #4

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ROUTE US - 50	STATE MO
DISTRICT SL	SHEET NO. 1

COUNTY
FRANKLIN

JOB NO.
J6P2350

CONTRACT ID.

PROJECT NO.	
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BRIDGE NO.

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DATE	_____
TIME	_____
LOCATION	_____
NAME	_____
ADDRESS	_____
CITY	_____
STATE	_____
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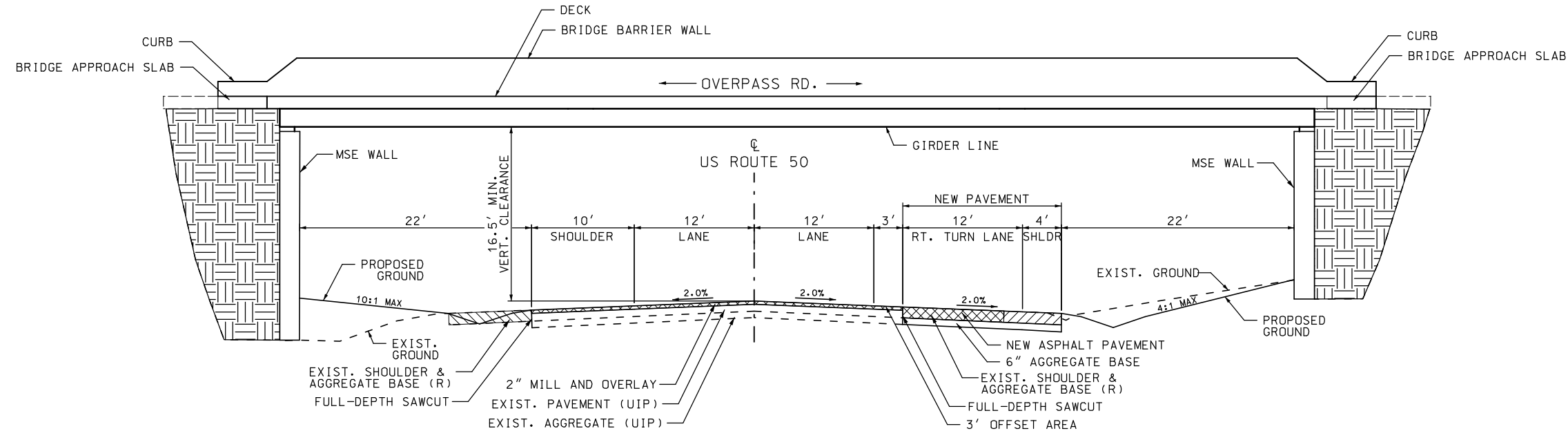
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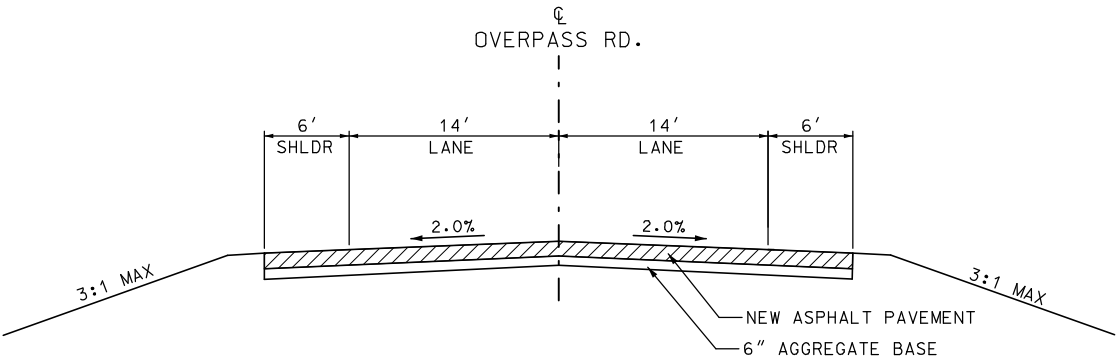
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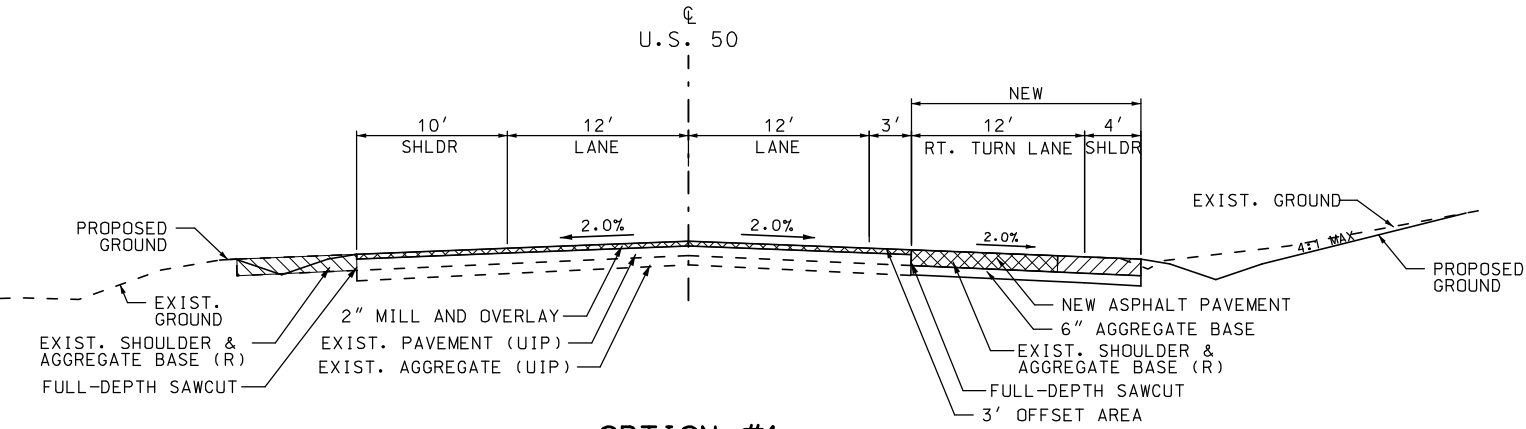
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OPTION #4
OVERPASS TYPICAL SECTION AT U.S. ROUTE 50



OPTION #4
OVERPASS ROAD TYPICAL SECTION



OPTION #4
U.S. 50 TYPICAL SECTION

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DISTRICT SL	SHEET NO. 2

COUNTY
FRANKLIN

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CONTRACT ID.
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TYPICAL SECTIONS:
ROUTE AT BRIDGE
OVER U.S. 50

U.S. 50 @ ROUTES AT/AH

SHEET 2 OF 2

Appendix 04 – HSM Spreadsheets

Option #1: Dual Lane Roundabout

Option #2: Intersection Shift

Option #3: Minor Road Underpass

Option #4: Route AT bridge over U.S. Route 50

Option #5: No Build

Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections							
General Information				Location Information			
Analyst		CAF T ² 05/22/19		Roadway		US 50	
Agency or Company				Intersection		US 50 w/Route AT & Route AN (I-44 NOR)	
Date Performed				Jurisdiction		Franklin Co., Union, MO	
				Analysis Year		2020	
Input Data				Base Conditions		Site Conditions	
Intersection type (3ST, 4ST, 4SG)				–		4ST	
AADT _{major} (veh/day)		AADT _{MAX} = 14,700 (veh/day)		–		13,700	
AADT _{minor} (veh/day)		AADT _{MAX} = 3,500 (veh/day)		–		3,500	
Intersection skew angle (degrees)		[If 4ST, does skew differ for minor legs?] No		0		Skew for Leg 1 (All): 5	Skew for Leg 2 (4ST only): 5
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)				0		1	
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)				0		0	
Intersection lighting (present/not present)				Not Present		Present	
Calibration Factor, C _i				1.00		1.00	

Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)*(5)
1.03	0.72	1.00	0.91	0.19

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crash Severity Level	N _{spf} 3ST, 4ST or 4SG from Equations 10-8, 10-9, or 10-10	Overdispersion Parameter, k from Section 10.6.2	Crash Severity Distribution from Table 10-5	N _{spf} 3ST, 4ST or 4SG by Severity Distribution (2) _{TOTAL} * (4)	Combined CMFs from (5) of Worksheet 2B	Calibration Factor, C _i	Predicted average crash frequency, N _{predicted int}
							(5)*(6)*(7)
Total	8.440	0.24	1.000	8.440	0.19	1.00	1.643
Fatal and Injury (FI)	--	–	0.245	2.070	0.19	1.00	0.403
Property Damage Only (PDO)	--	–	0.755	6.370	0.19	1.00	1.240

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collision Type	Proportion of Collision Type _(TOTAL) from Table 10-6	N _{predicted int} (TOTAL) (crashes/year)	Proportion of Collision Type _(FI)	N _{predicted int} (FI) (crashes/year)	Proportion of Collision Type _(PDO)	N _{predicted int} (PDO) (crashes/year)
		(8) _{TOTAL} from Worksheet 2C	from Table 10-6	(8) _{FI} from Worksheet 2C	from Table 10-6	(8) _{PDO} from Worksheet 2C
Total	1.000	1.643	0.000	0.403	0.000	1.240
		(2)x(3) _{TOTAL}		(4)x(5) _{FI}		(6)x(7) _{PDO}
SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overtuned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.031	0.000	0.000	0.000	0.000
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.031	0.000	0.000	0.000	0.000
MULTIPLE-VEHICLE						
Angle collision	0.340	0.558	0.000	0.000	0.000	0.000
Head-on collision	0.019	0.031	0.000	0.000	0.000	0.000
Rear-end collision	0.434	0.713	0.000	0.000	0.000	0.000
Sideswipe collision	0.019	0.031	0.000	0.000	0.000	0.000
Other multiple-vehicle collision	0.170	0.279	0.000	0.000	0.000	0.000
Total multiple-vehicle crashes	0.981	1.612	0.000	0.000	0.000	0.000

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1)	(2)	(3)
Crash severity level	Crash Severity Distribution (proportion)	Predicted average crash frequency (crashes / year)
	(4) from Worksheet 2C	(8) from Worksheet 2C
Total	1.000	1.6
Fatal and Injury (FI)	0.245	0.4
Property Damage Only (PDO)	0.755	1.2

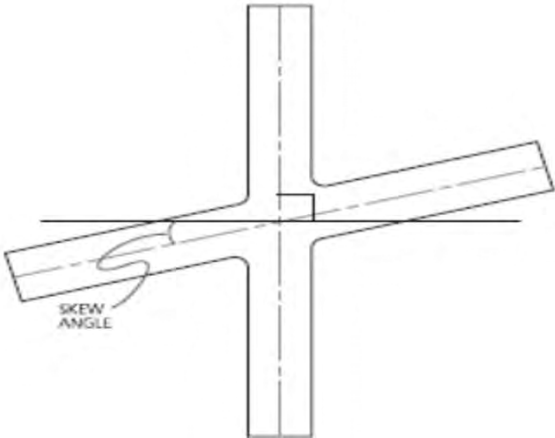
Option #1

Unsignalized four-leg (stop control on minor-road approaches)

AADT OK

AADT OK

Skew Intersection:



CMF ID:	CMF ID:	CMF ID:	(5) CMF ID:
5229	4930	4697	229
Value	Value	Value	Value
0.659	0.751	0.32	0.29
N _{expected}			N _{expected}
2.75	3.14	1.34	1.21
0.67	0.77	0.33	0.30
2.08	2.37	1.01	0.91
Convert Intersection into high-speed roundabout	Conversion of TWSC intersection into single or multi-lane roundabout	Convert high-speed rural intersection (4-leg) to roundabout	Convert intersection with minor-road stop control to modern roundabout

Option #1

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	Predicted average crash frequency (crashes/year)			Observed crashes, N _{observed} (crashes/year)	Overdispersion Parameter, k	Weighted adjustment, w	Expected average crash frequency,
	N _{predicted} (TOTAL)	N _{predicted} (FI)	N _{predicted} (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
ROADWAY SEGMENTS							
Segment 1					0.157	1.000	0.0
Segment 2					2.360	1.000	0.0
Segment 3						1.000	0.0
Segment 4						1.000	0.0
Segment 5						1.000	0.0
Segment 6						1.000	0.0
Segment 7						1.000	0.0
Segment 8						1.000	0.0
INTERSECTIONS							
Intersection 1	1.643	0.403	1.240	10.6	0.240	0.717	4.2
Intersection 2						1.000	0.0
Intersection 3						1.000	0.0
Intersection 4						1.000	0.0
Intersection 5						1.000	0.0
Intersection 6						1.000	0.0
Intersection 7						1.000	0.0
Intersection 8						1.000	0.0
COMBINED (sum of column)	1.643	0.403	1.240	10.6	—	—	4.2

