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# Alternatives Analysis

Highway 125 Feasibility Study

Missouri Department of Transportation

*Strafford, MO*

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## Executive Summary

Highway 125 is a supplementary route through southwestern Missouri. This study evaluated alternatives for the Highway 125 corridor in Strafford, Missouri between Highway DD and Peachtree Lane. The objective of this report is to provide conceptual ideas that will improve safety and accommodate planned growth throughout the study corridor.

Eight initial concepts – some with multiple variations – were developed and assessed at a high level. Concepts 1 through 6 were prescribed in the scope of services, and Concepts 7 and 8 were developed based on needs identified by the project team. The major features of each concept are listed below, and exhibits showing the specifics of each layout are included in **Appendix A**. Topographical survey was unavailable for the project corridor. Existing LIDAR and boundary data provided by MoDOT was used in the development of the conceptual design alternatives.

### **Concept 1 (included in Concept 2/2A and Concept 3/3A)**

- Signalizing the Highway 125 and I-44 Westbound Ramp terminal intersection.

### **Concept 2/2A**

- Signalizing the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Relocating the intersection of Highway 125 and Evergreen Street to the north, with construction as a signalized intersection.
- Realigning Evergreen Street on the east side of Highway 125.
- For Concept 2 only, realigning Evergreen Street on the west side of Highway 125 behind the existing TA Travel Center.

### **Concept 3/3A**

- Signalizing the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Relocating the intersection of Highway 125 and Evergreen Street to the north, with construction as a roundabout.
- Realigning Evergreen Street on the east side of Highway 125.
- For Concept 3 only, realigning Evergreen Street on the west side of Highway 125 behind the existing TA Travel Center.

## **Concept 4/4A**

- Widening Highway 125 to provide a continuous three-lane section between the Highway OO intersection and the Washington Avenue / Olive Street intersection.
- Signalizing the Highway 125 and Highway OO intersection.
- Signalizing the Highway 125 and Washington Avenue/Olive Street intersection.
- Converting the intersection of Highway 125 and Chestnut Street to  $\frac{3}{4}$ -access or a roundabout.
- For Concept 4A only, constructing a roundabout at the I-44 Eastbound Ramp terminal.

## **Concept 5/5A**

- Constructing a roundabout at the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Constructing a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal intersection.
- Aligning Evergreen Street to intersect with the I-44 Westbound Ramp terminal, creating a six-leg roundabout.
- Providing  $\frac{3}{4}$ -access to the TA Travel Center on the west side of the existing Highway 125 / Evergreen Street intersection.

## **Concept 6**

- Constructing a roundabout at Highway 125 and Washington Avenue/Olive Street.
- Restricting access to right-in/right-out at Pine Street to/from Washington Avenue.

## **Concept 7/7A**

- Signalizing the Highway 125 and Highway OO intersection.
- Constructing a new at-grade railroad crossing directly south of Highway 125 and Highway OO intersection connecting to Bumgarner Boulevard and Birchwood Street.
- Signalizing the Highway 125 and Washington Avenue/Olive Street intersection.
- Closing the existing railroad crossing on Washington Avenue/Olive Street just south of Highway 125.
- Converting to  $\frac{3}{4}$ -access or a roundabout at Highway 125 and Chestnut Street.
- For Concept 7A only, constructing a roundabout at the I-44 Eastbound Ramp terminal.

## **Concept 8 (included in Concept 4A and Concept 7A)**

- Constructing a roundabout at Highway 125 and I-44 Eastbound Ramp terminal.
- Constructing a roundabout at Highway 125 and Chestnut Street.

Based on a preliminary screening that assessed the benefits and disadvantages of each concept, the project team narrowed down the initial design alternatives to four final concepts. The preliminary screening of the design alternatives was approved by the MoDOT Core Project Team, including the City of Strafford, during a meeting on December 8, 2021. Concepts 2, 3, 4A, and 7A were then analyzed in more detail, taking into account traffic operations, constructability, environmental considerations, and safety.

Existing traffic operations and safety were evaluated in addition to traffic operations for all alternatives for the Opening Year (2024) and the Design Year (2044). Assumptions about future construction of residential and industrial property in southwest Strafford were included in the traffic modeling for the No-Build conditions and the Build conditions.

Cost estimates for each Concept that moved past the screening exercise are provided in **Appendix B**.

# Introduction

## Study Area

HDR Engineering, Inc. (HDR) was retained to evaluate, and scope needed intersection improvements for the Highway 125 corridor between Highway DD and Peachtree Lane in Strafford, Missouri. Centered near the intersection of Highway 125 with I-44, Strafford is a small community about 5 miles northeast of Springfield, Missouri. The study corridor and study intersections are shown in **Figure 1**. The Highway 125 corridor, as indicated by the blue line, is not linear through the study area.

**Figure 1: Study Area**



The purpose of this analysis was to evaluate intersection improvements along the corridor for their effectiveness at improving congestion, safety, and connectivity. Eleven (11) key study intersections were selected for analysis:

1. Highway 125 and Highway DD
2. Highway 125 and Evergreen Street
3. I-44 Westbound Ramp and Highway 125
4. I-44 Eastbound Ramp and Highway 125
5. Highway 125 and Chestnut Street
6. Highway 125 and Highway OO
7. Highway 125 and Jefferson Street
8. Highway 125 and Washington Avenue/Olive Street
9. Highway 125 and Old Orchard Drive
10. Highway 125 and Pinecrest Avenue
11. Highway 125 and Peachtree Lane

## Existing and Future No-Build Conditions

### Traffic Operations

**Appendix C** provides a complete traffic memorandum summarizing the operational analysis methodology and results of the existing and future No-Build conditions for the study corridor. Future conditions were considered for both the opening year (2024) and the design year (2044). These results serve as a basis for the development of improvement alternatives.

To summarize, existing traffic operations for each intersection in the study area are generally within acceptable levels, defined as LOS D or better. However, the existing conditions analysis indicates there is already a need for potential improvements at two study intersections. The intersection of Highway 125 with Evergreen Street is currently signalized and operates at LOS C overall, but the westbound approach is shown to operate at LOS E during both the AM and PM peak hours. Additionally, the I-44 Westbound Ramp terminal, which is currently two-way-stop-controlled, is shown to operate at LOS F on the westbound approach, during both peak periods.

Under the future No-Build conditions, as volumes increase and existing capacity and traffic control remains the same, operations are projected to begin to deteriorate. By 2044, most of the study intersections would begin to show poor operating conditions for one or more approaches.

### Safety

Historic safety data was also assessed to determine if any crash trends or “hot spots” would help identify needed design improvements. Study area data for the five-year period from 2016-2020 was obtained for this analysis. A full safety memo outlining the results of the historic safety analysis is included as **Appendix D**.

To summarize, four intersections emerged as locations with a high number of total crashes for the five-year period, as well as high crash rates (a measure that accounts for the entering traffic volume, or exposure, at each intersection).

1. **Highway 125 and Washington Ave** – 62 total crashes; right-angle crashes are the predominant type, making up over half of all crashes at the intersection (36).
2. **Highway 125 and Evergreen Street** – 40 total crashes; rear-end crashes are most common (11), followed by left-turn (7), and sideswipe (6).
3. **Highway 125 and Highway 00** – 22 total crashes; head-on crashes are most common (7), followed by rear-end (5).
4. **Highway 125 and Peachtree Lane** – 20 total crashes; head-on crashes are the predominant crash type (14).



## Alternatives Development

To address the issues uncovered in the Existing and Future No-Build traffic operations and safety analyses, eight different concepts, some with multiple variations, were evaluated. The benefits and disadvantages of each concept are outlined below. An illustration of each concept is also included in **Appendix A**.

It should be noted that concept development was constrained by the fact that, per MoDOT, the Highway 125 bridge over I-44 (Bridge A5400) has a remaining asset life that extends past the planned 2024 opening year, with preventive maintenance scheduled in 2027. Additionally, proposed concepts were not evaluated for utility impacts due to lack of existing survey data. Installation of new lighting is assumed for each concept within the work limits along Highway 125 and Highway OO and is included in the concept cost estimates. Pedestrian ramps at signalized intersections and sidewalks around the proposed roundabouts are also included in the concept cost estimates. ADA improvements along the corridor are programmed for 2024.

### Concept 1

The major feature of Concept 1 includes signalizing the intersection of Highway 125 at the I-44 Westbound Ramp terminal, see **Figure 2**.

#### Benefits

Signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection would improve the interchange level of service. This is the least impactful concept (in terms of footprint, right-of-way, and cost), and would be the quickest to implement with minimal Maintenance of Traffic (MOT) requirements.

#### Disadvantages

This concept does not address any of the key safety concerns along the corridor, nor does it address deteriorating LOS at other intersections along the study corridor.

It was determined that Concept 1 should not be carried forward as a standalone project. Rather, the signalization improvement was included as part of a larger package in Concepts 2/2A and 3/3A, as described in subsequent sections.

**Figure 2: Concept 1 Layout**



## Concepts 2/2A

The major features of Concepts 2/2A include:

- Signalizing the Highway 125 / I-44 Westbound Ramp intersection.
- Relocating the intersection of Highway 125 and Evergreen Street approximately 500 feet north (about 1350 feet north of the existing I-44 Westbound Ramp terminal intersection). The relocated intersection would be signalized.
- Realigning Evergreen Street, on the east side of Highway 125, to the east side of the existing McDonalds and Love's Travel Stop properties. The existing section of Evergreen Street would "T" into the new alignment and be retained as an outer road to provide access to existing businesses. The existing Highway 125 / Evergreen Street intersection would be reduced to right-in/right-out access on the east side of Highway 125 only.

The difference between Concepts 2 and 2A is the alignment of Evergreen Street on the west side of Highway 125. Concept 2 would retain much of the existing road, while Concept 2A would realign Evergreen Street further west around the west side of the existing TA Travel Center. See **Figures 3 and 4** for a visual comparison.

### Benefits

Both Concepts 2 and 2A would shift Evergreen Street to the north, providing improved intersection spacing between the I-44 westbound ramp and Evergreen Street. This improved distance would help reduce the instances of sideswipe collisions. The relocation would also allow for better roadway geometrics, with sufficient space for turn lanes and queues. The signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection proposed in Concepts 2 and 2A would be expected to improve the interchange level of service. MOT for this concept would not be complex due to the widening and new alignment scope of work, which could be accomplished with minimal traffic shifts and temporary closures for resurfacing.

From a development perspective, relocating Evergreen Street to the north in both variations would provide improved access opportunities for the currently undeveloped parcels north of the Love's Travel Stop and TA Travel Center.

### Disadvantages

Both Concepts 2 and 2A would require substantial right-of-way acquisition and would change access to multiple high-traffic businesses along the northern section of Highway 125 and Evergreen Street. Representatives from the TA Travel Center, located on the west side of Highway 125, have expressed concerns about access and impacts to their site. An engineered site plan, developed for the future expansion of the site, reportedly does not account for the modified entrance location or the taking of property for the realigned road.

Concept 2A, which would realign Evergreen Street further to the west, behind the existing TA Travel Center facility, was removed from consideration after discussions with the Project Core Team. Concerns regarding the TA Travel Center's expansion plans led the team away from Concept 2A. **Therefore, Concept 2A did not move forward for further analysis.**

Figure 3: Concept 2 Layout

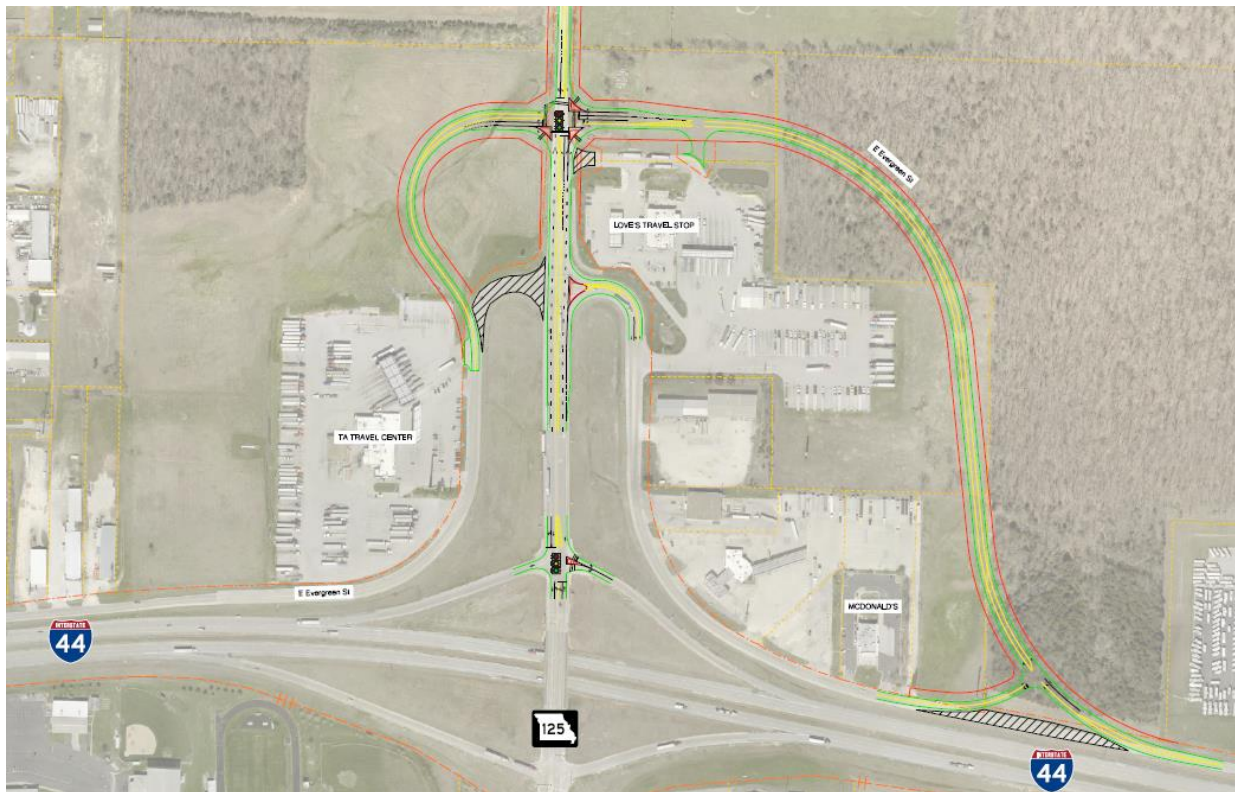


Figure 4: Concept 2A Layout





**Concepts 3/3A**

The major features of Concepts 3/3A include:

- Signalizing the Highway 125 / I-44 Westbound Ramp terminal intersection.
- Relocating the intersection of Highway 125 with Evergreen Street approx. 500 feet north (about 1350 feet north of the existing I-44 Westbound Ramp terminal intersection).
- Constructing a roundabout at the relocated Highway 125 / Evergreen Street intersection.
- Realigning Evergreen Street, on the east side of Highway 125, to the east side of the existing McDonalds and Love's Travel Stop properties. The existing section of Evergreen Street would "T" into the new alignment and be retained as an outer road to provide access to existing businesses. The existing Highway 125 / Evergreen Street intersection would be reduced to right-in/right-out access on the east side of Highway 125 only.