Worksheet 3B -- Site-Specific EB Method Summary Results

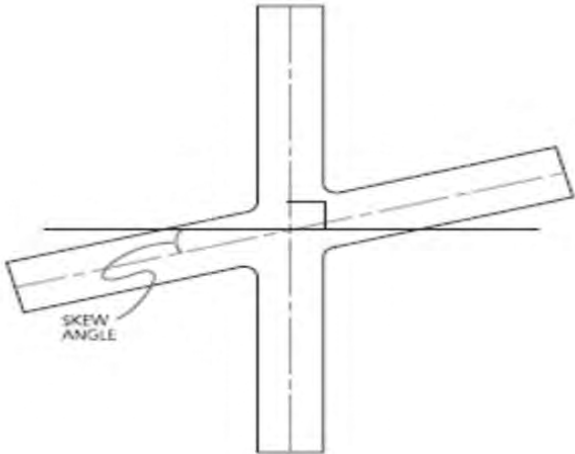
(1)	(2)	(3)
Crash severity level	$N_{\text{predicted}}$	N_{expected}
Total	(2) _{COMB} from Worksheet 3A 1.643	(8) _{COMB} from Worksheet 3A 4.175
Fatal and Injury (FI)	(3) _{COMB} from Worksheet 3A 0.403	(3) _{TOTAL} * (2) _{FI} / (2) _{TOTAL} 1.024
Property Damage Only (PDO)	(4) _{COMB} from Worksheet 3A 1.240	(3) _{TOTAL} * (2) _{PDO} / (2) _{TOTAL} 3.151

Option #2

Worksheet 2A – General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections					
General Information			Location Information		
Analyst	MLS	Roadway	US 50		
Agency or Company	TWM	Intersection	US 50 w/ Route AN (N Outer 44)		
Date Performed	05/22/19	Jurisdiction	Franklin Co, Union, MO		
		Analysis Year	2020		
Input Data		Base Conditions	Site Conditions		
Intersection type (3ST, 4ST, 4SG)		--	3ST		
AADT _{major} (veh/day)	AADT _{MAX} = 19,500 (veh/day)	--	15,900		
AADT _{minor} (veh/day)	AADT _{MAX} = 4,300 (veh/day)	--	2,350		
Intersection skew angle (degrees)	[If 4ST, does skew differ for minor legs?] No	0	Skew for Leg 1 (All): 0	Skew for Leg 2 (4ST only): 0	
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)		1	1		
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)		0	1		
Intersection lighting (present/not present)		Present	Present		
Calibration Factor, C _i		1.00	1.00		

Unsignalized three-leg (stop control on minor-road approaches)

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)*(5a)
1.00	0.56	0.86	0.90	0.33

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1) Crash Severity Level	(2) N _{spl} 3ST, 4ST or 4SG from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spl} 3ST, 4ST or 4SG by Severity Distribution (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i	(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	4.884	0.54	1.000	4.884	0.33	1.00	1.590
Fatal and Injury (FI)	--	--	0.245	1.198	0.33	1.00	0.390
Property Damage Only (PDO)	--	--	0.755	3.686	0.33	1.00	1.200

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int} (TOTAL) (crashes/year)	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int} (FI) (crashes/year)	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int} (PDO) (crashes/year)
Total	1.000	1.590	1.000	0.390	1.000	1.200
		(2)x(3) _{TOTAL}		(4)x(5) _{FI}		(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overtuned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.030	0.000	0.000	0.025	0.030
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.030	0.000	0.000	0.025	0.030

MULTIPLE-VEHICLE						
Angle collision	0.491	0.780	0.846	0.330	0.375	0.450
Head-on collision	0.019	0.030	0.077	0.030	0.000	0.000
Rear-end collision	0.434	0.690	0.077	0.030	0.550	0.660
Sideswipe collision	0.019	0.030	0.000	0.000	0.025	0.030
Other multiple-vehicle collision	0.019	0.030	0.000	0.000	0.025	0.030
Total multiple-vehicle crashes	0.981	1.560	1.000	0.390	0.975	1.170

Worksheet 2E – Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	1.6
Fatal and Injury (FI)	0.245	0.4
Property Damage Only (PDO)	0.755	1.2

(5a)
CMF ID: 201
Value 0.75
N_{predicted} 3.66
N_{expected} 1.23

0.30

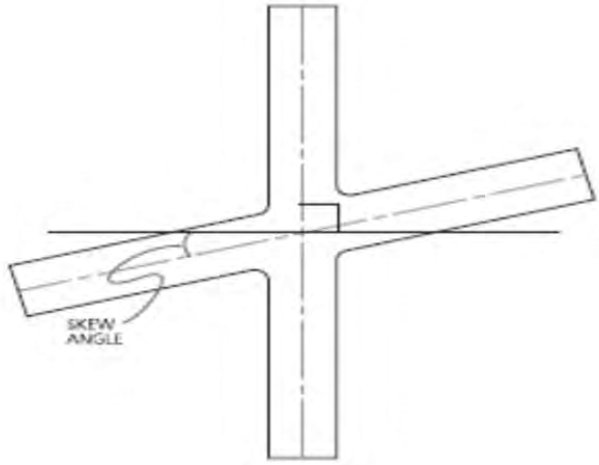
0.93
For all crash types and serious, minor and property damage only severities, urban application. HSM lists this CMF in bold font to indicate that it has the highest reliability since it has an adjusted standard error of 0.1 or less.

Although this area is more a rural configuration than urban, the area and the close proximity of the intersection off the Interstate with the potential growing development, the are could be considered urban in kind. The rural options are higher in crash reductions, but based on their star ratings, are not as realible.

Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections						
General Information				Location Information		
Analyst	MLS TWM 05/22/19			Roadway	US 50	
Agency or Company				Intersection	US 50 w/ Route AT	
Date Performed				Jurisdiction	Franklin Co, Union, MO	
				Analysis Year	2020	
Input Data				Base Conditions	Site Conditions	
Intersection type (3ST, 4ST, 4SG)				--	3ST	
AADT _{major} (veh/day)		AADT _{MAX} = 19,500 (veh/day)		--	14,100	
AADT _{minor} (veh/day)		AADT _{MAX} = 4,300 (veh/day)		--	3,750	
Intersection skew angle (degrees) [If 4ST, does skew differ for minor legs?]			No	0	Skew for Leg 1 (All): 4	Skew for Leg 2 (4ST only): 0
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)				0	1	
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)				0	1	
Intersection lighting (present/not present)				Not Present	Present	
Calibration Factor, C _i				1.00	1.00	

Unsignalized three-leg (stop control on minor-road approaches)

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)*(5a)
1.02	0.56	0.86	0.90	0.33

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1) Crash Severity Level	(2) N _{spf} 3ST, 4ST or 4SG from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spf} 3ST, 4ST or 4SG by Severity Distribution (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i	(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	5.585	0.54	1.000	5.585	0.33	1.00	1.847
Fatal and Injury (FI)	--	--	0.245	1.370	0.33	1.00	0.453
Property Damage Only (PDO)	--	--	0.755	4.215	0.33	1.00	1.394

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int} (TOTAL) (crashes/year)	(4) Proportion of Collision Type _(FI)	(5) N _{predicted int} (FI) (crashes/year)	(6) Proportion of Collision Type _(PDO)	(7) N _{predicted int} (PDO) (crashes/year)
		(8) _{TOTAL} from Worksheet 2C	from Table 10-6	(8) _{FI} from Worksheet 2C	from Table 10-6	(8) _{PDO} from Worksheet 2C
Total	1.000	1.847	1.000	0.453	1.000	1.394
		(2)x(3) _{TOTAL}		(4)x(5) _{FI}		(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overturned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.035	0.000	0.000	0.025	0.035
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.035	0.000	0.000	0.025	0.035

MULTIPLE-VEHICLE						
Angle collision	0.491	0.906	0.846	0.383	0.375	0.523
Head-on collision	0.019	0.035	0.077	0.035	0.000	0.000
Rear-end collision	0.434	0.802	0.077	0.035	0.550	0.767
Sideswipe collision	0.019	0.035	0.000	0.000	0.025	0.035
Other multiple-vehicle collision	0.019	0.035	0.000	0.000	0.025	0.035
Total multiple-vehicle crashes	0.981	1.812	1.000	0.453	0.975	1.359

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	1.8
Fatal and Injury (FI)	0.245	0.5
Property Damage Only (PDO)	0.755	1.4

Option #2

(5a)

CMF ID: 201

Value 0.75

N_{predicted} 4.19

N_{expected} 8.63

2.12

6.52

For all crash types and serious, minor and property damage only severities, urban application. 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.

Although this area is more a rural configuration than urban, the area and the close proximity of the intersection off the Interstate with the potential growing development, the are could be considered urban in kind. The rural options are higher in crash reductions, but based on their star ratings, are not as realible.

Option #2

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	Predicted average crash frequency (crashes/year)			Observed crashes, N _{observed} (crashes/year)	Overdispersion Parameter, k	Weighted adjustment, w	Expected average crash frequency,
	N _{predicted} (TOTAL)	N _{predicted} (FI)	N _{predicted} (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
ROADWAY SEGMENTS							
Segment 1	0.000	0.000	0.000		0.236	1.000	0.0
Segment 2	0.000	0.000	0.000		0.236	1.000	0.0
Segment 3						1.000	0.0
Segment 4						1.000	0.0
Segment 5						1.000	0.0
Segment 6						1.000	0.0
Segment 7						1.000	0.0
Segment 8						1.000	0.0
INTERSECTIONS							
Intersection 1	1.590	0.390	1.200		0.540	0.538	0.9
Intersection 2	1.847	0.453	1.394	10.6	0.540	0.501	6.2
Intersection 3						1.000	0.0
Intersection 4						1.000	0.0
Intersection 5						1.000	0.0
Intersection 6						1.000	0.0
Intersection 7						1.000	0.0
Intersection 8						1.000	0.0
COMBINED (sum of column)	3.437	0.843	2.594	10.6	–	--	7.1

Worksheet 3B -- Site-Specific EB Method Summary Results

(1)	(2)	(3)
Crash severity level	$N_{\text{predicted}}$	N_{expected}
Total	(2) _{COMB} from Worksheet 3A	(8) _{COMB} from Worksheet 3A
	3.437	7.1
Fatal and Injury (FI)	(3) _{COMB} from Worksheet 3A	(3) _{TOTAL} * (2) _{FI} / (2) _{TOTAL}
	0.843	1.7
Property Damage Only (PDO)	(4) _{COMB} from Worksheet 3A	(3) _{TOTAL} * (2) _{PDO} / (2) _{TOTAL}
	2.594	5.3

Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections					
General Information			Location Information		
Analyst	MLS	Roadway	US 50		
Agency or Company	TWM	Intersection	US 50 w/ Route AT & Route AN (N Outer 44)		
Date Performed	05/22/19	Jurisdiction	Franklin Co, Union, MO		
		Analysis Year	2020		
Input Data		Base Conditions	Site Conditions		
Intersection type (3ST, 4ST, 4SG)		--	4ST		
AADT _{major} (veh/day)	AADT _{MAX} = 14,700 (veh/day)	--	13,700		
AADT _{minor} (veh/day)	AADT _{MAX} = 3,500 (veh/day)	--	3,150		
Intersection skew angle (degrees) [If 4ST, does skew differ for minor legs?]		Yes	0	Skew for Leg 1 (All):	Skew for Leg 2 (4ST only): 11
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)		1	0		
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)		0	1		
Intersection lighting (present/not present)		Present	Present		
Calibration Factor, C _i		1.00	1.00		

Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)*(5a)*(5b)
1.03	1.00	0.86	0.91	0.14

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections						
(1) Crash Severity Level	(2) N _{spl} 3ST, 4ST or 4SG from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spl} 3ST, 4ST or 4SG by Severity Distribution (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i
Total	7.915	0.24	1.000	7.915	0.14	1.00
Fatal and Injury (FI)	--	--	0.170	1.346	0.14	1.00
Property Damage Only (PDO)	--	--	0.830	6.569	0.14	1.00
						Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
						1.144
						0.195
						0.950

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int} (TOTAL) (crashes/year)	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int} (FI) (crashes/year)	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int} (PDO) (crashes/year)
Total	1.000	1.144	0.000	0.195	0.000	0.950
		(2)x(3) _{TOTAL}			(4)x(5) _{FI}	(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.010	0.011	0.000	0.000	0.000	0.000
Collision with bicycle	0.001	0.001	0.000	0.000	0.000	0.000
Collision with pedestrian	0.002	0.002	0.000	0.000	0.000	0.000
Overtuned	0.003	0.003	0.000	0.000	0.000	0.000
Ran off road	0.110	0.126	0.000	0.000	0.000	0.000
Other single-vehicle collision	0.017	0.019	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.143	0.164	0.000	0.000	0.000	0.000

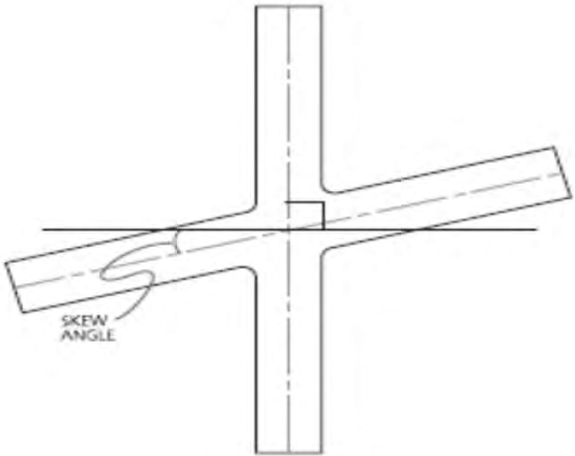
MULTIPLE-VEHICLE						
Angle collision	0.430	0.492	0.000	0.000	0.000	0.000
Head-on collision	0.077	0.088	0.000	0.000	0.000	0.000
Rear-end collision	0.230	0.263	0.000	0.000	0.000	0.000
Sideswipe collision	0.090	0.103	0.000	0.000	0.000	0.000
Other multiple-vehicle collision	0.030	0.034	0.000	0.000	0.000	0.000
Total multiple-vehicle crashes	0.857	0.981	0.000	0.000	0.000	0.000

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	1.1
Fatal and Injury (FI)	0.170	0.2
Property Damage Only (PDO)	0.830	0.9

Option #3

Unsignalized four-leg (stop control on minor-road approaches)

Skew Intersection:



(5a) CMF ID: 459 Value 0.58 N _{predicted} 4.59 N _{expected} 7.74	CMF ID: 460 Value 0.43 N _{predicted} 3.40 N _{expected} 6.64	(5b) CMF ID: 2777 Value 0.31 N _{predicted} 2.45 N _{expected} 5.47
1.32	8.93	0.00

6.42 For all crash types and severities at existing four-leg intersections. 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.	43.61 For all crash types and serious, minor and property damage only severities, at existing four-leg intersections. 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.	0.00 For angle crashes, all severities, at four-leg rural intersections. This CMF was approved for use on MoDOT's Safety Design-Build project.
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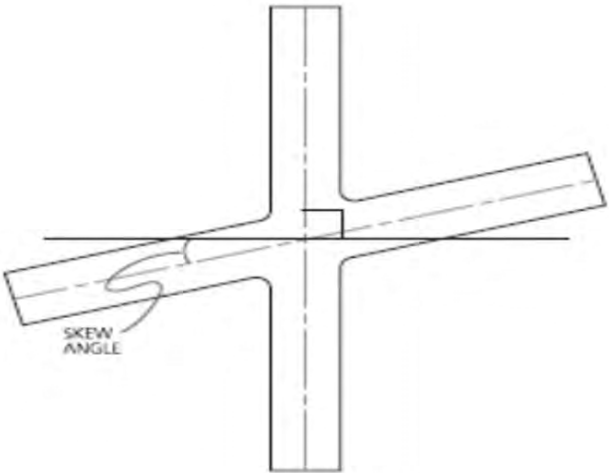
Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections										
General Information					Location Information					
Analyst		MLS TWM 05/22/19			Roadway Intersection Jurisdiction Analysis Year		US 50 Route AT w/ Minor Road Underpass Franklin Co, Union, MO 2020			
Agency or Company										
Date Performed										
Input Data					Base Conditions		Site Conditions			
Intersection type (3ST, 4ST, 4SG)					--		3ST			
AADT _{major} (veh/day)		AADT _{MAX} = 19,500 (veh/day)			--		3,250			
AADT _{minor} (veh/day)		AADT _{MAX} = 4,300 (veh/day)			--		2,600			
Intersection skew angle (degrees) [If 4ST, does skew differ for minor legs?]			No		0		Skew for Leg 1 (All): 0		Skew for Leg 2 (4ST only): 0	
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)					0		0			
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)					0		0			
Intersection lighting (present/not present)					Not Present		Present			
Calibration Factor, C _i					1.00		1.00			

Unsignalized three-leg (stop control on minor-road approaches)

AADT OK

AADT OK

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)
1.00	1.00	1.00	0.90	0.90

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1) Crash Severity Level	(2) N _{spf 3ST, 4ST or 4SG} from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spf 3ST, 4ST or 4SG by Severity Distribution} (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i	(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	1.464	0.54	1.000	1.464	0.90	1.00	1.319
Fatal and Injury (FI)	--	--	0.245	0.359	0.90	1.00	0.324
Property Damage Only (PDO)	--	--	0.755	1.105	0.90	1.00	0.996

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int (TOTAL)} (crashes/year) (8) _{TOTAL} from Worksheet 2C	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int (FI)} (crashes/year) (8) _{FI} from Worksheet 2C	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int (PDO)} (crashes/year) (8) _{PDO} from Worksheet 2C
Total	1.000	1.319	1.000	0.324	1.000	0.996
		(2)x(3) _{TOTAL}		(4)x(5) _{FI}		(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overturned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.025	0.000	0.000	0.025	0.025
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.025	0.000	0.000	0.025	0.025

MULTIPLE-VEHICLE						
Angle collision	0.491	0.647	0.846	0.274	0.375	0.373
Head-on collision	0.019	0.025	0.077	0.025	0.000	0.000
Rear-end collision	0.434	0.573	0.077	0.025	0.550	0.548
Sideswipe collision	0.019	0.025	0.000	0.000	0.025	0.025
Other multiple-vehicle collision	0.019	0.025	0.000	0.000	0.025	0.025
Total multiple-vehicle crashes	0.981	1.295	1.000	0.324	0.975	0.971

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	1.3
Fatal and Injury (FI)	0.245	0.3
Property Damage Only (PDO)	0.755	1.0

CMF ID:

Value

N_{predicted}
0.00

N_{expected}
0.00

0.00

0.00

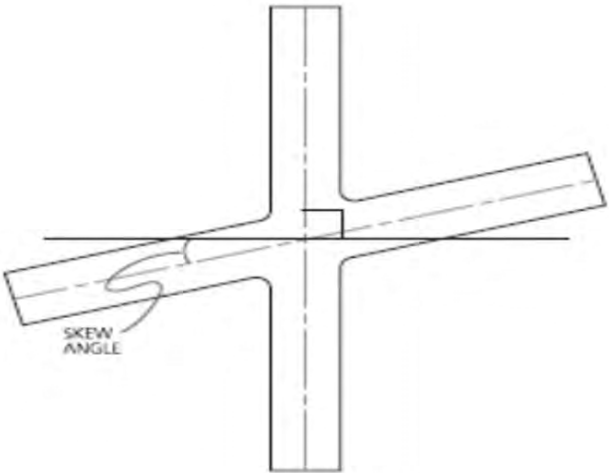
Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections						
General Information				Location Information		
Analyst	MLS TWM 05/22/19		Roadway Intersection Jurisdiction Analysis Year		US 50 Route AN w/ Minor Road Underpass Franklin Co, Union, MO 2020	
Agency or Company						
Date Performed						
Input Data			Base Conditions	Site Conditions		
Intersection type (3ST, 4ST, 4SG)			--	3ST		
AADT _{major} (veh/day)		AADT _{MAX} = 19,500 (veh/day)	--	2,250		
AADT _{minor} (veh/day)		AADT _{MAX} = 4,300 (veh/day)	--	2,250		
Intersection skew angle (degrees) [If 4ST, does skew differ for minor legs?]		No	0	Skew for Leg 1 (All):	0	Skew for Leg 2 (4ST only): 0
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)			0	0		
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)			0	0		
Intersection lighting (present/not present)			Not Present	Present		
Calibration Factor, C _i			1.00	1.00		

Unsignalized three-leg (stop control on minor-road approaches)

AADT OK

AADT OK

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)
1.00	1.00	1.00	0.90	0.90

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1) Crash Severity Level	(2) N _{spf 3ST, 4ST or 4SG} from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spf 3ST, 4ST or 4SG by Severity Distribution} (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i	(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	1.020	0.54	1.000	1.020	0.90	1.00	0.919
Fatal and Injury (FI)	--	--	0.245	0.250	0.90	1.00	0.225
Property Damage Only (PDO)	--	--	0.755	0.770	0.90	1.00	0.694

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int (TOTAL)} (crashes/year) (8) _{TOTAL} from Worksheet 2C	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int (FI)} (crashes/year) (8) _{FI} from Worksheet 2C	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int (PDO)} (crashes/year) (8) _{PDO} from Worksheet 2C
Total	1.000	0.919	1.000	0.225	1.000	0.694
		(2)x(3) _{TOTAL}		(4)x(5) _{FI}		(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overturned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.017	0.000	0.000	0.025	0.017
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.017	0.000	0.000	0.025	0.017

MULTIPLE-VEHICLE						
Angle collision	0.491	0.451	0.846	0.191	0.375	0.260
Head-on collision	0.019	0.017	0.077	0.017	0.000	0.000
Rear-end collision	0.434	0.399	0.077	0.017	0.550	0.382
Sideswipe collision	0.019	0.017	0.000	0.000	0.025	0.017
Other multiple-vehicle collision	0.019	0.017	0.000	0.000	0.025	0.017
Total multiple-vehicle crashes	0.981	0.902	1.000	0.225	0.975	0.676

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	0.9
Fatal and Injury (FI)	0.245	0.2
Property Damage Only (PDO)	0.755	0.7

Option #3

CMF ID:

Value

N_{predicted}
0.00

N_{expected}
0.00

0.00

0.00

Option #3

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	Predicted average crash frequency (crashes/year)			Observed crashes, N _{observed} (crashes/year)	Overdispersion Parameter, k	Weighted adjustment, w	Expected average crash frequency,
	N _{predicted} (TOTAL)	N _{predicted} (FI)	N _{predicted} (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
ROADWAY SEGMENTS							
Segment 1	0.000	0.000	0.000		0.236	1.000	0.0
Segment 2	0.000	0.000	0.000		0.236	1.000	0.0
Segment 3						1.000	0.0
Segment 4						1.000	0.0
Segment 5						1.000	0.0
Segment 6						1.000	0.0
Segment 7						1.000	0.0
Segment 8						1.000	0.0
INTERSECTIONS							
Intersection 1	1.144	0.195	0.950	10.6	0.240	0.785	3.2
Intersection 2	1.319	0.324	0.996		0.540	0.584	0.8
Intersection 3	0.919	0.225	0.694		0.540	0.668	0.6
Intersection 4						1.000	0.0
Intersection 5						1.000	0.0
Intersection 6						1.000	0.0
Intersection 7						1.000	0.0
Intersection 8						1.000	0.0
COMBINED (sum of column)	3.383	0.744	2.639	10.6	—	--	4.6