The difference between Concepts 3 and 3A is the same as for 2/2A: the proposed alignment of Evergreen Street on the west side of Highway 125. See **Figures 5 and 6** for a visual comparison.

**Benefits**

Similar to Concepts 2/2A, Concepts 3/3A propose shifting Evergreen Street to the north, providing improved intersection spacing between the I-44 westbound ramp and Evergreen Street. Increasing the weaving distance will help reduce instances of sideswipe collisions. Additionally, by converting the Highway 125 / Evergreen Street intersection to a roundabout in lieu of a traffic signal, the possibility of left-turn crashes is eliminated. The yield conditions and lower through speeds of a roundabout may also help reduce the number of rear-end collisions, as drivers will expect traffic to slow as it nears the roundabout. The signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection, proposed in both concept variations, is expected to improve the interchange level of service.

From a development perspective, relocating Evergreen Street to the north in both Concepts 3 and 3A would provide improved access opportunities for the currently undeveloped parcels north of the Love's Travel Stop and TA Travel Center.

**Disadvantages**

Both Concepts 3 and 3A would require substantial right-of-way acquisition and would change access to multiple high-traffic businesses on the northern section of Highway 125 and Evergreen Street. If built, the proposed roundabout would be the first roundabout in Strafford. Due to a lack of familiarity, concerns have been raised about safety, as well as the ability of large trucks to navigate through roundabouts. MOT during the construction of the new alignments would be minimal, but construction of the roundabout would require multiple traffic shifts, temporary alignments, and construction stages.

As with Concept 2A, Concept 3A was eliminated from consideration after discussions with the Project Core Team due to the planned remodeling of the TA Travel Center. **Therefore, Concept 3A did not move forward for further analysis.**

Figure 5: Concept 3 Layout



Figure 6: Concept 3A Layout



**Concepts 4/4A**

The major features of Concepts 4/4A include:

- Widening Highway 125 to provide a continuous three-lane section between the Highway OO intersection and the Washington Avenue / Olive Street intersection.
- Signalizing the Highway 125 at Washington Avenue intersection.
- Signalizing the Highway 125 at Highway OO intersection.
- Converting the Highway 125 and Chestnut Street intersection to  $\frac{3}{4}$ -access (Concept 4) or a roundabout (Concept 4A).
- For Concept 4A only, constructing a roundabout at the I-44 Eastbound Ramp terminal.

The difference between Concepts 4 and 4A is confined to the Highway 125 intersections with Chestnut Street and the I-44 eastbound ramps. Concept 4 would convert the Chestnut Street intersection to a  $\frac{3}{4}$ -access, while Concept 4A would convert it to a roundabout. Concept 4A would also include a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal intersection. See **Figures 7 and 8** for a visual comparison.

**Benefits**

The intersection of Highway 125 with Washington Avenue / Olive Street has a high incidence of right-angle crashes, which often occur when side-street vehicles make unprotected turns onto Highway 125. Thus, the signalization of this intersection in Concepts 4/4A should improve safety by lowering the instances of these crashes. Similarly, the signalization of the Highway 125 and Highway OO intersection in both variations should help reduce the instances of head-on and angle collisions that currently exist. By lowering the number of potential conflict points, both the  $\frac{3}{4}$ -access and the roundabout options at Chestnut Street could help improve safety at this intersection, while also improving the intersection LOS. MOT for Concept 4 would not be complex due to the widening scope of work, which could be accomplished with minimal traffic shifts and temporary closures for resurfacing.

The dual-lane roundabout proposed at the I-44 Eastbound Ramp terminal intersection in Concept 4A is expected to improve the intersection LOS to acceptable conditions through the 2044 design year.

**Disadvantages**

The  $\frac{3}{4}$ -access at Chestnut Street would likely divert eastbound-to-northbound Highway 125 traffic onto other local roadways (i.e. south on Jefferson Street to the east-west portion of Highway 125). Additionally, the  $\frac{3}{4}$ -access would restrict westbound-to-southbound movements, forcing traffic northbound with no reasonable U-turn potential. MOT for Concept 4A would be more complex than Concept 4 and would require multiple traffic shifts, temporary alignments, and construction stages. The proximity of the roundabout to the existing bridge over I-44 would further complicate the MOT.

**Due to the movement restrictions associated with Concept 4, only Concept 4A was moved forward for further analysis.**



Figure 7: Concept 4 Layout

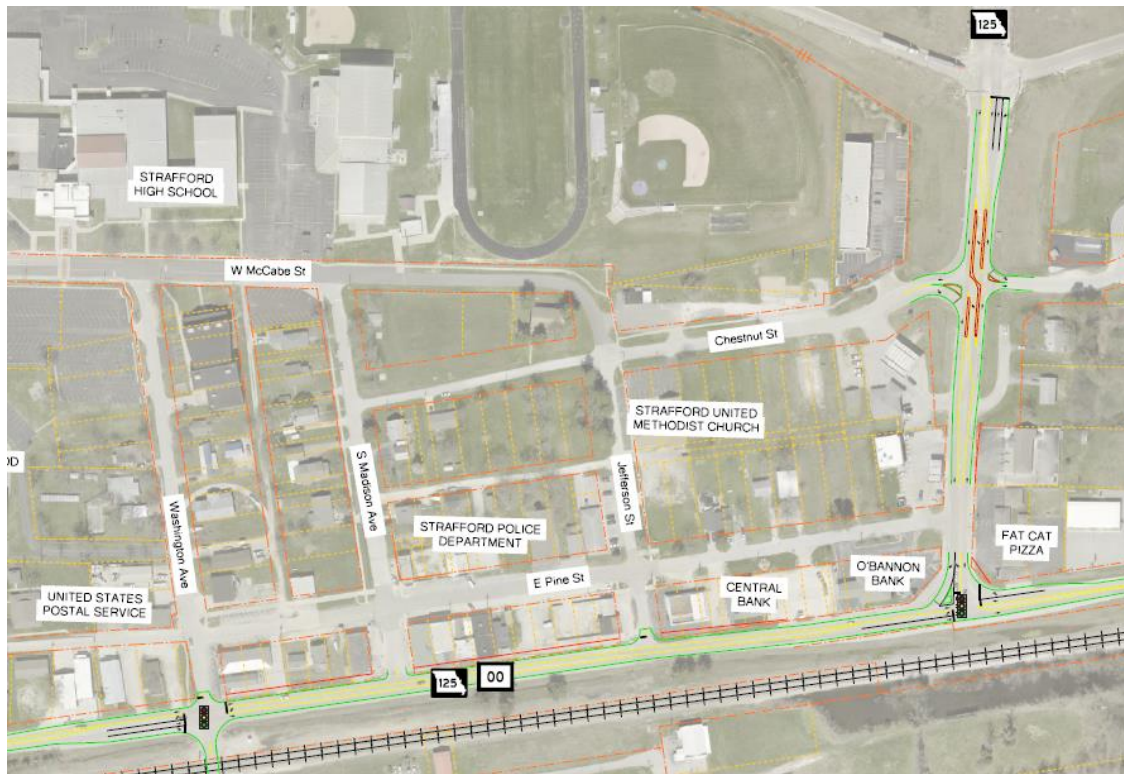
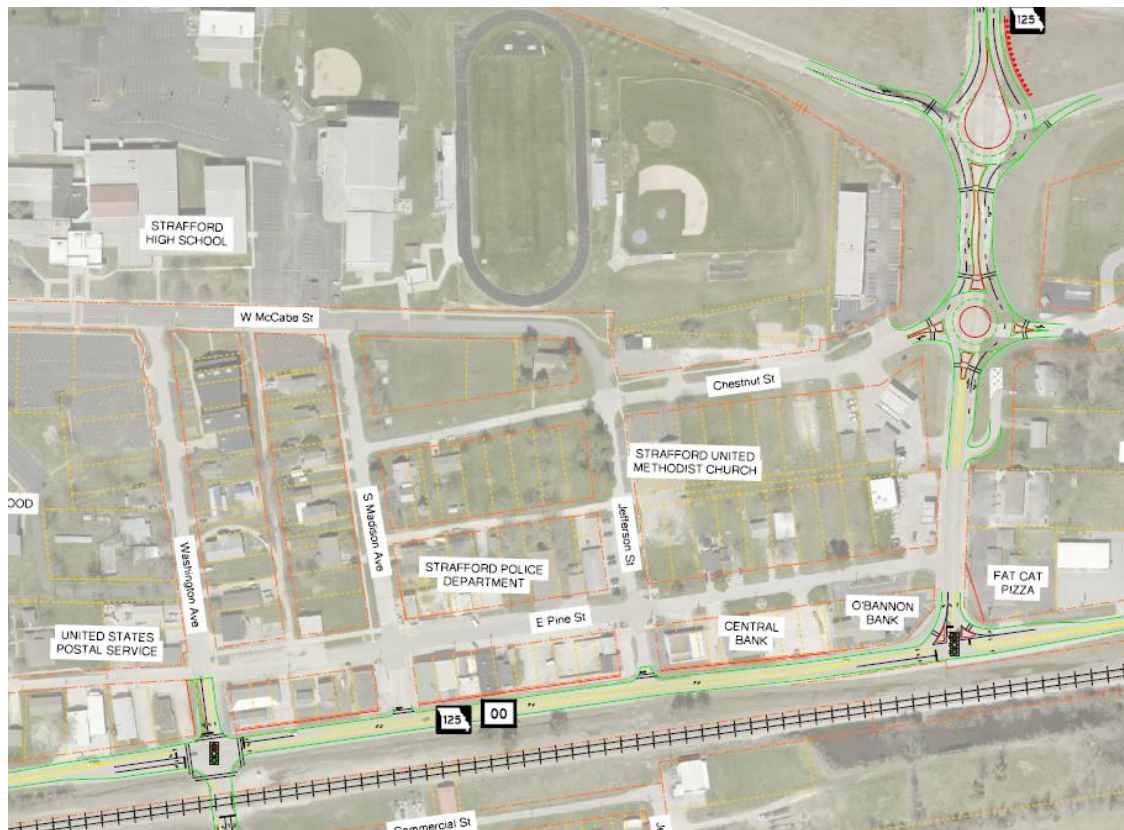


Figure 8: Concept 4A Layout



**Concept 5/5A**

The major features of Concepts 5 and 5A, pictured in **Figures 9 and 10**, include:

- Constructing a roundabout at the I-44 Westbound Ramp terminal.
- Constructing a roundabout at the I-44 Eastbound Ramp terminal.
- Aligning Evergreen Street to intersect with the I-44 Westbound Ramp terminal, creating a six-leg roundabout.
- Converting the west side of the existing Highway 125 / Evergreen Street intersection to a  $\frac{3}{4}$ -access driveway serving the TA Travel Center.
- Concept 5 would realign Evergreen Street on the east side of Highway 125 to the north, running between the XVIII Wheelers Truck Wash and JR All Metal Polishing. Concept 5A would keep the east side of Evergreen Street on its current alignment.

**Benefits**

Both Concepts 5 and 5A propose aligning Evergreen Street to intersect with the I-44 Westbound Ramp intersection at a six-leg roundabout. The yield conditions of a roundabout may reduce the number of rear-end collisions, as drivers would expect traffic to slow as it nears the roundabout. Additionally, both Concepts 5 and 5A propose a multi-lane roundabout at the I-44 Eastbound Ramp terminal intersection, which is expected to improve the intersection LOS to acceptable conditions through the design year.

From a development perspective under both variations, relocating Evergreen Street to the north would allow access opportunities for the currently undeveloped parcels north of the Love's Travel Stop and TA Travel Center. By lowering the potential conflict points, the  $\frac{3}{4}$ -access to the TA Travel Center in Concepts 5 and 5A could help improve safety at this intersection, while reducing the number of approaches, and reducing the amount of traffic coming to a stop, should also improve the intersection LOS.

**Disadvantages**

The multi-lane roundabouts proposed in both variations could pose initial safety concerns due to a lack of driver familiarity, particularly at the 6-leg roundabout proposed at Highway 125 / I-44 Westbound Ramp terminal / Evergreen Street (realigned). Additionally, both variations propose a  $\frac{3}{4}$ -access to the TA Travel Center, which may divert additional traffic to the proposed Highway 125 / I-44 Westbound Ramp terminal / Evergreen Street (realigned) roundabout. That proposed roundabout also poses access challenges to the various truck stops along Evergreen Street.

Concept 5 proposes realigning Evergreen Street to the north, which requires around 5.8 acres of right-of-way acquisition. This concept would change access to multiple high-traffic businesses on the northern section of Highway 125 and Evergreen Street. MOT for Concepts 5 and 5A would require multiple traffic shifts, temporary alignments, and construction stages. The proximity of the roundabouts to the existing bridge over I-44 would further complicate MOT. Also, the geometry of the roundabout in Concept 5A would not provide enough room for two inbound lanes from the I-44 westbound ramp, which would be needed to provide acceptable LOS in the design year (2044).



With disadvantages outweighing benefits, neither Concept 5 nor 5A moved forward for further analysis.

Figure 9: Concept 5 Layout

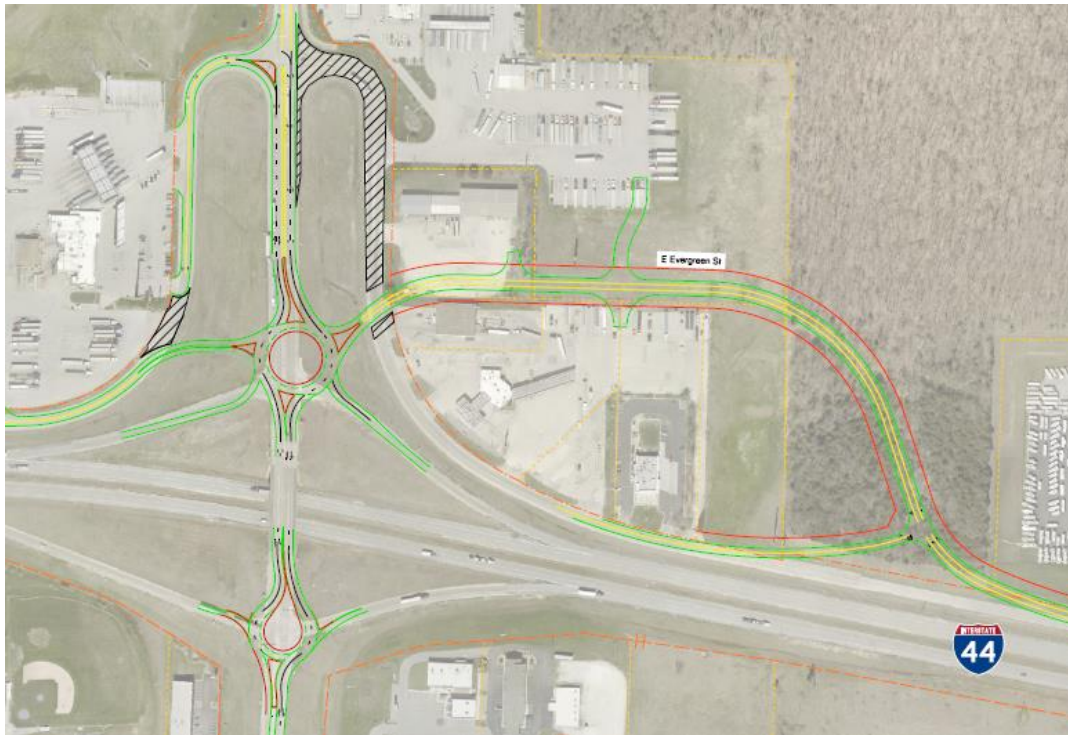
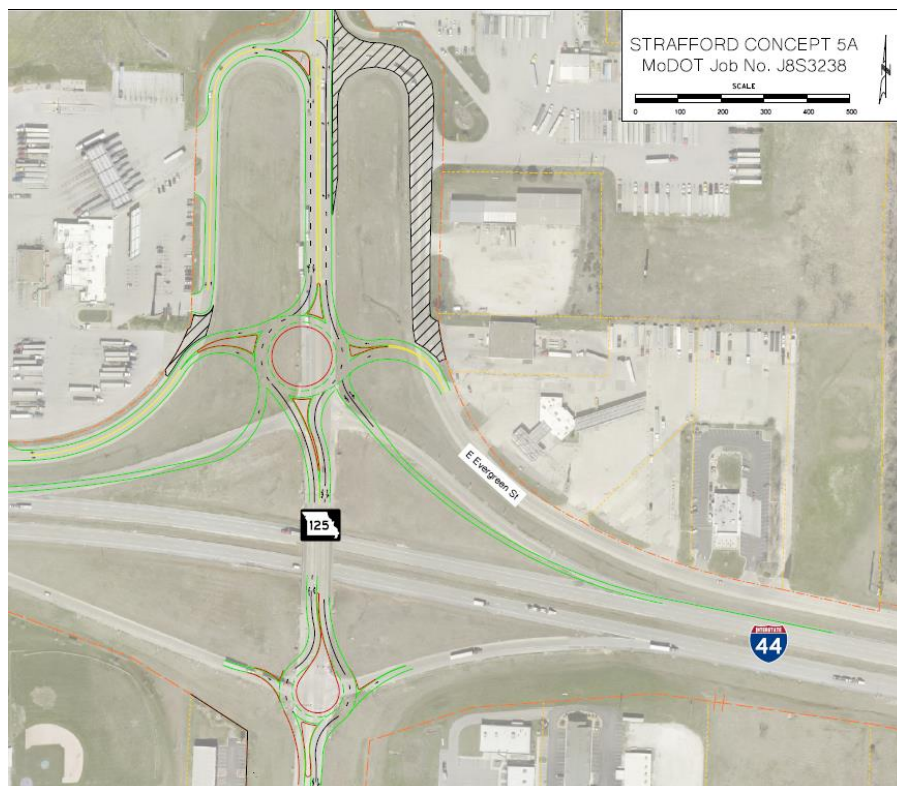


Figure 10: Concept 5A Layout



### Concept 6

The major features of Concept 6, pictured in **Figure 11**, include:

- Constructing a roundabout at Highway 125 and Washington Avenue/Olive Street.
- Restricting access to right-in/right-out at Pine Street to/from Washington Avenue.

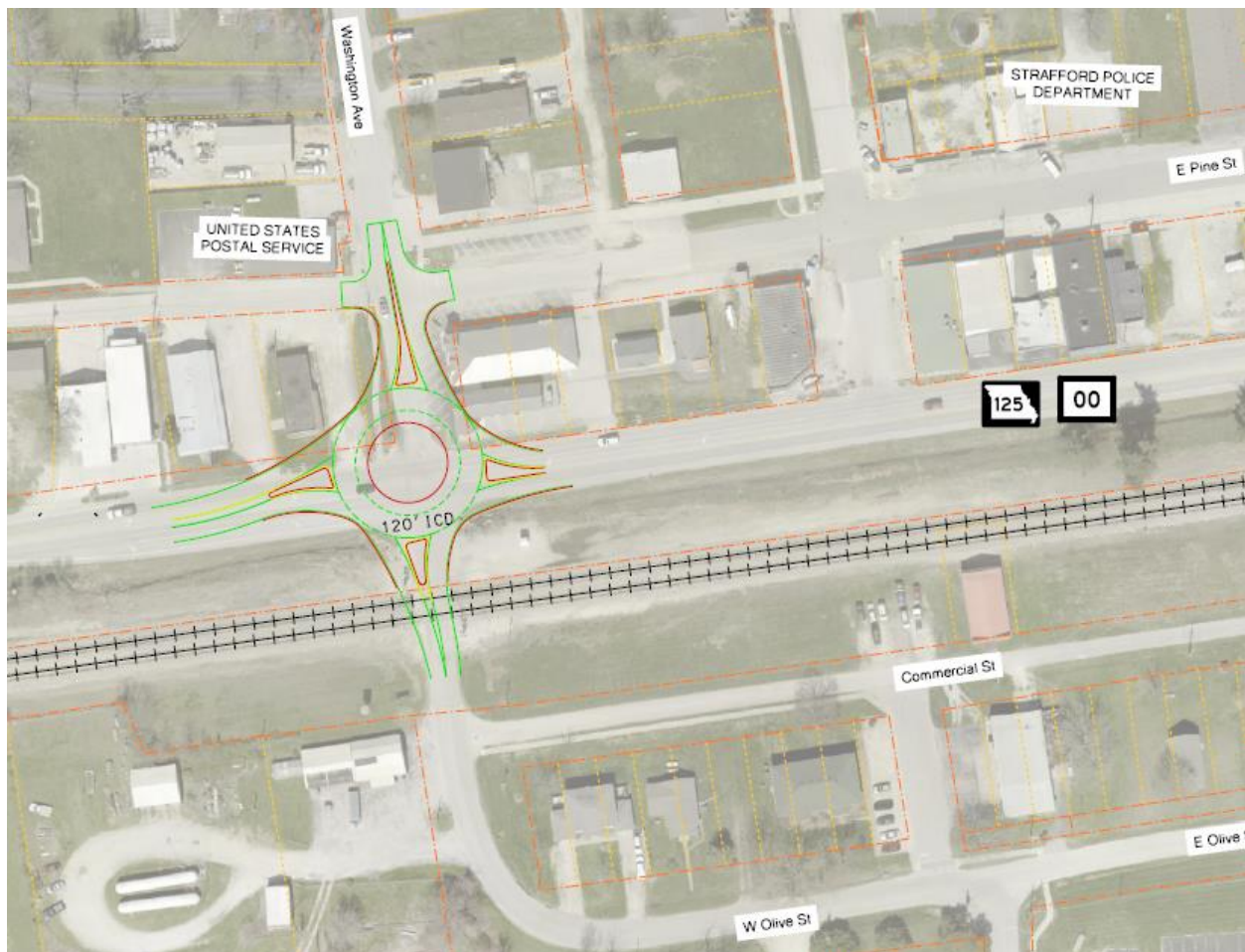
### Benefits

Conversion to a roundabout would reduce the number of conflict points, which may result in improved safety, particularly by reducing the number of right-angle crashes. Similarly, the right-in/right-out restrictions at Pine Street may also improve safety by reducing conflict points.

### Disadvantages

This concept would require the acquisition of 2-3 buildings, with potential impacts to the Strafford City Hall. The right-in/right-out restrictions at the Washington Avenue and Pine Street intersection would also impact the eastbound and westbound vehicular flows along Pine Street. MOT for the construction of the roundabout would also require multiple traffic shifts, temporary alignments, and construction stages. **Due to these impacts, Concept 6 did not move forward for further analysis.**

**Figure 11: Concept 6 Layout**



**Concepts 7/7A**

The major features of Concepts 7/7A include:

- Signalization of the Highway 125 and Highway OO intersection.
- New railroad crossing directly south of Highway 125 and Highway OO intersection connecting to Bumgarner Boulevard and Birchwood Street.
- Signalization of the Highway 125 and Washington Avenue/Olive Street intersection.
- Closure of existing railroad crossing on Washington Avenue/Olive Street just south of Highway 125.
- Conversion of Highway 125 and Chestnut Street to  $\frac{3}{4}$ -access (Concept 7) or a roundabout (Concept 7A).
- For Concept 7A only, construction of a roundabout at the I-44 Eastbound Ramp terminal.

The difference between the 7 and 7A concepts is confined to the Highway 125 intersections with Chestnut Street and the I-44 eastbound ramps. Concept 7 would convert the Chestnut Street intersection to a  $\frac{3}{4}$ -access, while Concept 7A would convert it to a roundabout. Concept 7A would also include a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal intersection. See **Figures 12 and 13** for a visual comparison.

**Benefits**

In both Concepts 7 and 7A, the proposed new extension of Highway 125 south to Bumgarner Boulevard would provide a direct connection to homes and businesses south of downtown Strafford without traffic having to travel through the downtown area. Additionally, in both variations, signalization at the Highway 125 and Highway OO intersection is expected to improve the safety of intersection, reducing the high incidence of head-on and other collision types by protecting traffic movements.

At Chestnut Street, both the  $\frac{3}{4}$ -access and the roundabout concepts could help improve safety by reducing the number of conflict points, while also improving the intersection LOS. MOT for the  $\frac{3}{4}$ -access in Concept 7 and the new alignments would not be complex and could be accomplished with minimal traffic shifts and temporary lane closures for the resurfacing, new alignment, and widening scope of work.

The multi-lane roundabout proposed at the I-44 Eastbound Ramp terminal intersection in Concept 7A would be expected to improve the intersection LOS to acceptable conditions through the design year.

**Disadvantages**

Concepts 7/7A would require a substantial amount of right-of-way acquisition, as well as coordination of a new crossing with the railroad. Coordination with BNSF Railroad would be required to determine if a new RR crossing could be introduced at this location with the expectation that one or more other RR crossings would be removed as commonly requested by BNSF under similar conditions. The railroad crossing at Washington Avenue / Olive Street would close if this new crossing were added, forcing a change in driver habits. Additionally, if



built, the two roundabouts proposed in Concept 7A would be the first roundabouts in Strafford, which could pose initial safety concerns due to a lack of driver familiarity. MOT for the construction of the roundabout would also require multiple traffic shifts, temporary alignments, and construction stages.

The  $\frac{3}{4}$ -access at Chestnut Street would likely divert eastbound-to-northbound Highway 125 traffic onto other local roadways (i.e. south on Jefferson Street to the east-west portion of Highway 125). Additionally, the  $\frac{3}{4}$ -access restricts westbound-to-southbound movements, forcing traffic northbound with no reasonable U-turn potential. **Due to these movement restrictions, Concept 7 did not move forward for further analysis.**

Figure 12: Concept 7 Layout



Figure 13: Concept 7A Layout





### Concept 8

The major features of Concept 8, pictured in **Figure 14**, include:

- Construct a roundabout at the I-44 Eastbound Ramp terminal.
- Construct a roundabout at the Highway 125 and Chestnut Street intersection.