Worksheet 3B -- Site-Specific EB Method Summary Results

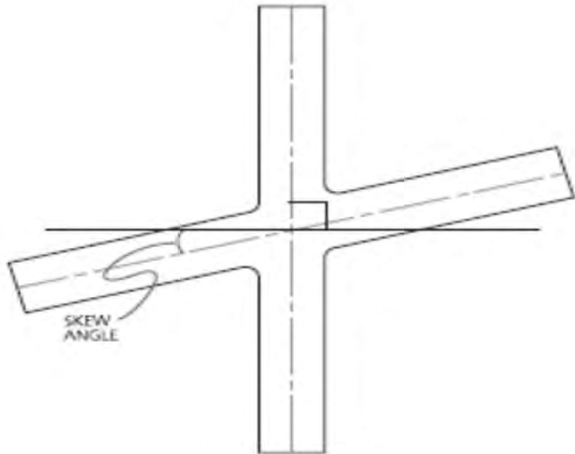
(1)	(2)	(3)
Crash severity level	$N_{\text{predicted}}$	N_{expected}
Total	(2) _{COMB} from Worksheet 3A	(8) _{COMB} from Worksheet 3A
	3.383	4.6
Fatal and Injury (FI)	(3) _{COMB} from Worksheet 3A	(3) _{TOTAL} * (2) _{FI} / (2) _{TOTAL}
	0.744	1.0
Property Damage Only (PDO)	(4) _{COMB} from Worksheet 3A	(3) _{TOTAL} * (2) _{PDO} / (2) _{TOTAL}
	2.639	3.6

Option #4

Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections					
General Information			Location Information		
Analyst	MLS	Roadway	US 50		
Agency or Company	TWM	Intersection	US 50 w/ Route AT & Route AN (N Outer 44)		
Date Performed	05/22/19	Jurisdiction	Franklin Co, Union, MO		
		Analysis Year	2020		
Input Data		Base Conditions	Site Conditions		
Intersection type (3ST, 4ST, 4SG)		--	4ST		
AADT _{major} (veh/day)	AADT _{MAX} = 14,700 (veh/day)	--	13,700		
AADT _{minor} (veh/day)	AADT _{MAX} = 3,500 (veh/day)	--	3,150		
Intersection skew angle (degrees)	[If 4ST, does skew differ for minor legs?] Yes	0	Skew for Leg 1 (All): 0	Skew for Leg 2 (4ST only): 11	
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)		1	0		
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)		0	1		
Intersection lighting (present/not present)		Present	Present		
Calibration Factor, C _i		1.00	1.00		

Unsignalized four-leg (stop control on minor-road approaches)

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)*(5a)*(5b)
1.03	1.00	0.86	0.91	0.14

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections						
(1) Crash Severity Level	(2) N _{spl} 3ST, 4ST or 4SG from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spl} 3ST, 4ST or 4SG by Severity Distribution (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i
						(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	7.915	0.24	1.000	7.915	0.14	1.144
Fatal and Injury (FI)	--	--	0.170	1.346	0.14	0.195
Property Damage Only (PDO)	--	--	0.830	6.569	0.14	0.950

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int} (TOTAL) (crashes/year) (8) _{TOTAL} from Worksheet 2C	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int} (FI) (crashes/year) (8) _{FI} from Worksheet 2C	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int} (PDO) (crashes/year) (8) _{PDO} from Worksheet 2C
Total	1.000	1.144	0.000	0.195	0.000	0.950
		(2)x(3) _{TOTAL}			(4)x(5) _{FI}	(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.010	0.011	0.000	0.000	0.000	0.000
Collision with bicycle	0.001	0.001	0.000	0.000	0.000	0.000
Collision with pedestrian	0.002	0.002	0.000	0.000	0.000	0.000
Overtuned	0.003	0.003	0.000	0.000	0.000	0.000
Ran off road	0.110	0.126	0.000	0.000	0.000	0.000
Other single-vehicle collision	0.017	0.019	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.143	0.164	0.000	0.000	0.000	0.000

MULTIPLE-VEHICLE						
Angle collision	0.430	0.492	0.000	0.000	0.000	0.000
Head-on collision	0.077	0.088	0.000	0.000	0.000	0.000
Rear-end collision	0.230	0.263	0.000	0.000	0.000	0.000
Sideswipe collision	0.090	0.103	0.000	0.000	0.000	0.000
Other multiple-vehicle collision	0.030	0.034	0.000	0.000	0.000	0.000
Total multiple-vehicle crashes	0.857	0.981	0.000	0.000	0.000	0.000

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	1.1
Fatal and Injury (FI)	0.170	0.2
Property Damage Only (PDO)	0.830	0.9

(5a) CMF ID: 459 Value 0.58 N _{predicted} 4.59 N _{expected} 7.74	CMF ID: 460 Value 0.43 N _{predicted} 3.40 N _{expected} 6.64	(5b) CMF ID: 2777 Value 0.31 N _{predicted} 2.45 N _{expected} 5.47
1.32	8.93	0.00

6.42 For all crash types and severities at existing four-leg intersections. 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.	43.61 For all crash types and serious, minor and property damage only severities, at existing four-leg intersections. 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.	0.00 For angle crashes, all severities, at four-leg rural intersections. This CMF was approved for use on MoDOT's Safety Design-Build project.
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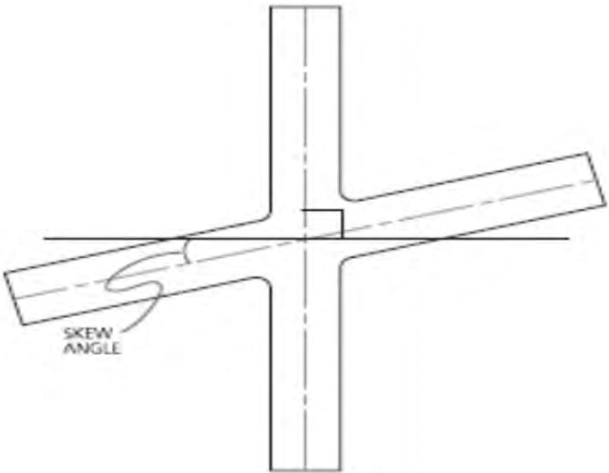
Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections											
General Information					Location Information						
Analyst		MLS TWM 05/22/19			Roadway Intersection Jurisdiction Analysis Year		US 50 Route AT w/ AT Bridge Franklin Co, Union, MO 2020				
Agency or Company											
Date Performed											
Input Data					Base Conditions		Site Conditions				
Intersection type (3ST, 4ST, 4SG)					--		3ST				
AADT _{major} (veh/day)		AADT _{MAX} = 19,500 (veh/day)			--		3,250				
AADT _{minor} (veh/day)		AADT _{MAX} = 4,300 (veh/day)			--		2,600				
Intersection skew angle (degrees)			[If 4ST, does skew differ for minor legs?]		No		0		Skew for Leg 1 (All): 0		
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)					0		Skew for Leg 2 (4ST only): 0			0	
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)					0		0				
Intersection lighting (present/not present)					Not Present		Present				
Calibration Factor, C _i					1.00		1.00				

Unsignalized three-leg (stop control on minor-road approaches)

AADT OK

AADT OK

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)
1.00	1.00	1.00	0.90	0.90

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections						
(1) Crash Severity Level	(2) N _{spf 3ST, 4ST or 4SG} from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spf 3ST, 4ST or 4SG by Severity Distribution} (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i
						(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	1.464	0.54	1.000	1.464	0.90	1.319
Fatal and Injury (FI)	--	--	0.245	0.359	0.90	0.324
Property Damage Only (PDO)	--	--	0.755	1.105	0.90	0.996

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int (TOTAL)} (crashes/year)	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int (FI)} (crashes/year)	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int (PDO)} (crashes/year)
		(8) _{TOTAL} from Worksheet 2C			(8) _{FI} from Worksheet 2C	(8) _{PDO} from Worksheet 2C
Total	1.000	1.319	1.000	0.324	1.000	0.996
		(2)x(3) _{TOTAL}			(4)x(5) _{FI}	(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overturned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.025	0.000	0.000	0.025	0.025
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.025	0.000	0.000	0.025	0.025

MULTIPLE-VEHICLE						
Angle collision	0.491	0.647	0.846	0.274	0.375	0.373
Head-on collision	0.019	0.025	0.077	0.025	0.000	0.000
Rear-end collision	0.434	0.573	0.077	0.025	0.550	0.548
Sideswipe collision	0.019	0.025	0.000	0.000	0.025	0.025
Other multiple-vehicle collision	0.019	0.025	0.000	0.000	0.025	0.025
Total multiple-vehicle crashes	0.981	1.295	1.000	0.324	0.975	0.971

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	1.3
Fatal and Injury (FI)	0.245	0.3
Property Damage Only (PDO)	0.755	1.0

CMF ID:

Value

N_{predicted}
0.00

N_{expected}
0.00

0.00

0.00

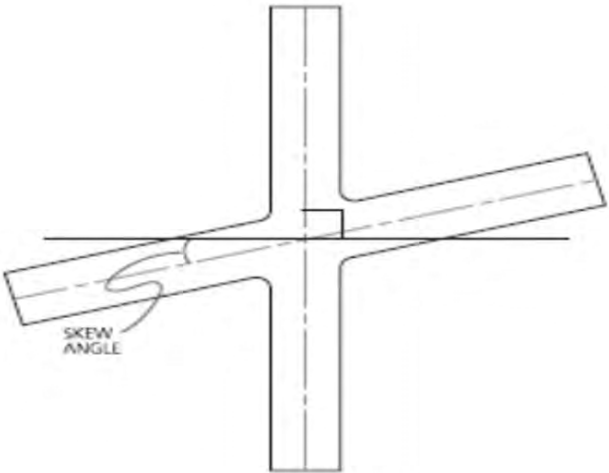
Worksheet 2A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections										
General Information					Location Information					
Analyst		MLS TWM 05/22/19			Roadway Intersection Jurisdiction Analysis Year		US 50 Route AN w/ AT Bridge Franklin Co, Union, MO 2020			
Agency or Company										
Date Performed										
Input Data					Base Conditions		Site Conditions			
Intersection type (3ST, 4ST, 4SG)					--		3ST			
AADT _{major} (veh/day)		AADT _{MAX} = 19,500 (veh/day)			--		2,250			
AADT _{minor} (veh/day)		AADT _{MAX} = 4,300 (veh/day)			--		2,250			
Intersection skew angle (degrees)			[If 4ST, does skew differ for minor legs?] No		0		Skew for Leg 1 (All): 0		Skew for Leg 2 (4ST only): 0	
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)					0		0			
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)					0		0			
Intersection lighting (present/not present)					Not Present		Present			
Calibration Factor, C _i					1.00		1.00			

Unsignalized three-leg (stop control on minor-road approaches)

AADT OK

AADT OK

Skew Intersection:



Worksheet 2B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14	(4) CMF for Lighting CMF _{4i} from Equation 10-24	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4)
1.00	1.00	1.00	0.90	0.90

Worksheet 2C -- Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1) Crash Severity Level	(2) N _{spf 3ST, 4ST or 4SG} from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spf 3ST, 4ST or 4SG by Severity Distribution} (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i	(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	1.020	0.54	1.000	1.020	0.90	1.00	0.919
Fatal and Injury (FI)	--	--	0.245	0.250	0.90	1.00	0.225
Property Damage Only (PDO)	--	--	0.755	0.770	0.90	1.00	0.694

Worksheet 2D -- Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int (TOTAL)} (crashes/year) (8) _{TOTAL} from Worksheet 2C (2)x(3) _{TOTAL}	(4) Proportion of Collision Type _(FI) from Table 10-6	(5) N _{predicted int (FI)} (crashes/year) (8) _{FI} from Worksheet 2C (4)x(5) _{FI}	(6) Proportion of Collision Type _(PDO) from Table 10-6	(7) N _{predicted int (PDO)} (crashes/year) (8) _{PDO} from Worksheet 2C (6)x(7) _{PDO}
Total	1.000	0.919	1.000	0.225	1.000	0.694

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overturned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.017	0.000	0.000	0.025	0.017
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.017	0.000	0.000	0.025	0.017

MULTIPLE-VEHICLE						
Angle collision	0.491	0.451	0.846	0.191	0.375	0.260
Head-on collision	0.019	0.017	0.077	0.017	0.000	0.000
Rear-end collision	0.434	0.399	0.077	0.017	0.550	0.382
Sideswipe collision	0.019	0.017	0.000	0.000	0.025	0.017
Other multiple-vehicle collision	0.019	0.017	0.000	0.000	0.025	0.017
Total multiple-vehicle crashes	0.981	0.902	1.000	0.225	0.975	0.676