### Benefits

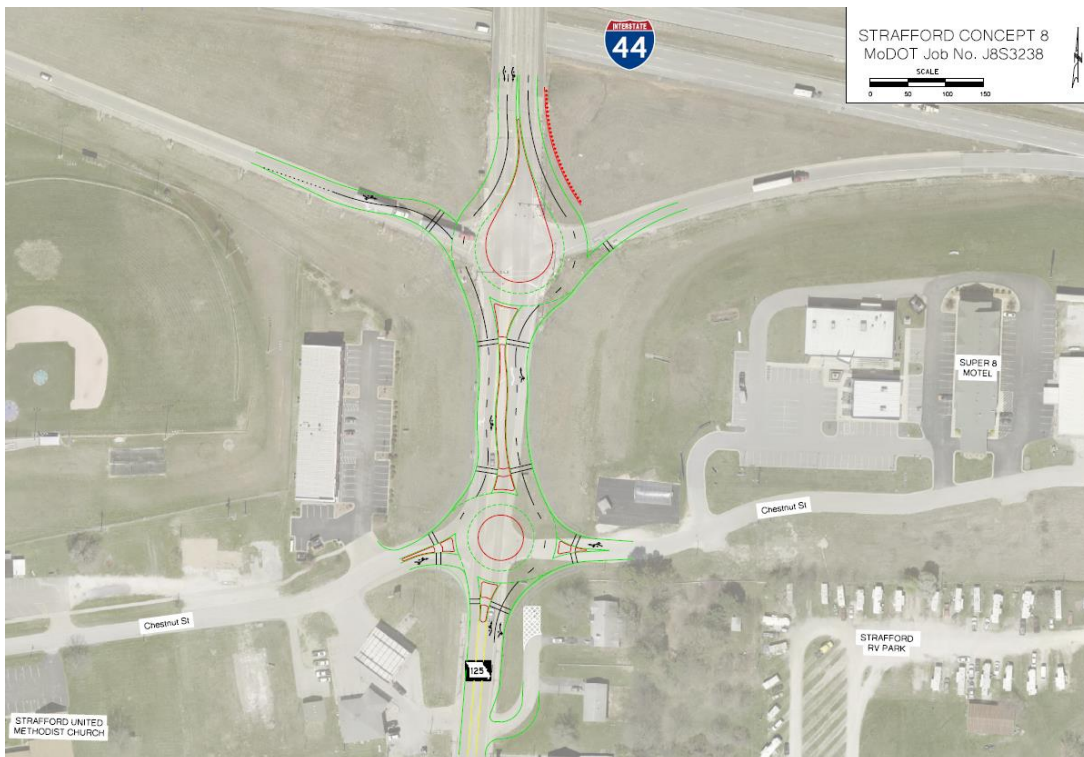
Concept 8 proposes a multi-lane roundabout at the I-44 Eastbound Ramp terminal intersection, which is expected to improve the intersection LOS to acceptable conditions through the design year. Functional and safety concerns at the Highway 125 / Chestnut Street intersection would be addressed by eliminating left turns and creating free-flow conditions for all traffic movements. The roundabout option at Highway 125 / Chestnut Street would allow eastbound traffic to directly access northbound Highway 125, and westbound traffic to directly access southbound Highway 125, unlike the  $\frac{3}{4}$ -access option proposed under other concepts.

### Disadvantages

If built, these would be the first roundabouts in Strafford, which could pose initial safety concerns due to a lack of driver familiarity. On its own, this concept does not address safety issues at any of the four intersections with highest crash rates. MOT would require multiple traffic shifts, temporary alignments, and construction stages, and the proximity of the roundabout to the existing bridge over I-44 would be an additional challenge.

Concept 8 was not carried forward as a standalone project; however, both of the proposed roundabouts were included as part of Concepts 4A and 7A.

**Figure 14: Concept 8 Layout**



## Alternatives Analysis

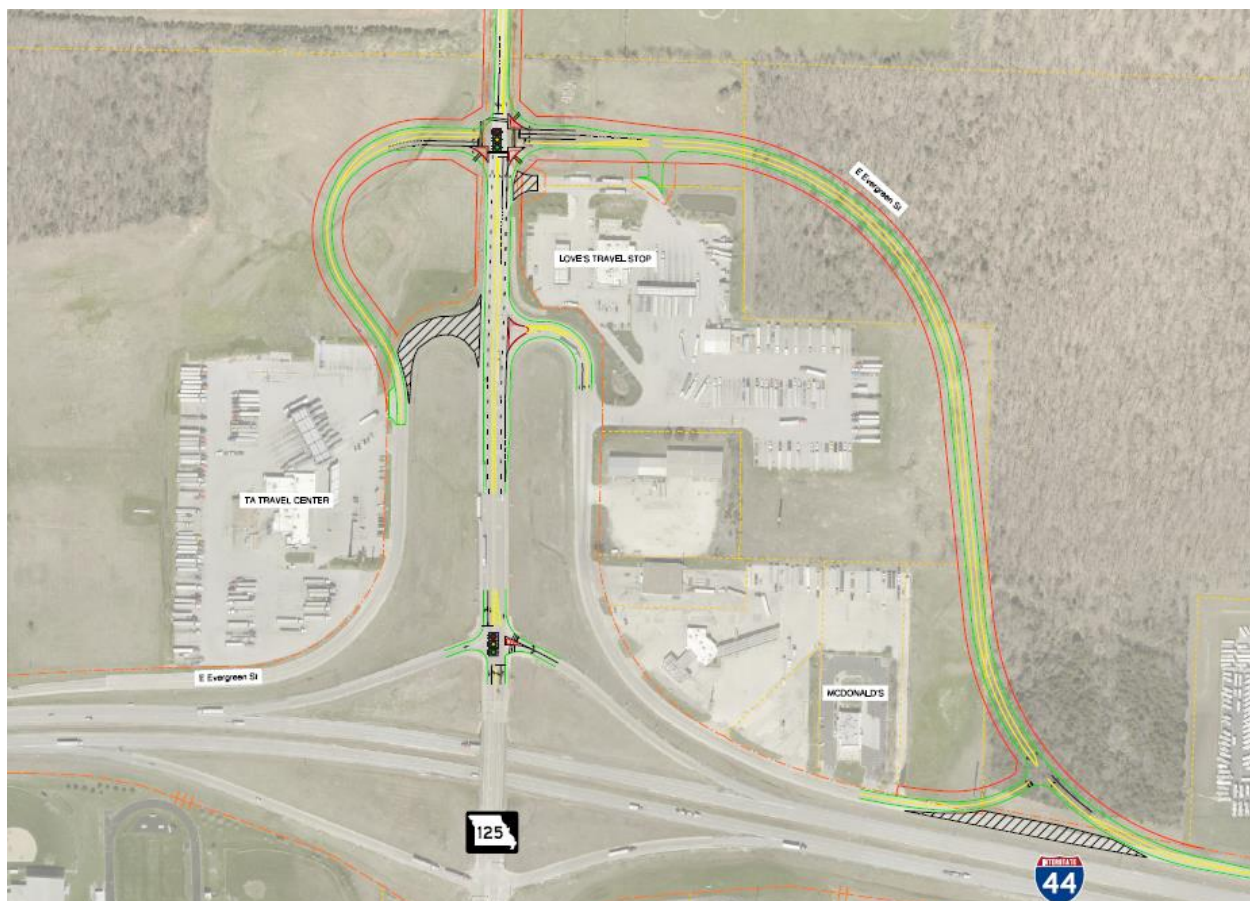
Ultimately, the eight initially proposed alternatives were narrowed down to four final concepts: two concepts focusing on improvements north of the I-44 interchange (Concepts 2 and 3), and two concepts focusing on improvements south of the I-44 interchange (Concepts 4A and 7A). As mentioned previously, each of the concepts excluded any bridge improvements or costs for the Highway 125 bridge over I-44 as its asset life extends beyond the 2024 opening year. As summarized in the following sections, each of the final four concepts were evaluated for constructability, traffic operations, safety, and environmental impacts. See Appendix C (*Traffic Memorandum*), Appendix D (*Safety Analysis Memo*), and Appendix E (*Request for Environmental Services*) for more details.

### Concept 2 – Relocate Evergreen with Traffic Signal

As shown in **Figure 15**, Concept 2 proposes the following:

- Signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Relocation of the Highway 125 and Evergreen Street intersection to the north. The relocated intersection would be signalized.
- Realignment of Evergreen Street on the east side of Highway 125.

**Figure 15: Concept 2 Layout** (See Appendix A for larger version)



## Constructability

The proposed realignment of Evergreen Street could be largely constructed while maintaining existing traffic operations. Installation of the traffic signal at the I-44 Westbound Ramp terminal and at relocated Evergreen Street would also occur with minimal interruption to traffic flows.

## Traffic Analysis

Based on the extents of the concept improvements, two of the study intersections would be impacted operationally: Highway 125 at the I-44 Westbound Ramp terminal and Highway 125 at Evergreen Street. The results of the operational analysis at those two intersections are shown in **Table 1**, along with the future No-Build conditions for comparison. As shown, adding a traffic signal to the I-44 Westbound Ramp terminal intersection is expected to improve operations to LOS D or better during both peak periods, through the design year.

Conversely, the signal at the relocated Evergreen Street would experience slightly worsening levels of service under Concept 2, when compared to No-Build. This is likely due to the signalization of the Westbound Ramp terminal, which would result in three somewhat closely spaced traffic signals along Highway 125 (from Evergreen Street to the I-44 Eastbound Ramp terminal). In the analysis, the cycle lengths for all three intersections were optimized as a coordinated system, resulting in longer cycle lengths and additional delays at Evergreen Street than there would be if that intersection were to be optimized on its own. Additionally, moving the Evergreen Street intersection to the north would cause some minimal shifting of traffic volumes due to maintaining the right-in/right-out access on the east side of Highway 125, which may also contribute to the slight projected worsening of the levels of service. Despite LOS being slightly worse, the Concept 2 conditions are still considered to be operationally acceptable through the 2044 design year.

**Table 1. Concept 2 Operational Results**

		No-Build			Concept 2		
		Control Type	AM LOS	PM LOS	Control Type	AM LOS	PM LOS
<i>Opening Year 2024</i>							
2	Hwy 125 & Evergreen	Signal	C	B	Signal	B	B
3	Hwy 125 & I-44 WB Ramps	TWSC	F (WB)	F (WB)	Signal	C	A
<i>Design Year 2044</i>							
2	Hwy 125 & Evergreen	Signal	D	B	Signal	D	C
3	Hwy 125 & I-44 WB Ramps	TWSC	F (WB)	F (WB)	Signal	D	B

*For TWSC intersections, the LOS for the worst movement is reported.*

### **Safety**

The I-44 Westbound Ramp terminal intersection did not experience a particularly high number of crashes (7) over the five-year analysis period; however, signalization is still expected to improve safety. A 2014 study<sup>1</sup> suggests a crash modification factor (CMF) of 0.61 (a 39% reduction in crashes) as a result of installing a traffic signal.

The relocation of the Evergreen Street intersection to the north is also expected to provide a safety benefit. While there is no specific CMF that can be applied, the *Highway Safety Manual* (HSM) indicates that reducing the number of access points within the functional area of an intersection (or interchange) reduces the potential for crashes<sup>2</sup>. In particular, rear-end crashes related to speed changes near driveways, and angle crashes related to vehicles turning in and out of driveways, can be expected to be reduced.

Additionally, by increasing the weaving distance between the I-44 ramp terminal and Evergreen Street, sideswipe collisions should be reduced as a result of the improvements included in Concept 2.

### **Environmental Considerations**

- The new right-of-way for Evergreen Street makes this concept subject to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, which provides guidelines for the acquisition of affected properties. Potential impacts to the socioeconomics for this concept would need to be considered as more information becomes available.
- The new alignment also qualifies this concept as a Type 1 project under 23 CFR 772 of the U.S. Code of Federal Regulations, which requires noise analysis. There should be few, if any, noise impacts and no needed noise abatement.
- Permanent post-construction stormwater treatment best management practices should be considered.
- Structures within the project limits could have nesting migratory birds, which would require field checks pre-construction.
- Tree clearing for the new alignment of Evergreen Street may impact suitable roosting habitat for the Northern long-eared bat and Indiana bat. Some of the clearing would occur greater than 300 feet outside of existing road alignments, which would require a habitat assessment for both species and submittal of a biological assessment to USFWS.
- There are 686 linear feet of stream (likely ephemeral) and 453 linear feet of roadside ditch/wetlands within the project area that are likely non-jurisdictional under the Clean Water Act.

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<sup>1</sup> *Safety Evaluation of Signal Installation With and Without Left Turn Lanes on Two Lane Rural and Suburban Areas*, Srinivasan Et. Al., 2014.

<sup>2</sup> *Highway Safety Manual*, Appendix 14A – Treatments without CMFs, 14A.3.1.1.

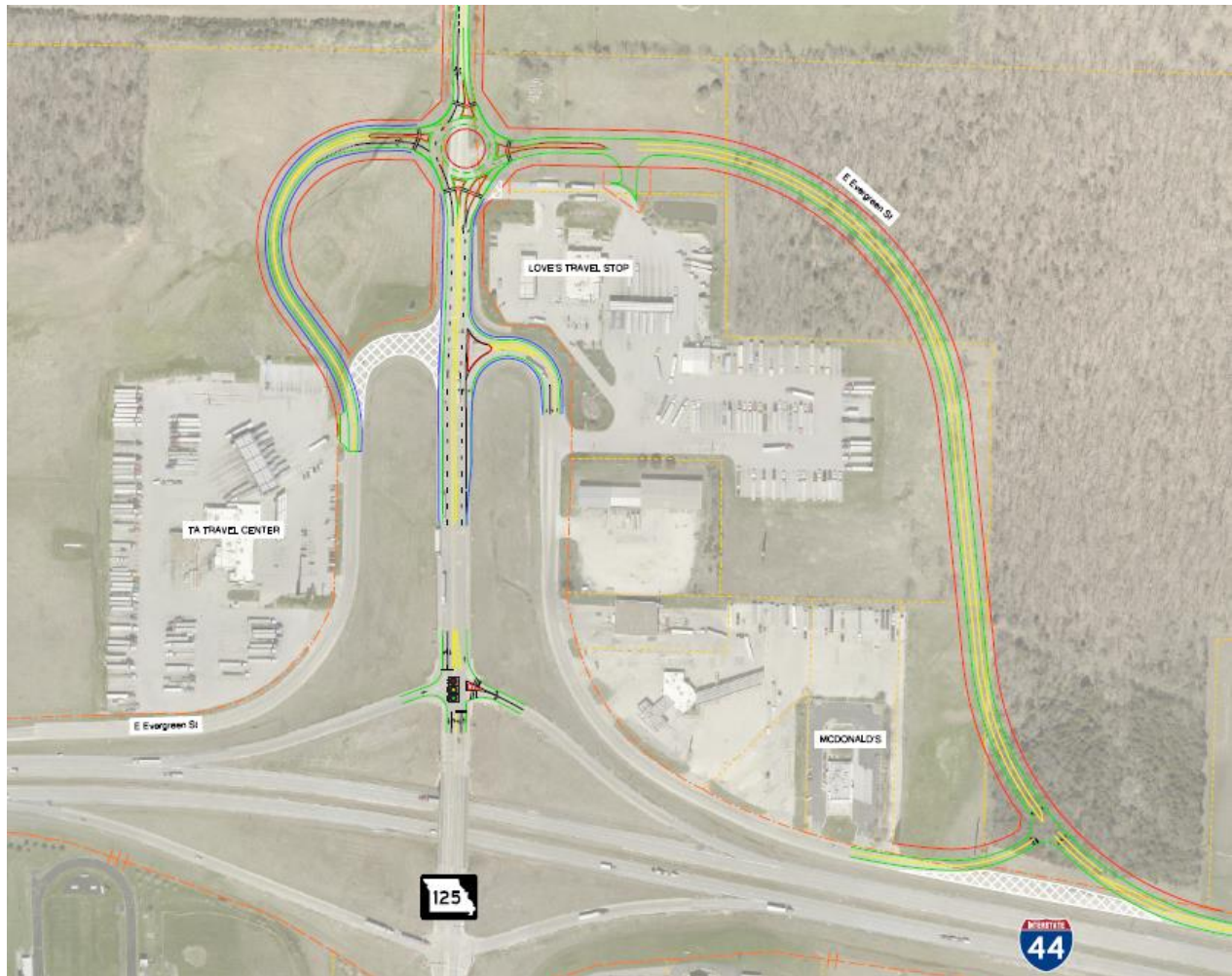


### Concept 3 – Relocate Evergreen with Roundabout

As shown in **Figure 16**, Concept 3 proposes the following:

- Signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Relocation of the Highway 125 and Evergreen Street intersection to the north.
- Construction of the relocated Highway 125 and Evergreen Street intersection as a roundabout.
- Realignment of Evergreen Street on the east side of Highway 125.

**Figure 16: Concept 3 Layout** (See Appendix A for larger version)



### Constructability

The proposed realignment of Evergreen Street could be largely constructed while maintaining existing traffic operations. Unlike Concept 2, in which the relocated Highway 125 / Evergreen Street intersection would be constructed with a signal, Concept 3 would include a roundabout. Construction of that roundabout would require multiple phases of construction for maintenance of through traffic along Highway 125. Installation of the traffic signal at the I-44 Westbound Ramp terminal could occur with minimal interruption to traffic flows.

### Traffic Analysis

Concept 3, like Concept 2, impacts only the intersections on the north side of the I-44 interchange. **Table 2** compares the results of the Concept 3 operational analysis with the No-Build alternative, at the two applicable intersections. The Concept 2 results are also included for reference. As shown, signalization at the Westbound Ramp terminal intersection would improve operations to LOS C or better through the 2044 design year. Despite including the same signalization project for both Concept 2 and 3, the Westbound Ramp terminal shows better projected operations under Concept 3 than Concept 2 because of signal optimization. Under Concept 2, the Evergreen Street signal was analyzed as an optimized coordinated system with the I-44 interchange ramp terminals, leading to longer cycle lengths. Under Concept 3, because Evergreen Street is a roundabout, the I-44 ramp terminals could be optimized independently for a shorter cycle length and fewer delays.

The proposed roundabout at the relocated Evergreen Street intersection is expected to operate at LOS B or better through the design year. During the AM peak hour, the roundabout configuration proposed for Concept 3 shows better operating conditions than the signal proposed for Concept 2 (LOS A/B vs. LOS C/D).

**Table 2. Concept 3 Operational Results**

		No-Build			Concept 2			Concept 3		
		Control Type	AM LOS	PM LOS	Control Type	AM LOS	PM LOS	Control Type	AM LOS	PM LOS
<i>Opening Year 2024</i>										
2	Hwy 125 & Evergreen	Signal	C	B	Signal	B	B	Roundabout	A	A
3	Hwy 125 & I-44 WB Ramps	TWSC	F (WB)	F (WB)	Signal	C	A	Signal	A	B
<i>Design Year 2044</i>										
2	Hwy 125 & Evergreen	Signal	D	B	Signal	D	C	Roundabout	B	B
3	Hwy 125 & I-44 WB Ramps	TWSC	F (WB)	F (WB)	Signal	D	B	Signal	C	B

*For TWSC intersections, the LOS for the worst movement is reported.*



## **Safety**

As stated for Concept 2, signalization of the currently stop-controlled I-44 Westbound Ramp terminal intersection is expected to reduce crashes and increase safety. Additionally, moving the Evergreen Street intersection to the north, away from the functional area of the interchange, and increasing the weaving distance between I-44 and Evergreen Street, should also help reduce crashes.

The inclusion of the roundabout in Concept 3 introduces additional safety benefits for the relocated Highway 125 / Evergreen Street intersection. A 2011 study<sup>3</sup> places a CMF of 0.79 (a 21% crash reduction) on projects that convert a signalized intersection to a modern roundabout. However, most research on the safety of roundabouts is applicable to single lane roundabouts. Since the configuration proposed under Concept 3 would include multiple lanes on some approaches, the full safety potential may not be reached, particularly early on, before drivers become familiar with the intersection layout. Certain safety benefits can still be expected, however; for example, by eliminating traditional left turns at the intersection, the possibility of left-turn crashes would be removed. The yield conditions of a roundabout may also help reduce the number of rear-end collisions, as drivers will expect traffic to slow down when approaching the roundabout.

## **Environmental Considerations**

This concept would have the same environmental considerations as Concept 2 above.

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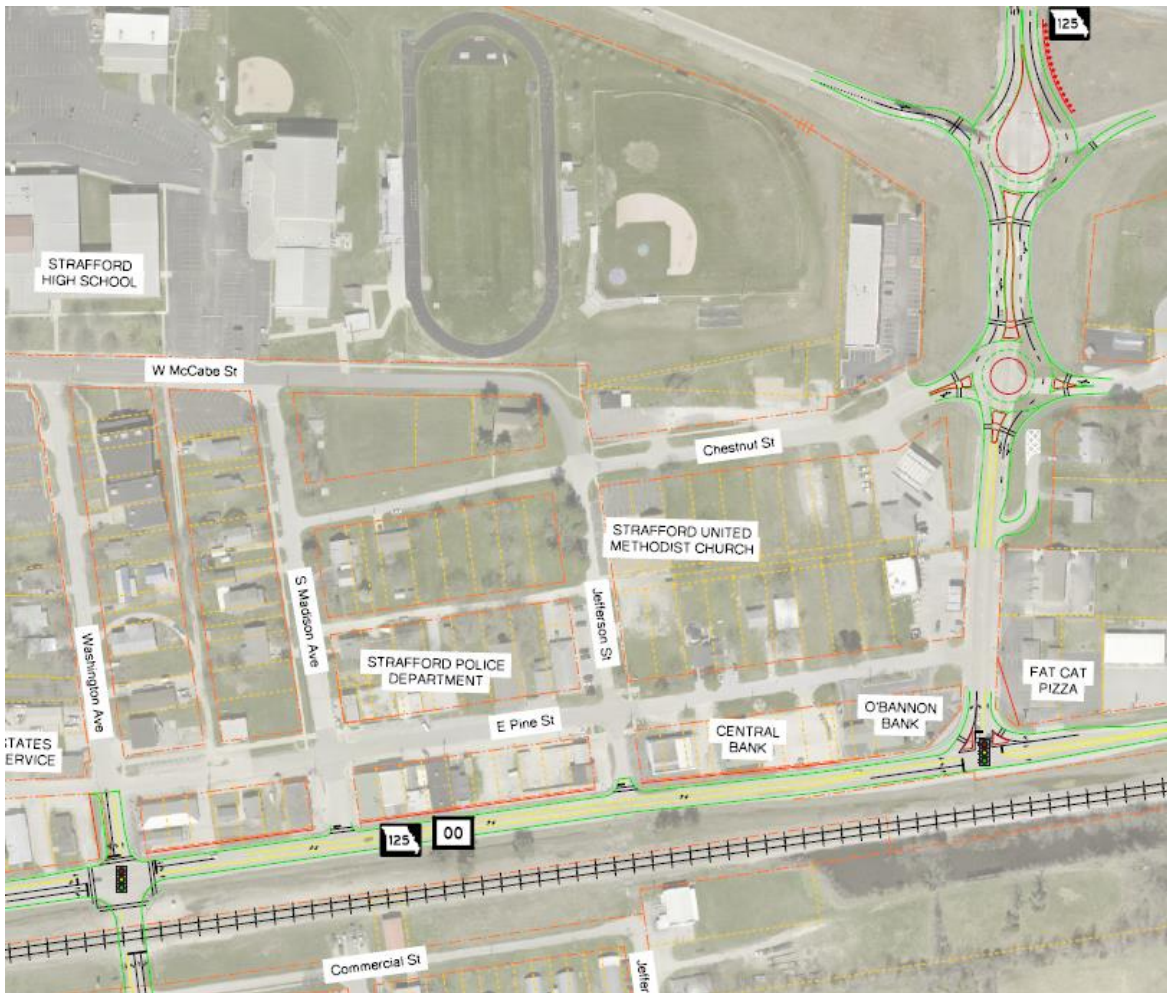
<sup>3</sup> *Evaluation of Safety Strategies at Signalized Intersections*, Srivivasan, Et. Al., 2011.

## Concept 4 – Three-Lane Roadway between Washington and Highway 00 with Traffic Signals

As described under the Alternatives Development section, the originally proposed Concept 4 design was eliminated from further analysis, due to movement restrictions at Chestnut Street. Concept 4A was carried forward and has been renamed as Concept 4. The revised Concept 4 includes the following elements, shown in **Figure 17**:

- Widen Highway 125 to provide a continuous three-lane section between the Highway 00 intersection and the Washington Avenue / Olive Street intersection (portions of this segment are already 3 lanes).
- Signalization of the Highway 125 at Washington Avenue intersection.
- Signalization of the Highway 125 at Highway 00 intersection.
- Construction of a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal.
- Construction of a roundabout at the Highway 125 and Chestnut Street intersection.

**Figure 17: Concept 4 Layout** (See Appendix A for larger version)



### Constructability

Widening of Highway 125 will likely occur to the south and can be constructed with minimal interruption to existing traffic flows. Similarly, the installation of the two traffic signals can occur while existing operations are maintained. Construction of the two roundabouts, however, will require multiple complex construction phases to allow for maintenance of traffic.

### Traffic Analysis

Concept 4 has potential traffic impacts on five study intersections, all located south of I-44.

**Table 3** compares the operational results of the Concept 4 improvements at those five intersections to the operational results of the No-Build concept. As shown, the proposed roundabouts at the Eastbound Ramp terminal intersection and the Chestnut Street intersection are expected to improve operations to LOS A/B for both peak periods through the 2044 design year.

Additionally, the proposed signals at the Highway OO intersection and the Washington Avenue intersection are expected to improve operations to LOS D or better for both peak periods through the 2044 design year.

At the Jefferson Street intersection, the addition of the third lane (TWLTL) along Highway 125 would allow southbound left-turning traffic to make a two-stage left turn, improving operations for that movement, particularly in the design year, when traffic opposing that move is expected to be much higher.

**Table 3. Concept 4 Operational Results**

		No-Build			Concept 4		
		Control Type	AM LOS	PM LOS	Control Type	AM LOS	PM LOS
<i>Opening Year 2024</i>							
4	Hwy 125 & I-44 EB Ramps	Signal	C	C	Roundabout	A	A
5	Hwy 125 & Chestnut	TWSC	F (EB)	C (EB)	Roundabout	A	A
6	Hwy 125 & Rte. 66 (Hwy OO)	TWSC	F (SB)	F (SB)	Signal	C	C
7	Hwy 125 & Jefferson St	TWSC	B (SB)	C (SB)	TWSC	B (SB)	B (SB)
8	Hwy 125 & Washington Ave	TWSC	F (NB)	F (NB)	Signal	C	D
<i>Design Year 2044</i>							
4	Hwy 125 & I-44 EB Ramps	Signal	C	D	Roundabout	A	B
5	Hwy 125 & Chestnut	TWSC	F (EB)	F (EB)	Roundabout	A	A
6	Hwy 125 & Rte. 66 (Hwy OO)	TWSC	F (SB)	F (SB)	Signal	C	C
7	Hwy 125 & Jefferson St	TWSC	D (SB)	E (SB)	TWSC	C (SB)	C (SB)
8	Hwy 125 & Washington Ave	TWSC	F (NB)	F (NB)	Signal	D	D

*For TWSC intersections, the LOS for the worst movement is reported.*

### **Safety**

Constructing a three-lane section along Highway 125 will have safety benefits both by creating a buffer between opposing traffic flows, and by separating left-turning vehicles to eliminate slowing or stopping in the through traffic lane. A study on the safety effectiveness of turn lanes<sup>4</sup> details a CMF of 0.52 (a 48% crash reduction) for providing left turn lanes on both major-road approaches to an intersection, as would be the new configuration at the Highway 125 / Jefferson Street intersection.

As discussed previously, there are widely accepted CMFs for installing a traffic signal (0.61 at a 4-leg intersection and 0.72 at a 3-leg intersection). Therefore, both of the intersections for which signals are proposed in Concept 4 should experience a safety benefit. As described previously, the Highway 125 and Washington Avenue intersection reported the most crashes (and highest crash rate) during the five-year analysis period, including a high incidence of right-angle crashes. Signalization at this intersection should improve safety by lowering the instances of these crashes.

The conversion of an intersection with minor-road stop control to a modern roundabout provides a CMF of 0.81 (a 19% reduction in crashes), according to *NCHRP Report 572*. This CMF would be applicable to the roundabout proposed at Chestnut Street. As discussed under Concept 3, the conversion of a signal to a roundabout, as is proposed at the I-44 Eastbound Ramp terminal, is also expected to improve safety, with a CMF of 0.79. While multi-lane roundabouts (as proposed under this concept) have not shown as great a safety benefit as single lane roundabouts, especially when driver-familiarity is low, certain crash types can still be expected to be reduced.

### **Environmental Considerations**

- Concept 4 has the potential to impact cultural resources along Highway 125, which is part of an old Route 66 alignment and will require an archaeological and architectural survey with submittal to the State Historic Preservation Officer.
- The Historic Route 66 Park and Strafford High School are located adjacent to the alignment, and additional right-of-way from these public lands would trigger Section 4(f)/6(f) documentation.
- Structures exist within the project area that may host nesting migratory birds and would require field checks prior to construction.
- Aerial imagery indicates possible wetlands south of the Highway 125 and OO intersection that would require a field-check.