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	0.9
Fatal and Injury (FI)	0.245	0.2
Property Damage Only (PDO)	0.755	0.7

CMF ID:

Value

N_{predicted}
0.00

N_{expected}
0.00

0.00

0.00

Option #4

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	Predicted average crash frequency (crashes/year)			Observed crashes, N _{observed} (crashes/year)	Overdispersion Parameter, k	Weighted adjustment, w	Expected average crash frequency,
	N _{predicted} (TOTAL)	N _{predicted} (FI)	N _{predicted} (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
ROADWAY SEGMENTS							
Segment 1	0.000	0.000	0.000		0.236	1.000	0.0
Segment 2	0.000	0.000	0.000		0.236	1.000	0.0
Segment 3						1.000	0.0
Segment 4						1.000	0.0
Segment 5						1.000	0.0
Segment 6						1.000	0.0
Segment 7						1.000	0.0
Segment 8						1.000	0.0
INTERSECTIONS							
Intersection 1	1.144	0.195	0.950	10.6	0.240	0.785	3.2
Intersection 2	1.319	0.324	0.996		0.540	0.584	0.8
Intersection 3	0.919	0.225	0.694		0.540	0.668	0.6
Intersection 4						1.000	0.0
Intersection 5						1.000	0.0
Intersection 6						1.000	0.0
Intersection 7						1.000	0.0
Intersection 8						1.000	0.0
COMBINED (sum of column)	3.383	0.744	2.639	10.6	—	--	4.6

Worksheet 3B -- Site-Specific EB Method Summary Results

(1)	(2)	(3)
Crash severity level	$N_{\text{predicted}}$	N_{expected}
Total	(2) _{COMB} from Worksheet 3A	(8) _{COMB} from Worksheet 3A
	3.383	4.6
Fatal and Injury (FI)	(3) _{COMB} from Worksheet 3A	(3) _{TOTAL} * (2) _{FI} / (2) TOTAL
	0.744	1.0
Property Damage Only (PDO)	(4) _{COMB} from Worksheet 3A	(3) _{TOTAL} * (2) _{PDO} / (2) TOTAL
	2.639	3.6

Worksheet 2A – General Information and Input Data for Rural Two-Lane Two-Way Roadway Intersections						
General Information				Location Information		
Analyst	CAF T ² 05/22/19			Roadway	US 50	
Agency or Company				Intersection	US 50 w/Route AT & Route AN (I-44 NOR)	
Date Performed				Jurisdiction	Franklin Co., Union, MO	
				Analysis Year	2020	
Input Data				Base Conditions	Site Conditions	
Intersection type (3ST, 4ST, 4SG)				--	4ST	
AADT _{major} (veh/day)		AADT _{MAX} = 14,700 (veh/day)		--	13,700	
AADT _{minor} (veh/day)		AADT _{MAX} = 3,500 (veh/day)		--	3,500	
Intersection skew angle (degrees) [If 4ST, does skew differ for minor legs?]			No	0	Skew for Leg 1 (All): 5	Skew for Leg 2 (4ST only): 5
Number of signalized or uncontrolled approaches with a left-turn lane (0, 1, 2, 3, 4)				0	2	
Number of signalized or uncontrolled approaches with a right-turn lane (0, 1, 2, 3, 4)				0	1	
Intersection lighting (present/not present)				Not Present	Present	
Calibration Factor, C _i				1.00	1.00	

Worksheet 2B – Crash Modification Factors for Rural Two-Lane Two-Way Roadway Intersections				
(1) CMF for Intersection Skew Angle CMF _{1i} from Equations 10-22 or 10-23 1.03	(2) CMF for Left-Turn Lanes CMF _{2i} from Table 10-13 0.52	(3) CMF for Right-Turn Lanes CMF _{3i} from Table 10-14 0.86	(4) CMF for Lighting CMF _{4i} from Equation 10-24 0.91	(5) Combined CMF CMF _{COMB} (1)*(2)*(3)*(4) 0.42

Worksheet 2C – Intersection Crashes for Rural Two-Lane Two-Way Roadway Intersections							
(1) Crash Severity Level	(2) N _{spf} 3ST, 4ST or 4SG from Equations 10-8, 10-9, or 10-10	(3) Overdispersion Parameter, k from Section 10.6.2	(4) Crash Severity Distribution from Table 10-5	(5) N _{spf} 3ST, 4ST or 4SG by Severity Distribution (2) _{TOTAL} * (4)	(6) Combined CMFs from (5) of Worksheet 2B	(7) Calibration Factor, C _i	(8) Predicted average crash frequency, N _{predicted int} (5)*(6)*(7)
Total	8.440	0.24	1.000	8.440	0.42	1.00	3.518
Fatal and Injury (FI)	–	–	0.245	2.070	0.42	1.00	0.863
Property Damage Only (PDO)	–	–	0.755	6.370	0.42	1.00	2.655

Worksheet 2D – Crashes by Severity Level and Collision Type for Rural Two-Lane Two-Way Road Intersections						
(1) Collision Type	(2) Proportion of Collision Type _(TOTAL) from Table 10-6	(3) N _{predicted int} (TOTAL) (crashes/year)	(4) Proportion of Collision Type _(FI)	(5) N _{predicted int} (FI) (crashes/year)	(6) Proportion of Collision Type _(PDO)	(7) N _{predicted int} (PDO) (crashes/year)
		(8) _{TOTAL} from Worksheet 2C	from Table 10-6	(8) _{FI} from Worksheet 2C	from Table 10-6	(8) _{PDO} from Worksheet 2C
Total	1.000	3.518	0.000	0.863	0.000	2.655
		(2)x(3) _{TOTAL}		(4)x(5) _{FI}		(6)x(7) _{PDO}

SINGLE-VEHICLE						
Collision with animal	0.000	0.000	0.000	0.000	0.000	0.000
Collision with bicycle	0.000	0.000	0.000	0.000	0.000	0.000
Collision with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000
Overtuned	0.000	0.000	0.000	0.000	0.000	0.000
Ran off road	0.019	0.066	0.000	0.000	0.000	0.000
Other single-vehicle collision	0.000	0.000	0.000	0.000	0.000	0.000
Total single-vehicle crashes	0.019	0.066	0.000	0.000	0.000	0.000

MULTIPLE-VEHICLE						
Angle collision	0.340	1.195	0.000	0.000	0.000	0.000
Head-on collision	0.019	0.066	0.000	0.000	0.000	0.000
Rear-end collision	0.434	1.527	0.000	0.000	0.000	0.000
Sideswipe collision	0.019	0.066	0.000	0.000	0.000	0.000
Other multiple-vehicle collision	0.170	0.597	0.000	0.000	0.000	0.000
Total multiple-vehicle crashes	0.981	3.452	0.000	0.000	0.000	0.000

Worksheet 2E -- Summary Results for Rural Two-Lane Two-Way Road Intersections		
(1) Crash severity level	(2) Crash Severity Distribution (proportion) (4) from Worksheet 2C	(3) Predicted average crash frequency (crashes / year) (8) from Worksheet 2C
Total	1.000	3.5
Fatal and Injury (FI)	0.245	0.9
Property Damage Only (PDO)	0.755	2.7

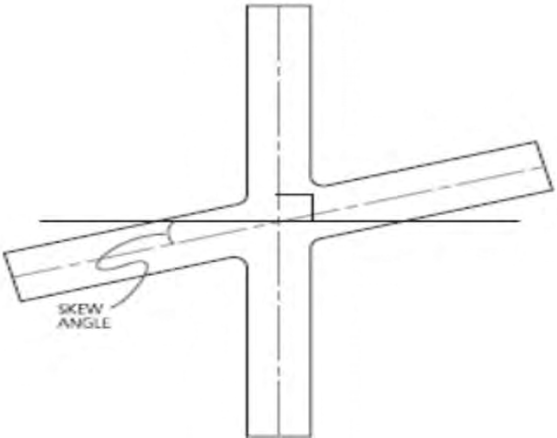
Option #5

Unsignalized four-leg (stop control on minor-road approaches)

AADT OK

AADT OK

Skew Intersection:



Option #5

Worksheet 3A -- Predicted and Observed Crashes by Severity and Site Type Using the Site-Specific EB Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Site type	Predicted average crash frequency (crashes/year)			Observed crashes, N _{observed} (crashes/year)	Overdispersion Parameter, k	Weighted adjustment, w	Expected average crash frequency,
	N _{predicted} (TOTAL)	N _{predicted} (FI)	N _{predicted} (PDO)			Equation A-5 from Part C Appendix	Equation A-4 from Part C Appendix
ROADWAY SEGMENTS							
Segment 1					0.157	1.000	0.0
Segment 2					2.360	1.000	0.0
Segment 3						1.000	0.0
Segment 4						1.000	0.0
Segment 5						1.000	0.0
Segment 6						1.000	0.0
Segment 7						1.000	0.0
Segment 8						1.000	0.0
INTERSECTIONS							
Intersection 1	3.518	0.863	2.655	10.6	0.240	0.542	6.8
Intersection 2						1.000	0.0
Intersection 3						1.000	0.0
Intersection 4						1.000	0.0
Intersection 5						1.000	0.0
Intersection 6						1.000	0.0
Intersection 7						1.000	0.0
Intersection 8						1.000	0.0
COMBINED (sum of column)	3.518	0.863	2.655	10.6	—	—	6.8

Worksheet 3B -- Site-Specific EB Method Summary Results

(1)	(2)	(3)
Crash severity level	$N_{\text{predicted}}$	N_{expected}
Total	(2) _{COMB} from Worksheet 3A 3.518	(8) _{COMB} from Worksheet 3A 6.760
Fatal and Injury (FI)	(3) _{COMB} from Worksheet 3A 0.863	(3) _{TOTAL} * (2) _{FI} / (2) _{TOTAL} 1.658
Property Damage Only (PDO)	(4) _{COMB} from Worksheet 3A 2.655	(3) _{TOTAL} * (2) _{PDO} / (2) _{TOTAL} 5.102