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<sup>4</sup> *Safety Effectiveness of Intersection Left- and Right-Turn Lanes*, Harwood Et. Al., 2002.



## Concept 7 – Construct new road south to Bumgarner Boulevard and Signalize Washington Avenue and Highway OO intersections

As described under the Alternatives Development section, the originally proposed Concept 7 design was eliminated from further analysis, due to movement restrictions at Chestnut Street. Concept 7A was carried forward and has been renamed as Concept 7. The revised Concept 7 includes the following elements, shown in **Figure 18**:

- Construction of a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal.
- Construction of a roundabout at the Highway 125 and Chestnut Street intersection.
- Signalization of the Highway 125 / Washington Avenue intersection, and closure of the south leg to eliminate the at-grade rail crossing.
- Signalization of the Highway 125 / Highway OO intersection, and addition of a fourth leg extending south to Bumgarner Boulevard. This would create a new at-grade rail crossing just south of Highway 125.

**Figure 18: Concept 7 Layout** (See Appendix A for larger version)



### Constructability

Installation of the two proposed traffic signals, as well as the construction of the new road south to Bumgarner Boulevard, are expected to occur with minimal interruption to existing traffic flows. Construction of the two roundabouts, however, will likely require multiple complex construction phases to allow for maintenance of traffic.

### Traffic Analysis

The operational analysis of Concept 7 includes the same five intersections that were included in Concept 4. **Table 4** provides the operational results of the Concept 7 improvements at those impacted intersections. However, it should be noted that these results do not present a fair comparison to the No-Build results because Concept 7 was analyzed without a key element included in the baseline volumes. As described in Appendix C, the site trips generated by the approved Stafford Industrial Park development were included in the No-Build analysis but not in Concept 7. This was due, in part, to the timing of the analysis. By the time those site trips were determined to be needed to fairly assess future conditions, Concept 7 had already been deemed unlikely to be selected for further consideration. Therefore, the Concept 7 volumes were not modified, and the analysis was not updated to include those baseline modifications.

As indicated in the table, the improvements included in Concept 7 are expected to provide acceptable operations, at each of the applicable intersections, through the design year. However, if this Concept is determined to be viable at some point in the future, the analysis should be updated to ensure acceptable operations could still be maintained with the additional industrial park site trips.

**Table 4. Concept 7 Operational Results\***

		Concept 7		
		Control Type	AM LOS	PM LOS
<i>Opening Year 2024</i>				
4	Hwy 125 & I-44 EB Ramps	Roundabout	A	A
5	Hwy 125 & Chestnut	Roundabout	A	A
6	Hwy 125 & Rte. 66 (Hwy 00)	Signal	C	B
7	Hwy 125 & Jefferson St	TWSC	B (SB)	B (SB)
8	Hwy 125 & Washington Ave	Signal	B	A
<i>Design Year 2044</i>				
4	Hwy 125 & I-44 EB Ramps	Roundabout	A	B
5	Hwy 125 & Chestnut	Roundabout	A	A
6	Hwy 125 & Rte. 66 (Hwy 00)	Signal	C	B
7	Hwy 125 & Jefferson St	TWSC	B (SB)	B (SB)
8	Hwy 125 & Washington Ave	Signal	D	A

*For TWSC intersections, the LOS for the worst movement is reported.*

*\*See text for why a comparison to No-Build is not provided.*

## **Safety**

As noted under the Concept 4 discussion, the conversion of an intersection from minor-road stop control to a modern roundabout provides measurable safety benefits, as does the installation of traffic signals to both 3-leg and 4-leg intersections. Therefore, the installation of each of the roundabouts and traffic signals proposed in Concept 7 should lead to reduced crashes.

Unlike Concept 4, Concept 7 does not include widening of Highway 125 to include three lanes, therefore the safety benefits incurred at Jefferson Street from the addition of major road left-turn lanes would not be realized.

Any safety benefits resulting from the closure of the at-grade rail crossing on Washington Avenue / Olive Street would be offset by the construction of a new at-grade crossing on the proposed southern extension of Highway 125.

## **Environmental Considerations**

- Concept 7 has the potential to impact cultural resources along Highway 125, which is part of an old Route 66 alignment and will require an archaeological and architectural survey with submittal to the State Historic Preservation Officer.
- Strafford High School is located adjacent to the alignment, and additional right-of-way from the school would trigger Section 4(f)/6(f) documentation.
- The extension south to Bumgarner Road would require new right-of-way and thus mandate a noise study as well as appropriate public involvement as defined by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.
- Approximately 0.387 acres of wetland impacts are possible south of the Highway 125 and Highway OO intersection, which would trigger a nationwide permit and preconstruction notification. A wetland delineation would be necessary to confirm the potential impacts to wetlands.
- Tree clearing for this concept would be necessary, which could impact suitable roosting habitat for the Northern long-eared bat and Indiana bat. All tree clearing sites are within 300 feet of existing right-of-way and would fall under USFWS FRA/FHWA Section 7 Range-wide Programmatic consultation for Indiana and Northern long-eared bats. Thus, consultation with USFWS would not be required.

## Concept Comparison

To compare the improvement concepts and help arrive at a recommendation, each of the four final concepts was rated (positive / neutral / negative) based on its potential impacts to each of the four assessment criteria: Constructability, Traffic Operations, Safety, and Environmental Considerations, see **Table 5**. The estimated costs of each concept are shown in more detail in Appendix B.

As shown, among the two potential concepts proposed for north of I-44, Concept 2 ranks best for constructability because construction of a signal would cause very little disruption to existing traffic flows, as opposed to the roundabout proposed in Concept 3. Concept 3 ranks slightly better for traffic operations and safety, although both concepts are expected to operate acceptably, and both are expected to achieve some level of improved safety. Due to the nature of both concepts building upon new alignments, both would have fairly extensive environmental considerations and are therefore both ranked negatively for impacts in that category.

For the two concepts proposed to the south of I-44, both rank poorly for constructability, mainly due to the two roundabouts proposed under both concepts (at the I-44 eastbound off-ramp and at Chestnut Street). As mentioned in the sections above, Concept 7 was not analyzed with the same background volume assumptions; therefore, a proper comparison of traffic operations cannot be made. However, it is assumed that both concepts would meet minimum levels for acceptable operations. In terms of safety, Concept 4 has a slight edge over Concept 7 because of the proposed third lane along Highway 125, which can be expected to help reduce crashes. Concept 4 also ranks better in terms of environmental considerations because the improvements are all proposed along the existing alignment.

**Table 5. Concept Comparison**

[ Legend: + positive, o neutral, -- negative ]

	Constructability	Traffic Operations	Safety	Environmental	Estimated Cost
<b>Concepts for North of I-44</b>					
<b>Concept 2</b> – Relocate Evergreen with Traffic Signal	+	o	o	--	\$10,443,000
<b>Concept 3</b> – Relocate Evergreen with Roundabout	o	+	+	--	\$10,002,000
<b>Concepts for South of I-44</b>					
<b>Concept 4</b> – Widen Highway 125 to three lanes; Signalize Washington and Highway OO intersections	--	o*	+	o	\$4,767,000
<b>Concept 7</b> – Construct new road to south; Signalize Washington and Highway OO intersections	--	o*	o	--	\$6,158,000

*\*The operational analysis results of Concepts 4 and 7 should not be compared directly, due to volume differences attributed to the proposed Stafford Industrial Park. However, both concepts are generally expected to be able to provide acceptable operations.*



## Estimated Costs

The estimated costs for Concepts 1, 2, 3, 4, 7, and 8 are tabulated in **Appendix B**. Concepts 2 and 3 include the costs for Concept 1. Concepts 4 and 7 include the costs for Concept 8. Right-of-way cost estimates were provided by MoDOT staff for all concepts. Utility costs were set at 2 percent of the construction total. Construction costs for all concepts include sidewalks/ADA ramps at the intersections and intersection streetlighting. Continuous sidewalks and streetlighting were excluded. It was assumed that existing concrete roadways would be replaced with concrete and existing asphalt roadways would be replaced with asphalt. A contingency of 10 percent was included for each concept.

**Table 6** is a summary of the estimated total project cost in 2021 dollars.

**Table 6. Total Estimated Project Costs**

	Concept 1	Concept 2	Concept 3	Concept 4	Concept 7	Concept 8
Construction	\$285,020	\$4,876,920	\$4,582,900	\$2,969,670	\$3,846,190	\$1,655,400
Contingency (10%)*	\$26,710	\$457,070	\$429,520	\$278,320	\$360,470	\$155,150
<b>Construction Sub-Total</b>	<b>\$311,730</b>	<b>\$5,333,990</b>	<b>\$5,012,420</b>	<b>\$3,247,990</b>	<b>\$4,206,660</b>	<b>\$1,810,550</b>
Right-of-Way	\$0	\$3,135,000	\$3,135,000	\$155,000	\$185,000	\$0
Utilities (2%)	\$6,230	\$106,680	\$100,250	\$64,960	\$84,130	\$36,210
Design Engineering (20%)	\$62,350	\$1,066,800	\$1,002,480	\$649,600	\$841,330	\$362,110
Construction Engineering (15%)	\$46,760	\$800,100	\$751,860	\$487,200	\$631,000	\$271,580
Railroad Coordination (5%)	\$0	\$0	\$0	\$162,400	\$210,330	\$0
<b>Total</b>	<b>\$427,000</b>	<b>\$10,443,000</b>	<b>\$10,002,000</b>	<b>\$4,767,000</b>	<b>\$6,158,000</b>	<b>\$2,480,000</b>

\*The 10% contingency is not applied to the Mobilization (5%) or Contractor Furnished Surveying and Staking (1.09%) items in the Construction costs.

## Next Steps

Each of the four final concepts will be taken through a public involvement process to help narrow down the concepts to a final recommendation.

A final recommendation will be documented in the project's Conceptual Study Report (CSR). Selected concepts should be programmed in the Statewide Transportation Improvement Program (STIP) document to allocate funding.

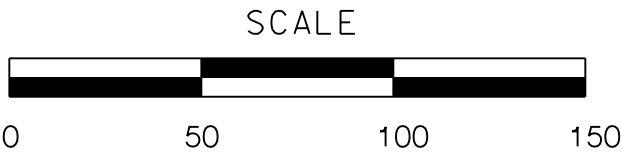
## Appendix A

### Concept Exhibits





STRAFFORD CONCEPT 1  
MoDOT Job No. J8S3238



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DATE

DATE PREPARED  
1/24/2022

ROUTE 125	STATE MO
DISTRICT SW	SHEET NO.

COUNTY  
GREENE

JOB NO.  
J8S3238

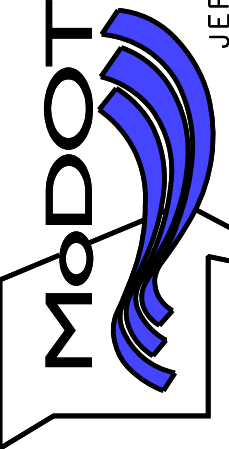
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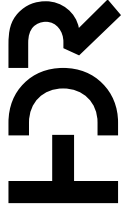
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DESCRIPTION	DATE

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JEFFERSON CITY, MO 65102  
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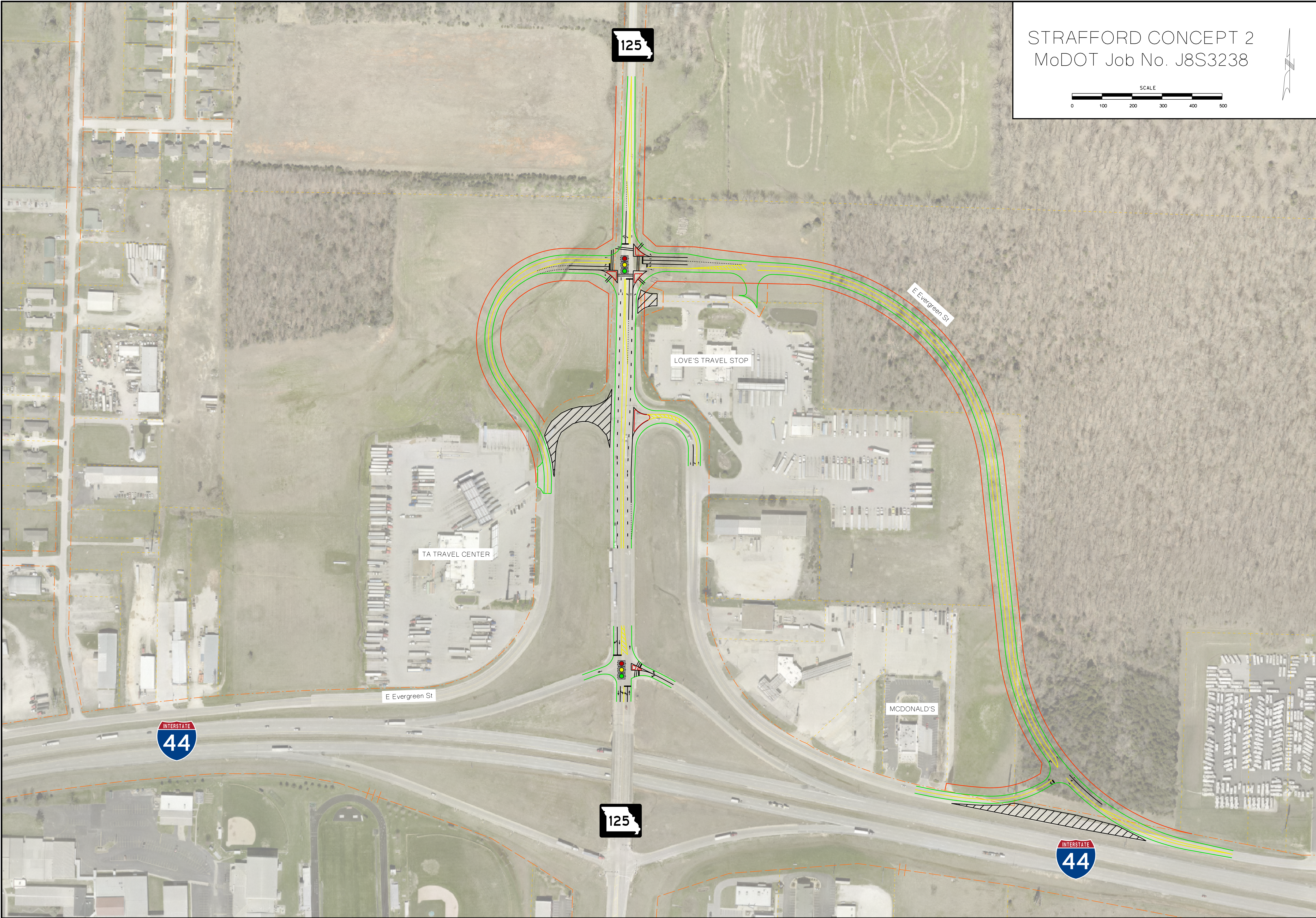


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Springfield, MO 65804  
(803) 909-2200

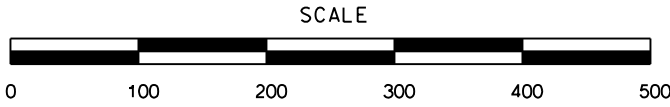
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STRAFFORD CONCEPT 2  
MoDOT Job No. J8S3238



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DISTRICT SW	SHEET NO.
COUNTY GREENE	
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PROJECT NO.	
BRIDGE NO.	

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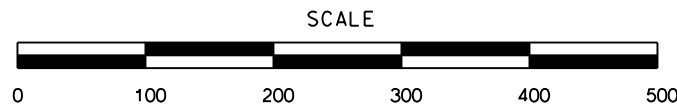
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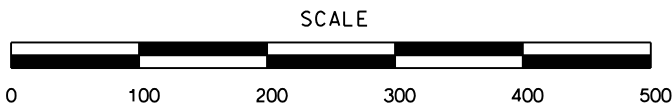
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COUNTY GREENE	
JOB NO. J8S3238	
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PROJECT NO.	
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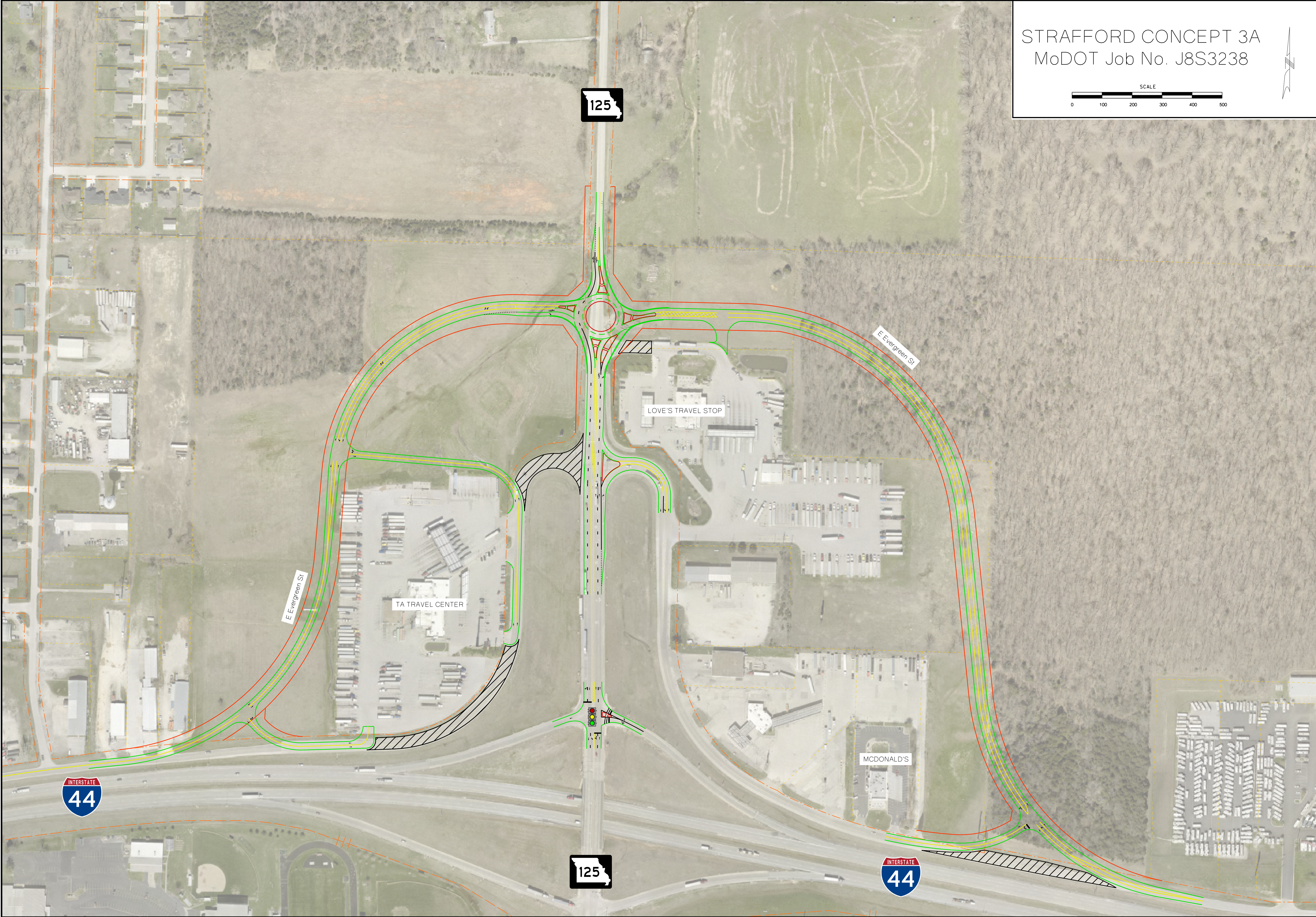
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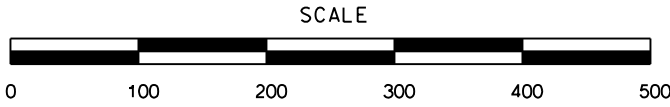
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1/21/2022

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COUNTY GREENE	
JOB NO. J8S3238	
CONTRACT ID.	
PROJECT NO.	
BRIDGE NO.	

DESCRIPTION	DATE

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION

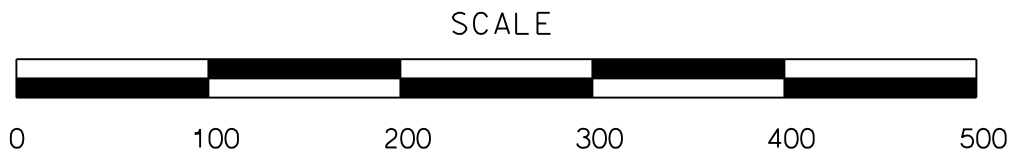
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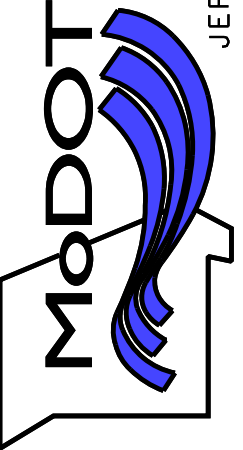
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COUNTY GREENE	
JOB NO. J8S3238	
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PROJECT NO.	
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JOB NO. J8S3238	
CONTRACT ID.	
PROJECT NO.	
BRIDGE NO.	

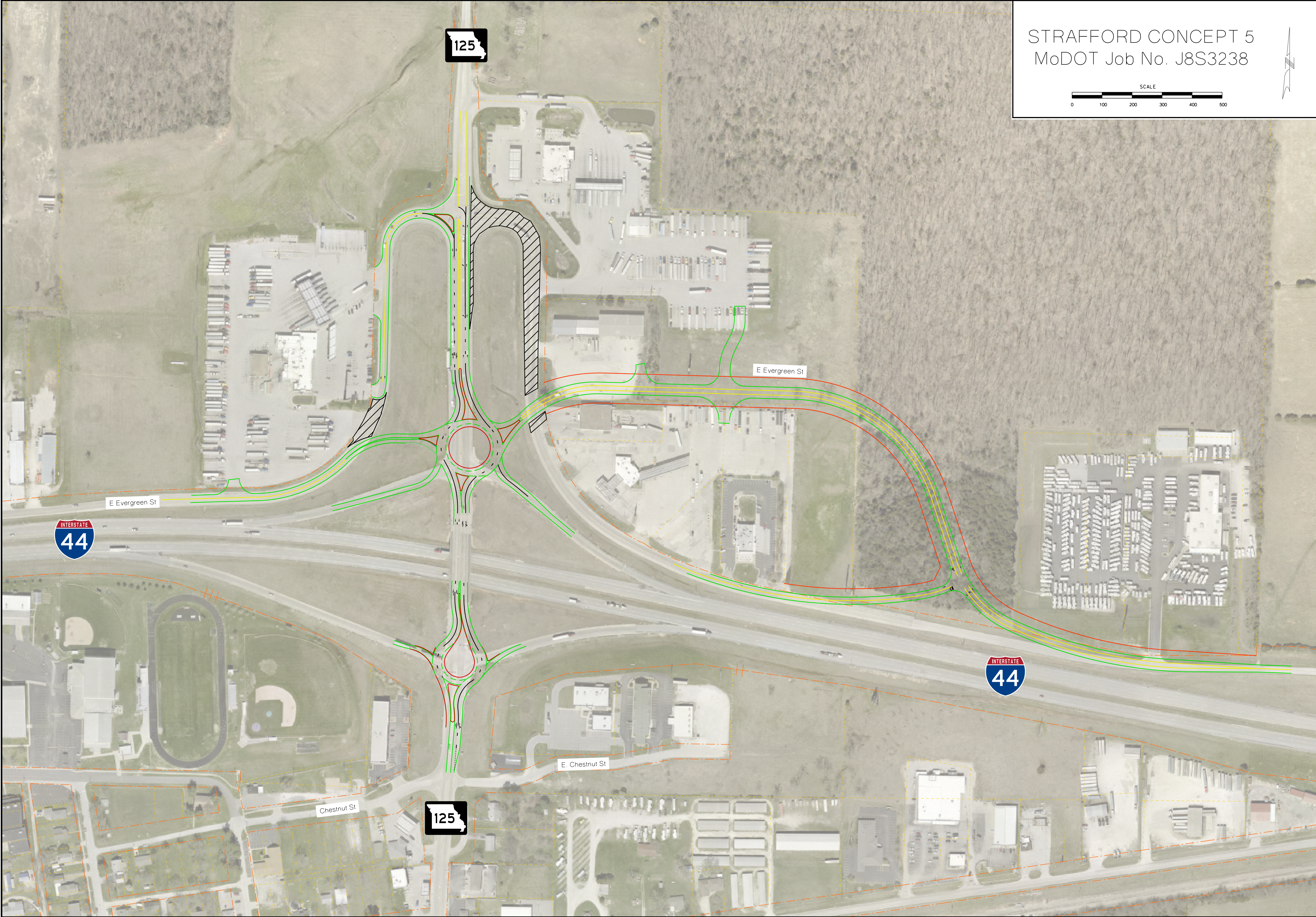
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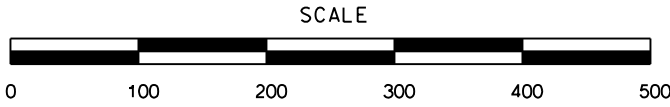
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PROJECT NO.	
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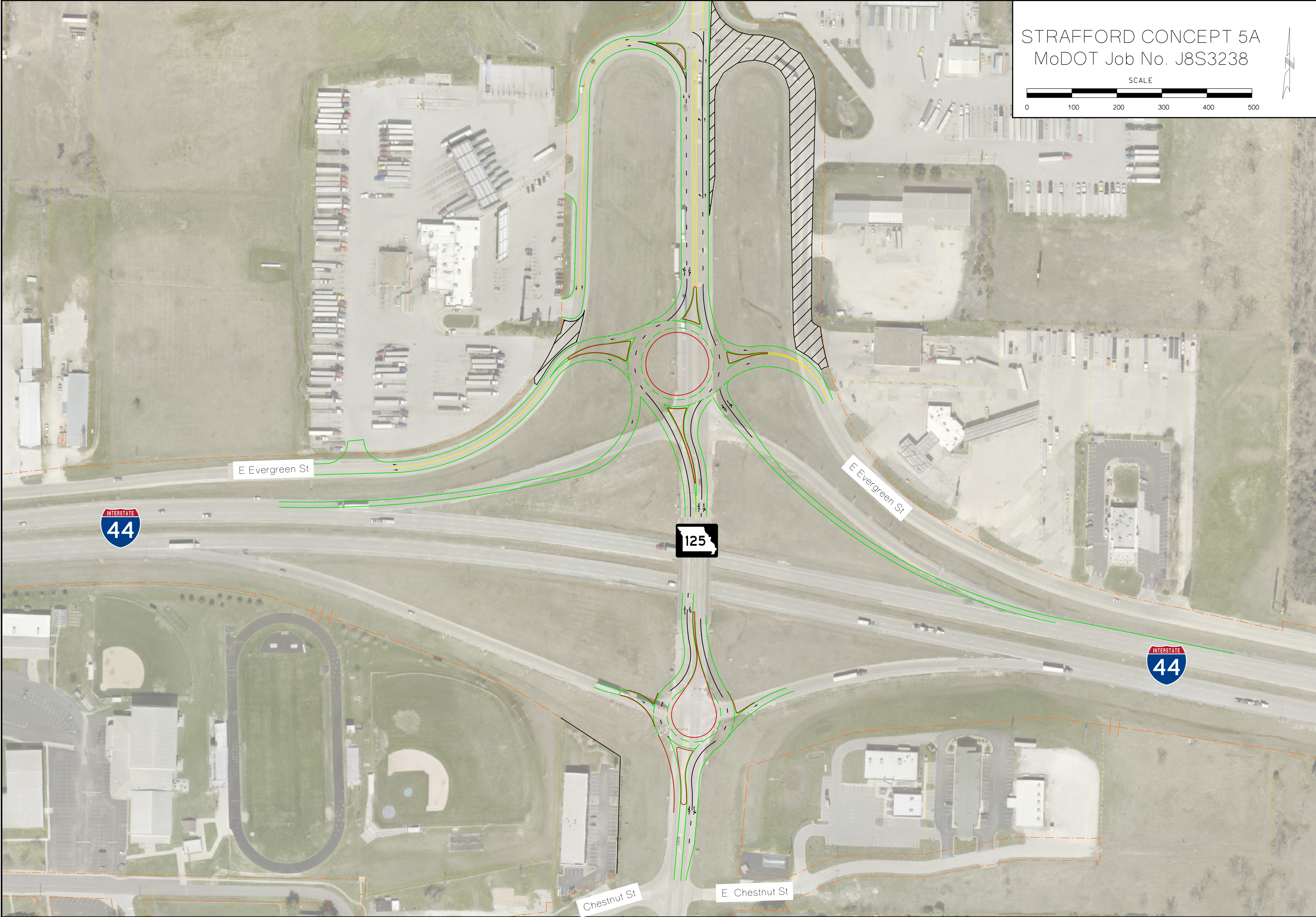
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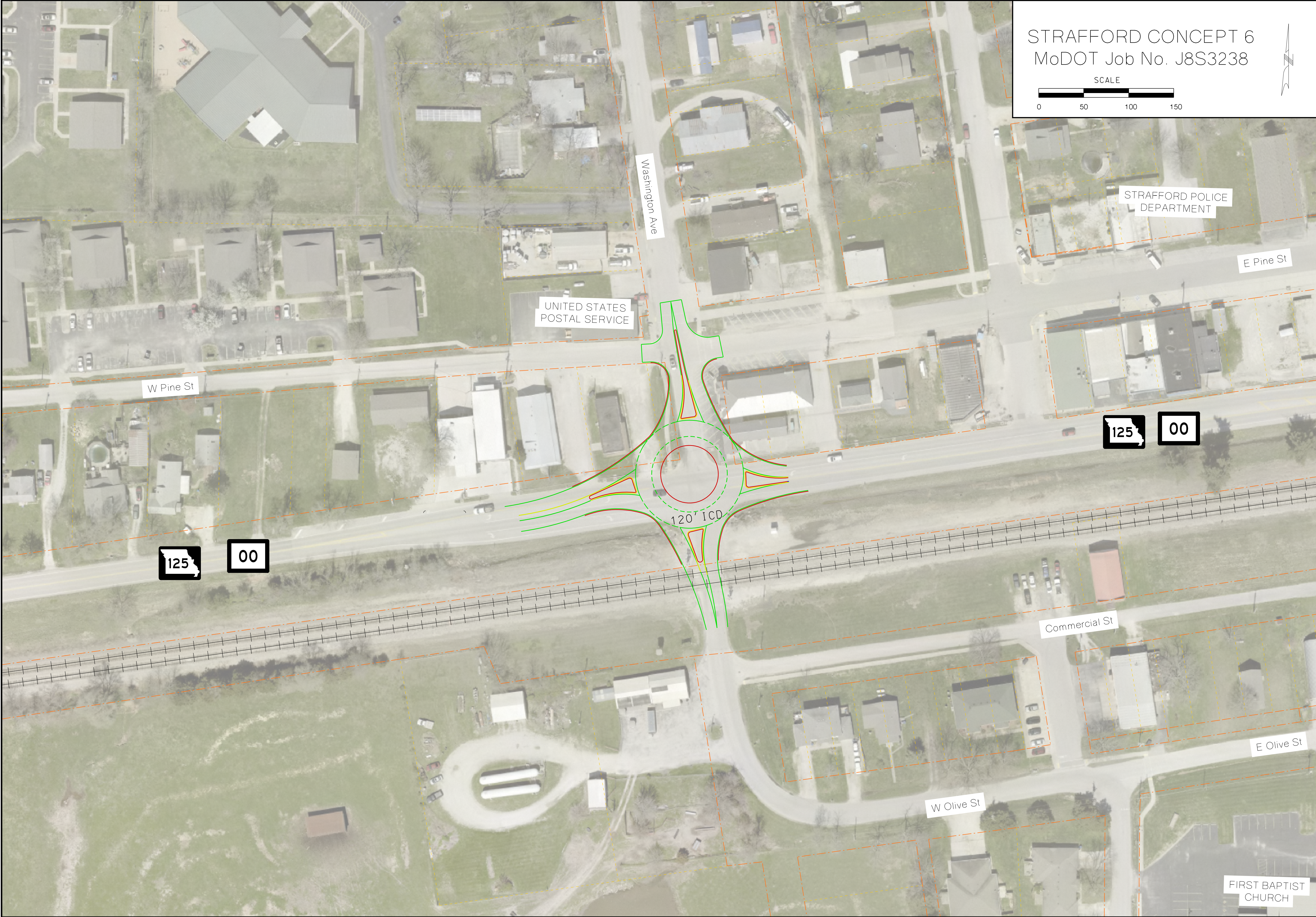
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DISTRICT SW	SHEET NO.