Appendix 05 – Conceptual Cost Estimates

Option #1: Dual Lane Roundabout

Option #2: Intersection Shift

Option #3: Minor Road Underpass

Option #4: Route AT bridge over U.S. Route 50

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST							
CONCEPTUAL COST ESTIMATE - OPTION #1 DUAL LANE ROUNDABOUT							
U.S. Route 50 & Route AT / N. Outer Road intersection, Franklin County, Missouri							
LINE NO.	SPEC.	ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	ITEM COST
ROADWAY ITEMS							
1	MODOT	202-20.10	REMOVAL OF IMPROVEMENTS	LS	\$130,000.00	1	\$130,000.00
2	MODOT	203/206/207	EARTHWORK	LS	\$75,000.00	1	\$75,000.00
3	MODOT	304-05.06	TYPE 5 AGGREGATE FOR BASE (6 IN. THICK)	SY	\$10.00	7775	\$77,746.47
4	MODOT	403	NEW ASPHALT PAVEMENT SECTION (14" THICK)	SY	\$80.00	4012	\$320,922.71
5	MODOT	403	ASPHALT OVERLAY	SY	\$40.00	5663	\$226,528.73
6	MODOT	502-13.10	CONCRETE PAVEMENT (10 IN NON-REINFORCED, 15FT JOINTS)	SY	\$85.00	2817	\$239,453.95
7	MODOT	502-99.01	TRUCK APRON CONCRETE PAVEMENT, TINTED (10 IN NON-REINFORCED, 15FT JOINTS)	SY	\$90.00	901	\$81,090.75
8	MODOT	606-10.61	MGS GUARDRAIL, 8FT POSTS, 6FT-3IN SPACING	LF	\$35.00	1480	\$51,800.00
9	MODOT	606-10.80	MGS END ANCHOR	EA	\$1,500.00	3	\$4,500.00
10	MODOT	606-30.14	TYPE A CRASHWORTH END TERMINAL (MASH)	EA	\$3,750.00	3	\$11,250.00
11	MODOT	608-30.06	6 IN. CONCRETE MEDIAN STRIP	SY	\$85.00	1308	\$111,207.96
12	MODOT	608-60.07	PAVED APPROACH, 7 IN. (DRIVEWAY)	SY	\$65.00	45	\$2,925.00
13	MODOT	609-10.51	CURB AND GUTTER TYPE A (MOUNTABLE)	LF	\$30.00	784	\$23,520.00
14	MODOT	609-10.52	CURB AND GUTTER TYPE B	LF	\$30.00	4429	\$132,870.00
15	MODOT	616	TRAFFIC CONTROL	LS	\$40,000.00	1	\$40,000.00
16	MODOT	618-10.00	MOBILIZATION	LS	\$97,427.69	1	\$97,427.69
17	MODOT	622	COLDMILLING BITUMINOUS PAVEMENT FOR REMOVAL OF SURFACING	SY	\$6.00	5663	\$33,979.31
18	MODOT	626.99-01	PORTLAND CEMENT CONCRETE TRANSVERSE RUMBLE STRIP	EA	\$1,200.00	5	\$6,000.00
19	MODOT	627-40.00	CONTRACTOR FURNISHED SURVEYING AND STAKING	LS	\$17,212.23	1	\$17,212.23
20	MODOT	803	LANDSCAPING	LS	\$15,000.00	1	\$15,000.00
21	MODOT	806	EROSION CONTROL ITEMS	LS	\$40,000.00	1	\$40,000.00
ROADWAY SUBTOTAL							\$1,738,434.80
SIGNALS / LIGHTING / SIGNING / STRIPING ITEMS							
22	MODOT	903	SIGNING COMPLETE	LS	\$25,000.00	1	\$25,000.00
23	MODOT	901	NEW LUMINAIRE COMPLETE	EACH	\$15,000.00	2	\$30,000.00
24	MODOT	901	EXISTING LIGHTS TO BE RELOCATED COMPLETE	EACH	\$4,000.00	3	\$12,000.00
25	MODOT	620	PAVEMENT STRIPING COMPLETE	1	\$10,000.00	1	\$10,000.00
SIGNAL / LIGHTING / SIGNING / STRIPING SUBTOTAL							\$77,000.00
DRAINAGE ITEMS							
26	MODOT	726/731/732	DRAINAGE ITEMS COMPLETE	LS	\$100,000.00	1	\$100,000.00
DRAINAGE / UTILITY SUBTOTAL							\$100,000.00
					SUBTOTAL	\$1,915,434.80	
					RIGHT-OF-WAY	\$0.00	
					TOTAL (ROUNDED UP)	\$1,920,000.00	
					NON-CONTRACT UTILITIES	\$0.00	

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST							
CONCEPTUAL COST ESTIMATE - OPTION #2 INTERSECTION SHIFT							
U.S. Route 50 & Route AT / N. Outer Road intersection, Franklin County, Missouri							
LINE NO.	SPEC.	ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	ITEM COST
ROADWAY ITEMS							
1	MODOT	202-20.10	REMOVAL OF IMPROVEMENTS	LS	\$71,543.26	1	\$71,543.26
2	MODOT	203/206/207	EARTHWORK	LS	\$50,000.00	1	\$50,000.00
3	MODOT	304-05.06	TYPE 5 AGGREGATE FOR BASE (6 IN. THICK)	SY	\$10.00	4703	\$47,031.33
4	MODOT	403	NEW ASPHALT PAVEMENT SECTION (14" THICK)	SY	\$80.00	4329	\$346,320.00
5	MODOT	403	ASPHALT OVERLAY	SY	\$40.00	13060	\$522,400.00
6	MODOT	606-10.61	MGS GUARDRAIL, 8FT POSTS, 6FT-3IN SPACING	LF	\$35.00	125	\$4,375.00
7	MODOT	606	TYPE A CRASHWORTH END TERMINAL (MASH) AND END ANCHOR	LS	\$7,500.00	1	\$7,500.00
8	MODOT	608-30.06	6 IN. CONCRETE MEDIAN STRIP	SY	\$85.00	329	\$27,976.33
9	MODOT	608-60.07	PAVED APPROACH, 7 IN. (DRIVEWAYS)	SY	\$65.00	45	\$2,925.00
10	MODOT	616	TRAFFIC CONTROL	LS	\$30,000.00	1	\$30,000.00
11	MODOT	627-40.00	CONTRACTOR FURNISHED SURVEYING AND STAKING	LS	\$12,639.31	1	\$12,639.31
12	MODOT	618-10.00	MOBILIZATION	LS	\$77,635.86	1	\$77,635.86
13	MODOT	622	COLDMILLING BITUMINOUS PAVEMENT FOR REMOVAL OF SURFACING	SY	\$6.00	13060	\$78,360.00
14	MODOT	803	LANDSCAPING	LS	\$10,000.00	1	\$10,000.00
15	MODOT	806	EROSION CONTROL ITEMS	LS	\$25,000.00	1	\$25,000.00
ROADWAY SUBTOTAL							\$1,313,706.09
SIGNALS / LIGHTING / SIGNING / STRIPING ITEMS							
16	MODOT	903	SIGNING COMPLETE	LS	\$7,500.00	1	\$7,500.00
17	MODOT	901	NEW LUMINAIRE COMPLETE	EACH	\$15,000.00	1	\$15,000.00
18	MODOT	901	EXISTING LIGHTS TO BE RELOCATED COMPLETE	EACH	\$4,000.00	2	\$8,000.00
19	MODOT	620	PAVEMENT STRIPING COMPLETE	1	\$10,000.00	1	\$10,000.00
SIGNAL / LIGHTING / SIGNING / STRIPING SUBTOTAL							\$40,500.00
DRAINAGE ITEMS							
20	MODOT	726/731/732	DRAINAGE ITEMS COMPLETE (INCLUDING EXTENDING BOX CULVERT)	LS	\$30,000.00	1	\$30,000.00
DRAINAGE / UTILITY SUBTOTAL							\$30,000.00
					SUBTOTAL		\$1,384,206.09
					RIGHT-OF-WAY		\$623,730.00
					TOTAL (ROUNDED UP)		\$2,010,000.00
					NON-CONTRACT UTILITIES		\$0.00

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST							
CONCEPTUAL COST ESTIMATE - OPTION #3 MINOR ROAD UNDERPASS							
U.S. Route 50 & Route AT / N. Outer Road intersection, Franklin County, Missouri							
LINE NO.	SPEC.	ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	ITEM COST
ROADWAY ITEMS							
1	MODOT	202-20.10	REMOVAL OF IMPROVEMENTS (SET AT 6% OF IMPROVEMENT COST)	LS	\$170,355.72	1	\$170,355.72
2	MODOT	203-10.00	CLASS A EXCAVATION	CY	\$10.00	32220	\$322,200.00
3	MODOT	203-20.00	CLASS C EXCAVATION	CY	\$30.00	300	\$9,000.00
4	MODOT	203-60.00	COMPACTING EMBANKMENT	CY	\$7.50	2155	\$16,162.50
5	MODOT	207-20.00	LINEAR GRADING CLASS 2	STA	\$1,200.00	7	\$8,400.00
6	MODOT	304-05.06	TYPE 5 AGGREGATE FOR BASE (6 IN. THICK)	SY	\$10.00	8240	\$82,398.89
7	MODOT	310-10.03	GRAVEL (A)	SY	\$30.00	690	\$20,700.00
8	MODOT	403	NEW ASPHALT PAVEMENT SECTION (14" THICK)	SY	\$80.00	8170	\$653,591.11
9	MODOT	403	ASPHALT OVERLAY	SY	\$40.00	10000	\$400,000.00
10	MODOT	606-10.61	MGS GUARDRAIL, 8FT POSTS, 6FT-3IN SPACING	LF	\$37.00	550.0	\$20,350.00
11	MODOT	606-10.80	MGS BRIDGE APPROACH TRANSITION SECTION	EA	\$1,750.00	8	\$14,000.00
12	MODOT	606-24.00	BRIDGE ANCHOR SECTION (THRIE BEAM)	EA	\$2,000.00	8	\$16,000.00
13	MODOT	606-30.14	TYPE A CRASHWORTH END TERMINAL (MASH)	EA	\$3,750.00	8	\$30,000.00
14	MODOT	608-10.00	CONCRETE MEDIAN	SY	\$85.00	510	\$43,350.00
15	MODOT	608-60.07	PAVED APPROACH, 7 IN. (DRIVEWAY)	SY	\$65.00	70	\$4,550.00
16	MODOT	616	TRAFFIC CONTROL	LS	\$75,000.00	1	\$75,000.00
17	MODOT	617-31.00	TYPE D CONCRETE TRAFFIC BARRIER	LF	\$85.00	485	\$41,225.00
18	MODOT	627-40.00	CONTRACTOR FURNISHED SURVEYING AND STAKING	LS	\$30,846.18	1	\$30,846.18
19	MODOT	618-10.00	MOBILIZATION	LS	\$185,077.06	1	\$185,077.06
20	MODOT	622	COLDMILLING BITUMINOUS PAVEMENT FOR REMOVAL OF SURFACING	SY	\$6.00	10000	\$60,000.00
21	MODOT	700	BOX BEAM BRIDGE (PRICED PER SF OF BRIDGE DECK)	SF	\$150.00	2453	\$367,950.00
22	MODOT	503-10.10A	BRIDGE APPROACH SLAB (MAJOR ROAD)	SY	\$230.00	232	\$53,334.44
23	MODOT	703	MSE RETAINING WALLS	SF	\$65.00	6070	\$394,550.00
24	MODOT	750-12.00	SELECT GRANULAR BACKFILL FOR STRUCTURAL SYSTEMS	CY	\$30.00	1850	\$55,500.00
25	MODOT	803	LANDSCAPING	LS	\$20,000.00	1	\$20,000.00
26	MODOT	806	EROSION CONTROL ITEMS	LS	\$50,000.00	1	\$50,000.00
ROADWAY SUBTOTAL							\$3,144,540.90
SIGNALS / LIGHTING / SIGNING / STRIPING ITEMS							
27	MODOT	903	SIGNING COMPLETE	LS	\$10,000.00	1	\$10,000.00
28	MODOT	901	NEW LUMINAIRE COMPLETE	EACH	\$15,000.00	2	\$30,000.00
29	MODOT	901	EXISTING LIGHTS TO BE RELOCATED COMPLETE	EACH	\$4,000.00	2	\$8,000.00
30	MODOT	901	UNDERPASS LIGHTING COMPLETE	LS	\$20,000.00	1	\$20,000.00
31	MODOT	620	PAVEMENT STRIPING COMPLETE	1	\$8,000.00	1	\$8,000.00
SIGNAL / LIGHTING / SIGNING / STRIPING SUBTOTAL							\$76,000.00
DRAINAGE ITEMS							
32	MODOT	726/731/732	DRAINAGE ITEMS COMPLETE	LS	\$80,000.00	1	\$80,000.00
DRAINAGE / UTILITY SUBTOTAL							\$80,000.00
					SUBTOTAL	\$3,300,540.90	
					RIGHT-OF-WAY	\$1,718,595.00	
					TOTAL (ROUNDED UP)	\$5,020,000.00	
					NON-CONTRACT UTILITIES	\$0.00	

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST							
CONCEPTUAL COST ESTIMATE - OPTION #4 ROUTE AT BRIDGE OVER U.S. ROUTE 50							
U.S. Route 50 & Route AT / N. Outer Road intersection, Franklin County, Missouri							
LINE NO.	SPEC.	ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	ITEM COST
ROADWAY ITEMS							
1	MODOT	202-20.10	REMOVAL OF IMPROVEMENTS (SET AT 6% OF IMPROVEMENT COST)	LS	\$179,856.27	1	\$179,856.27
2	MODOT	203-10.00	CLASS A EXCAVATION	CY	\$10.00	4565	\$45,650.00
3	MODOT	203-20.00	CLASS C EXCAVATION	CY	\$30.00	300	\$9,000.00
4	MODOT	203-60.00	COMPACTING EMBANKMENT	CY	\$5.00	31030	\$155,150.00
5	MODOT	207-20.00	LINEAR GRADING CLASS 2	STA	\$1,200.00	7	\$8,400.00
6	MODOT	304-05.06	TYPE 5 AGGREGATE FOR BASE (6 IN. THICK)	SY	\$10.00	7732	\$77,316.67
7	MODOT	310-10.03	GRAVEL (A)	SY	\$30.00	450	\$13,500.00
8	MODOT	403	NEW ASPHALT PAVEMENT SECTION (14" THICK)	SY	\$80.00	7692	\$615,333.33
9	MODOT	403	ASPHALT OVERLAY	SY	\$40.00	10361	\$414,426.67
10	MODOT	606-10.61	MGS GUARDRAIL, 8FT POSTS, 6FT-3IN SPACING	LF	\$35.00	825.0	\$28,875.00
11	MODOT	606-10.80	MGS BRIDGE APPROACH TRANSITION SECTION	EA	\$1,500.00	4	\$6,000.00
12	MODOT	606-24.00	BRIDGE ANCHOR SECTION (THRIE BEAM)	EA	\$2,000.00	4	\$8,000.00
13	MODOT	606-30.14	TYPE A CRASHWORTHY END TERMINAL (MASH)	EA	\$3,750.00	8	\$30,000.00
14	MODOT	608-10.00	CONCRETE MEDIAN	SY	\$85.00	510	\$43,350.00
15	MODOT	608-60.07	PAVED APPROACH, 7 IN. (DRIVEWAY)	SY	\$65.00	40	\$2,600.00
16	MODOT	616	TRAFFIC CONTROL	LS	\$40,000.00	1	\$40,000.00
17	MODOT	617-31.00	TYPE D CONCRETE TRAFFIC BARRIER	LF	\$85.00	445	\$37,825.00
18	MODOT	627-40.00	CONTRACTOR FURNISHED SURVEYING AND STAKING	LS	\$32,721.11	1	\$32,721.11
19	MODOT	618-10.00	MOBILIZATION	LS	\$196,326.65	1	\$196,326.65
20	MODOT	622	COLDMILLING BITUMINOUS PAVEMENT FOR REMOVAL OF SURFACING	SY	\$6.00	10361	\$62,164.00
21	MODOT	700	PSNU GIRDER BRIDGE	SF	\$150.00	4000	\$600,000.00
22	MODOT	503-10.10A	BRIDGE APPROACH SLAB (MAJOR ROAD)	SY	\$230.00	178	\$40,888.89
23	MODOT	703	MSE RETAINING WALL	SF	\$65.00	9085	\$590,525.00
24	MODOT	720-12.00	SELECT GRANULAR BACKFILL FOR STRUCTURAL SYSTEMS	CY	\$30.00	2775	\$83,250.00
25	MODOT	803	LANDSCAPING	LS	\$20,000.00	1	\$20,000.00
26	MODOT	806	EROSION CONTROL ITEMS	LS	\$50,000.00	1	\$50,000.00
ROADWAY SUBTOTAL							\$3,391,158.59
SIGNALS / LIGHTING / SIGNING / STRIPING ITEMS							
27	MODOT	903	SIGNING COMPLETE	LS	\$14,000.00	1	\$14,000.00
28	MODOT	901	NEW LUMINAIRE COMPLETE	EACH	\$15,000.00	2	\$30,000.00
29	MODOT	901	EXISTING LIGHTS TO BE RELOCATED COMPLETE	EACH	\$4,500.00	2	\$9,000.00
30	MODOT	901	INTERCHANGE LIGHTING COMPLETE	LS	\$20,000.00	1	\$20,000.00
31	MODOT	620	PAVEMENT STRIPING COMPLETE	LS	\$12,000.00	1	\$12,000.00
SIGNAL / LIGHTING / SIGNING / STRIPING SUBTOTAL							\$85,000.00
DRAINAGE ITEMS							
32	MODOT	726/731/732	DRAINAGE ITEMS COMPLETE	LS	\$25,000.00	1	\$25,000.00
DRAINAGE / UTILITY SUBTOTAL							\$25,000.00
					SUBTOTAL	\$3,501,158.59	
					RIGHT-OF-WAY	\$1,718,595.00	
					TOTAL (ROUNDED UP)	\$5,220,000.00	
					NON-CONTRACT UTILITIES	\$0.00	

Appendix 06 – B/C Ratio Spreadsheets

Option #1: Dual Lane Roundabout

Option #2: Intersection Shift

Option #3: Minor Road Underpass

Option #4: Route AT bridge over U.S. Route 50

BEFORE PROJECT BENEFIT/COST RATIO ANALYSIS ***

***Please complete all GRAY highlighted sections.

FIRST Read Cell COMMENT Boxes

(sheet for use with 5-,10-,15-,20-,25- or 30-year Service Life)

Red outlined cells fill automatically using DIR1+DIR2 ALL Sum Sheet (BEFORE)

Date: June 04, 2019

County: Franklin

Route: US 50

Continuous Log 221.76
To Continuous Log 221.76

Job #: J6P2350

Description & Purpose of Improvement:Conceptual redesign of US 50 at Route AT intersection
Pqjpo 2 - Spvoebcpvq 3-rbof (x f t upvoe)2-rbof (f bt upvoe)

Pick the number from the chart to the right that corresponds to the roadway type:

10

TWO-LANE**Assumption:****ADT Adjustment**

Use Crash Summary (Before) Tab to enter Yrs & AADT		Year to Year	
Year 1:	2013	AADT:	14219
Year 2:	2014	AADT:	14247
Year 3:	2015	AADT:	16268
Year 4:	2016	AADT:	16612
Year 5:	2017	AADT:	16966
3-Yr Ave AADT:		16620	

% ADT Change:	0.197
% ADT Change:	14.185
% ADT Change:	2.115
% ADT Change:	2.131

Note: Cell J13 formula to match # of Yrs of AADT used (EX Change

"I13" formula cells B12 and D12 to B14 and D14 for 3-Yrs of data)

ADT % Annual Change: 2.123

ADT Annual Multiplier: 1.0212

Estimated Improvement Life

Service Life of Improvement (Yrs.): 30

Assumed % Annual Growth for up to First 10 Years of Improvement:

0.50

Assumed Out-Years (Yr-11 to end of Service Life) % Annual Growth:

0.50

(Provide Comment if Growth > than 2.0% per Yr from Yr-11 to End of Service Life)

Estimated Annual (BEFORE) Improvement Crash Reduction

Crash Type	Estimated % Reduction	5 -Yr Crash Totals	Annual Number of Crashes Before Improvement		Est. Annual Reduction By Crash Type
		40	PDO	8.00	5.68
		12	MI	2.40	1.70
ALL	71	1	F & D	0.20	0.14
			PDO	0.00	0.00
			MI	0.00	0.00
			F & D	0.00	0.00
			PDO	0.00	0.00
			MI	0.00	0.00
			F & D	0.00	0.00
			PDO	0.00	0.00
			MI	0.00	0.00
			F & D	0.00	0.00
			PDO	0.00	0.00
			MI	0.00	0.00
			F & D	0.00	0.00
Annual Sum of:			PDO:	8.00	MI: 2.40
Total Estimated Annual Crash Reduction of:			PDO:	5.68	MI: 1.70
Annual Before Cost of Crashes:			\$ 950,700		

Average Annual Benefits

2011 Cost of Property Damage Only Crash: \$10,500

2011 Cost of Minor Injury Crash: \$150,300

2011 Cost of Fatal & Disabling Injury Crash: \$ 2,529,718

Average Annual Benefit from Reducing Crashes: \$ 675,000

Average Annual Benefits with Increasing Or Decreasing ADT

NOTE: You CAN complete this section if ADT INCREASES Or DECREASES during the service life of improvement.

Service life: 30

Existing Trend ADT at the end of service life: 19700

Average ADT during the service life: 18330

ADT Growth Factor: 1.080

Average Annual Benefits from Reducing Accidents with ADT Increasing: \$ 729,270

Enter secondary annual benefits from improvement (if known, please explain): \$ -

Average Annualized Cost Assuming 2% Compounded Annually

AVERAGE ANNUAL BENEFITS: \$ 729,300

Enter the initial cost of improvement: \$ 1,920,000

Capital Recovery Factor for the service life of improvement: 0.04465

Enter the terminal salvage value: \$ -

Sinking Fund Factor for the service life of improvement: 0.02465

Enter any other annual costs associated with the improvement: \$ -

Prepared by: C. Falkenrath

Reviewed by:

AVERAGE ANNUAL COST: \$ 85,700

ESTIMATED AVERAGE ANNUAL NET SAVINGS: \$ 643,600

BEFORE BENEFIT / COST RATIO: 8.5**Option #1**

BEFORE PROJECT BENEFIT/COST RATIO ANALYSIS ***

***Please complete all GRAY highlighted sections.

FIRST Read Cell COMMENT Boxes

(sheet for use with 5-,10-,15-,20-,25- or 30-year Service Life)

Red outlined cells fill automatically using DIR1+DIR2 ALL Sum Sheet (BEFORE)

Date: June 04, 2019

County: Franklin

Route: US 50

Continuous Log 221.76
To Continuous Log 221.76

Job #: J6P2350

Description & Purpose of Improvement:Conceptual redesign of US 50 at Route AT intersection
Pqjpo 3 - Juf st f djpo Ti jgu

Pick the number from the chart to the right that corresponds to the roadway type:

10

TWO-LANE**Assumption:****ADT Adjustment**

Use Crash Summary (Before) Tab to enter Yrs & AADT		Year to Year	
Year 1:	2013	AADT:	14219
Year 2:	2014	AADT:	14247
Year 3:	2015	AADT:	16268
Year 4:	2016	AADT:	16612
Year 5:	2017	AADT:	16966
3-Yr Ave AADT:		16620	

% ADT Change:	0.197
% ADT Change:	14.185
% ADT Change:	2.115
% ADT Change:	2.131

Note: Cell J13 formula to match # of Yrs of AADT used (EX Change "I13" formula cells B12 and D12 to B14 and D14 for 3-Yrs of data)

ADT % Annual Change: 2.123

ADT Annual Multiplier: 1.0212

Estimated Improvement Life

Service Life of Improvement (Yrs.): 30

Assumed % Annual Growth for up to First 10 Years of Improvement: 0.50

Assumed Out-Years (Yr-11 to end of Service Life) % Annual Growth: 0.50

(Provide Comment if Growth > than 2.0% per Yr from Yr-11 to End of Service Life)

Estimated Annual (BEFORE) Improvement Crash Reduction

Crash Type	Estimated % Reduction	5 -Yr Crash Totals	Annual Number of Crashes Before Improvement	Est. Annual Reduction By Crash Type
		40	PDO 8.00	2.00
		12	MI 2.40	0.60
ALL	25	1	F & D 0.20	0.05
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
Annual Sum of:			PDO: 8.00	MI: 2.40
Total Estimated Annual Crash Reduction of:			PDO: 2.00	MI: 0.60
Annual Before Cost of Crashes:			\$ 950,700	

Average Annual Benefits

2011 Cost of Property Damage Only Crash: \$10,500

2011 Cost of Minor Injury Crash: \$150,300

2011 Cost of Fatal & Disabling Injury Crash: \$ 2,529,718

Average Annual Benefit from Reducing Crashes: \$ 237,700

Average Annual Benefits with Increasing Or Decreasing ADT

NOTE: You CAN complete this section if ADT INCREASES Or DECREASES during the service life of improvement.

Service life: 30

Existing Trend ADT at the end of service life: 19700

Average ADT during the service life: 18330

ADT Growth Factor: 1.080

Average Annual Benefits from Reducing Accidents with ADT Increasing: \$ 256,820

Enter secondary annual benefits from improvement (if known, please explain): \$ -

Average Annualized Cost Assuming 2% Compounded Annually

AVERAGE ANNUAL BENEFITS: \$ 256,900

Enter the initial cost of improvement: \$ 2,010,000

Capital Recovery Factor for the service life of improvement: 0.04465

Enter the terminal salvage value: \$ -

Sinking Fund Factor for the service life of improvement: 0.02465

Enter any other annual costs associated with the improvement: \$ -

Prepared by: Michelle Schwierjohn

Reviewed by:

AVERAGE ANNUAL COST: \$ 89,700

ESTIMATED AVERAGE ANNUAL NET SAVINGS: \$ 167,200

BEFORE BENEFIT / COST RATIO: 2.9**Option #2**

BEFORE PROJECT BENEFIT/COST RATIO ANALYSIS ***

***Please complete all GRAY highlighted sections.

FIRST Read Cell COMMENT Boxes

(sheet for use with 5-,10-,15-,20-,25- or 30-year Service Life)

Red outlined cells fill automatically using DIR1+DIR2 ALL Sum Sheet (BEFORE)

Date: June 04, 2019

County: Franklin

Route: US 50

Continuous Log 221.76
To Continuous Log 221.76

Job #: J6P2350

Description & Purpose of Improvement:Conceptual redesign of US 50 at Route AT intersection
Option 3 - Minor Road Underpass

Pick the number from the chart to the right that corresponds to the roadway type:

10

TWO-LANE**Assumption:****ADT Adjustment**

Use Crash Summary (Before) Tab to enter Yrs & AADT		Year to Year	
Year 1:	2013	AADT:	14219
Year 2:	2014	AADT:	14247
Year 3:	2015	AADT:	16268
Year 4:	2016	AADT:	16612
Year 5:	2017	AADT:	16966
3-Yr Ave AADT:		16620	

% ADT Change:	0.197
% ADT Change:	14.185
% ADT Change:	2.115
% ADT Change:	2.131

Note: Cell J13 formula to match # of Yrs of AADT used (EX Change "I13" formula cells B12 and D12 to B14 and D14 for 3-Yrs of data)

ADT % Annual Change: 2.123

ADT Annual Multiplier: 1.0212

Estimated Improvement Life

Service Life of Improvement (Yrs.): 30

Assumed % Annual Growth for up to First 10 Years of Improvement: 0.50

Assumed Out-Years (Yr-11 to end of Service Life) % Annual Growth: 0.50

(Provide Comment if Growth > than 2.0% per Yr from Yr-11 to End of Service Life)

Estimated Annual (BEFORE) Improvement Crash Reduction

Crash Type	Estimated % Reduction	5 -Yr Crash Totals	Annual Number of Crashes Before Improvement	Est. Annual Reduction By Crash Type
		40	PDO 8.00	3.36
		12	MI 2.40	1.01
ALL	42	1	F & D 0.20	0.08
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
Annual Sum of:			PDO: 8.00	MI: 2.40
Total Estimated Annual Crash Reduction of:			PDO: 3.36	MI: 1.01
Annual Before Cost of Crashes: \$ 950,700			F & DI: 0.20	F & DI: 0.08

Average Annual Benefits

2011 Cost of Property Damage Only Crash: \$10,500

2011 Cost of Minor Injury Crash: \$150,300

2011 Cost of Fatal & Disabling Injury Crash: \$ 2,529,718

Average Annual Benefit from Reducing Crashes: \$ 399,300

Average Annual Benefits with Increasing Or Decreasing ADT

NOTE: You CAN complete this section if ADT INCREASES Or DECREASES during the service life of improvement.

Service life: 30

Existing Trend ADT at the end of service life: 19700

Average ADT during the service life: 18330

ADT Growth Factor: 1.080

Average Annual Benefits from Reducing Accidents with ADT Increasing: \$ 431,410

Enter secondary annual benefits from improvement (if known, please explain): \$ -

Average Annualized Cost Assuming 2% Compounded Annually

AVERAGE ANNUAL BENEFITS: \$ 431,500

Enter the initial cost of improvement: \$ 5,030,000

Capital Recovery Factor for the service life of improvement: 0.04465

Enter the terminal salvage value: \$ -

Sinking Fund Factor for the service life of improvement: 0.02465

Enter any other annual costs associated with the improvement: \$ -

Prepared by: Michelle Schwierjohn

Reviewed by:

AVERAGE ANNUAL COST: \$ 224,600

ESTIMATED AVERAGE ANNUAL NET SAVINGS: \$ 206,900

BEFORE BENEFIT / COST RATIO: 1.9**Option #3**

BEFORE PROJECT BENEFIT/COST RATIO ANALYSIS ***

***Please complete all GRAY highlighted sections.

FIRST Read Cell COMMENT Boxes

(sheet for use with 5-,10-,15-,20-,25- or 30-year Service Life)

Red outlined cells fill automatically using DIR1+DIR2 ALL Sum Sheet (BEFORE)

Date: June 04, 2019

County: Franklin

Route: US 50

Continuous Log 221.76
To Continuous Log 221.76

Job #: J6P2350

Description & Purpose of Improvement:Conceptual redesign of US 50 at Route AT intersection
Option 4 - AT Bridge

Pick the number from the chart to the right that corresponds to the roadway type:

10

TWO-LANE**Assumption:****ADT Adjustment**

Use Crash Summary (Before) Tab to enter Yrs & AADT		Year to Year	
Year 1:	2013	AADT:	14219
Year 2:	2014	AADT:	14247
Year 3:	2015	AADT:	16268
Year 4:	2016	AADT:	16612
Year 5:	2017	AADT:	16966
3-Yr Ave AADT:		16620	

% ADT Change:	0.197
% ADT Change:	14.185
% ADT Change:	2.115
% ADT Change:	2.131

Note: Cell J13 formula to match # of Yrs of AADT used (EX Change "I13" formula cells B12 and D12 to B14 and D14 for 3-Yrs of data)

ADT % Annual Change: 2.123

ADT Annual Multiplier: 1.0212

Estimated Improvement Life

Service Life of Improvement (Yrs.): 30

Assumed % Annual Growth for up to First 10 Years of Improvement: 0.50

Assumed Out-Years (Yr-11 to end of Service Life) % Annual Growth: 0.50

(Provide Comment if Growth > than 2.0% per Yr from Yr-11 to End of Service Life)

Estimated Annual (BEFORE) Improvement Crash Reduction

Crash Type	Estimated % Reduction	5 -Yr Crash Totals	Annual Number of Crashes Before Improvement	Est. Annual Reduction By Crash Type
		40	PDO 8.00	3.36
		12	MI 2.40	1.01
ALL	42	1	F & D 0.20	0.08
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
			PDO 0.00	0.00
			MI 0.00	0.00
			F & D 0.00	0.00
Annual Sum of:			PDO: 8.00	MI: 2.40
Total Estimated Annual Crash Reduction of:			PDO: 3.36	MI: 1.01
Annual Before Cost of Crashes:			\$ 950,700	

Average Annual Benefits

2011 Cost of Property Damage Only Crash: \$10,500

2011 Cost of Minor Injury Crash: \$150,300

2011 Cost of Fatal & Disabling Injury Crash: \$ 2,529,718

Average Annual Benefit from Reducing Crashes: \$ 399,300

Average Annual Benefits with Increasing Or Decreasing ADT

NOTE: You CAN complete this section if ADT INCREASES Or DECREASES during the service life of improvement.

Service life: 30

Existing Trend ADT at the end of service life: 19700

Average ADT during the service life: 18330

ADT Growth Factor: 1.080

Average Annual Benefits from Reducing Accidents with ADT Increasing: \$ 431,410

Enter secondary annual benefits from improvement (if known, please explain): \$ -

Average Annualized Cost Assuming 2% Compounded Annually

AVERAGE ANNUAL BENEFITS: \$ 431,500

Enter the initial cost of improvement: \$ 5,220,000

Capital Recovery Factor for the service life of improvement: 0.04465

Enter the terminal salvage value: \$ -

Sinking Fund Factor for the service life of improvement: 0.02465

Enter any other annual costs associated with the improvement: \$ -

Prepared by: Michelle Schwierjohn

Reviewed by:

AVERAGE ANNUAL COST: \$ 233,100

ESTIMATED AVERAGE ANNUAL NET SAVINGS: \$ 198,400

BEFORE BENEFIT / COST RATIO: 1.9**Option #4**

Appendix 07 – Level of Service Tables

Table #1: 2018 Baseline Intersection Operating Conditions (SIDRA Analyses)

Table #2: 2018 Baseline Intersection Operating Conditions (Synchro Analyses)

Table #3: Design Intersection Operating Conditions for Option #1 (SIDRA)

Table #4: Design Intersection Operating Conditions for Option #2 (Synchro)

Table #5: Design Intersection Operating Conditions for Options #3 & #4 (Synchro)

Table 1 2018 Baseline Intersection Operating Conditions SIDRA Analyses						
Traffic Movement	AM Peak Hour			PM Peak Hour		
	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)
US Route 50 at Route AT/ N Outer 44						
Intersection	-	-	-	-	-	-
Eastbound Left-Turn	A	4.0	0.3	A	5.0	0.5
Westbound Left-Turn	A	5.2	0.1	A	3.7	0.2
Northbound Approach	F	55.3	3.6	E	35.1	2.5
Southbound Approach	D	31.2	2.6	E	44.7	3.8

Table 2 2018 Baseline Intersection Operating Conditions Synchro Analyses						
Traffic Movement	AM Peak Hour			PM Peak Hour		
	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)
US Route 50 at Route AT/ N Outer 44						
Intersection	-	-	-	-	-	-
Eastbound Left-Turn	A	8.0	0.2	A	9.8	0.4
Westbound Left-Turn	A	9.2	0.0	A	8.6	0.2
Northbound Approach	F	53.5	3.6	F	117.9	5.6
Southbound Approach	D	27.3	2.4	F	85.3	5.3

Table 3 Design Intersection Operating Conditions Option #1 Dual Lane Roundabout, SIDRA Analyses						
Traffic Movement	AM Peak Hour			PM Peak Hour		
	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)
Construction Year 2020 - US Route 50 at Route AT/ N Outer 44						
Intersection	A	8.7	-	A	6.8	-
Eastbound Approach	B	12.0	7.0	A	9.3	4.1
Westbound Approach	A	4.5	0.6	A	6.5	2.0
Northbound Approach	B	10.8	1.0	A	7.7	0.8
Southbound Approach	A	1.2	0.2	A	1.7	0.4

Table 3 (Cont.) Design Intersection Operating Conditions Option #1 Dual Lane Roundabout, SIDRA Analyses						
Traffic Movement	AM Peak Hour			PM Peak Hour		
	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)
20-Year Design Year 2040 - US Route 50 at Route AT/ N Outer 44						
Intersection	B	10.6	-	A	7.7	-
Eastbound Approach	B	14.8	9.2	B	11.0	5.1
Westbound Approach	A	4.7	0.7	A	7.1	2.4
Northbound Approach	B	13.8	1.4	A	8.9	0.9
Southbound Approach	A	1.1	0.2	A	2.0	0.5

Table 4 Design Intersection Operating Conditions Option #2 Intersection Shift, Synchro Analyses						
Traffic Movement	AM Peak Hour			PM Peak Hour		
	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)
Construction Year 2020 - US Route 50 at Route AT						
Eastbound Left-Turn	A	8.1	0.2	B	10.2	0.5
Southbound Approach	C	17.0	1.0	E	41.7	5.1
Construction Year 2020 - US Route 50 at N Outer 44						
Westbound Left-Turn	A	9.5	0.1	A	9.0	0.3
Northbound Approach	B	14.9	0.9	D	30.5	2.1
20-Year Design Year 2040 - US Route 50 at Route AT						
Eastbound Left-Turn	A	8.2	0.3	B	10.8	0.6
Southbound Approach	C	19.4	1.4	F	73.1	8.1
20-Year Design Year 2040 - US Route 50 at N Outer 44						
Westbound Left-Turn	A	9.9	0.2	A	9.3	0.4
Northbound Approach	C	19.9	1.5	E	49.2	3.4

Table 5 Design Intersection Operating Conditions Options #3 & #4 Grade-Separated Options, Synchro Analyses						
Traffic Movement	AM Peak Hour			PM Peak Hour		
	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)	Level Of Service	Vehicular Delay (sec)	95% Back of Queue (veh)
Construction Year 2020 - US Route 50 at Route AT/ N Outer 44						
Northbound Approach	C	16.2	0.8	B	12.4	0.6
Southbound Approach	B	11.6	1.0	D	29.8	4.2
20-Year Design Year 2040 - US Route 50 at Route AT/ N Outer 44						
Northbound Approach	C	18.0	1.0	B	13.3	0.7
Southbound Approach	B	12.3	1.2	E	44.3	6.2

Appendix 08 – FEMA Flood Plain Map