COUNTY  
GREENE

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J8S3238

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DESCRIPTION	DATE

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ROUTE  
125

DISTRICT  
SW

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MO

SHEET NO.

COUNTY  
GREENE

JOB NO.  
J8S3238

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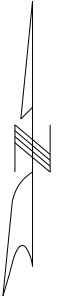
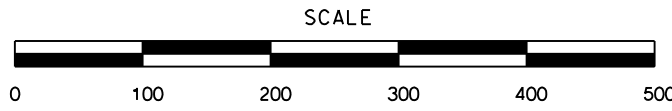
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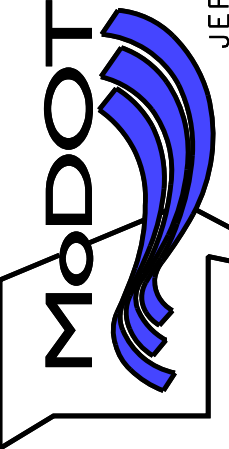
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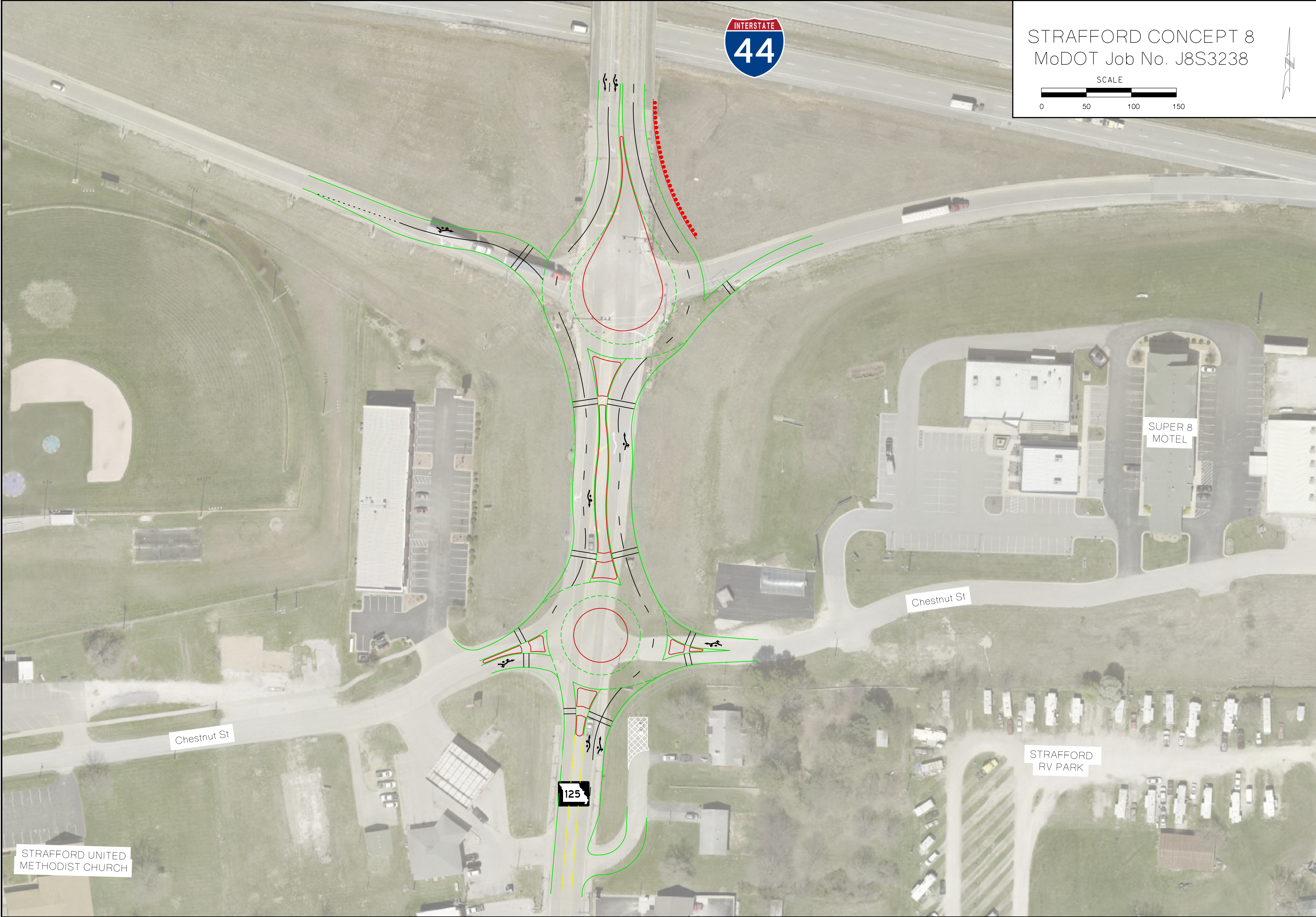
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DISTRICT SW SHEET NO.

COUNTY  
GREENE

JOB NO.  
J8S3238  
CONTRACT ID.

PROJECT NO.

BRIDGE NO.

DESCRIPTION	DATE

MISSOURI HIGHWAYS AND TRANSPORTATION  
COMMISSION

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## Appendix B

### Cost Estimates



Category	Item	Unit	BidTabs Avg Price	Concept 1		Concept 2		Concept 3		Concept 4		Concept 7		Concept 8	
				Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension
ROADWAY															
2013000	Clearing and Grubbing	AC	\$3,692.18	0	\$0	9	\$33,229.62	9	\$33,229.62	0	\$0	3	\$11,076.54	0	\$0
2022010	MISC. {Removal of RR XING}	LS	\$5,000	0	\$0	0	\$0	0	\$0	1	\$5,000	1.0	\$5,000.00	0	\$0
2029905	MISC. {Removal of Pavement}	SY	\$15	0	\$0	2266.1	\$33,991.50	2,010.0	\$30,150.00	0	\$0	1,042.7	\$15,640.50	0	\$0
2035000	Unclassified Excavation	C.Y.	\$17.59	0	\$0	8768	\$154,229.12	9,064	\$159,435.76	500	\$8,795.00	1,926	\$33,878.34	100	\$1,759.00
2035500	Embankment in Place	C.Y.	\$20.99	0	\$0	6,783	\$142,375.17	5,861	\$123,022.39	7,092	\$148,861.08	11,034	\$231,603.66	7,367	\$154,633.33
2036000	Compacting Embankment	C.Y.	\$6.73	0	\$0	6576	\$44,256.48	6,798	\$45,750.54	375	\$2,523.75	1,445	\$9,724.85	75	\$504.75
3040506	Type 5 Aggregate for Base (6 IN. Thick)	SY	\$9.26	0	\$0	30477	\$282,217.02	28,012	\$259,391.12	10,514	\$97,359.64	22,939	\$212,415.14	8,950	\$82,877.00
4010150	Type A2 Shoulder	SY	\$31.57	0	\$0	55.6	\$1,755.29	55.6	\$1,755.29	400.0	\$12,628.00	222.2	\$7,014.85	0	\$0
4030103	Asphaltic Concrete Mixture PG 70-22 (SP125C MIX)	TONS	\$69.32	0	\$0	246.7	\$17,101.24	246.7	\$17,101.24	1,056.6	\$73,243.51	723.6	\$50,159.95	0.0	\$0.00
4030208	Asphaltic Concrete Mixture PG 70-22 (SP190C MIX)	TONS	\$61.71	0	\$0	246.7	\$15,223.86	246.7	\$15,223.86	157.5	\$9,719.33	0.0	\$0.00	0.0	\$0.00
4030308	Asphaltic Concrete Mixture PG 70-22 (SP250C MIX)	TONS	\$138.00	0	\$0	740.2	\$102,147.60	740.2	\$102,147.60	472.5	\$65,205.00	2,170.7	\$299,556.60	0.0	\$0.00
5021310	Concrete Pavement (10 IN. Non-Reinforced 15 FT. Joints)	SY	\$95.00	0	\$0	28234.2	\$2,682,249.00	25,769.3	\$2,448,083.50	8,950.4	\$850,288.00	10,580.1	\$1,005,109.50	8,950.4	\$850,288.00
5021340	Type A2 Shoulder	SY	\$55.00	0	\$0	3235.2	\$177,936.00	3,111.1	\$171,110.50	288.9	\$15,889.50	292.2	\$16,071.00	111.1	\$6,110.50
6069901	MISC. {Guardrail}	LS	\$10,000	0	\$0	0	\$0	0	\$0	1	\$10,000.00	1	\$10,000.00	1	\$10,000.00
6081000	Concrete Median	SY	\$44.28	24.7	\$1,093.72	381.1	\$16,875.11	1,116.7	\$49,447.48	699.8	\$30,987.14	685.9	\$30,371.65	638.7	\$28,281.64
6086004	Sidewalk	SY	\$49.20	0	\$0	48.1	\$2,366.52	343.3	\$16,890.36	1,611.5	\$79,285.80	1,543.3	\$75,930.36	637.6	\$31,369.92
6091051	Curb and Gutter Type A	LF	\$47.20	0	\$0	0	\$0.00	380	\$17,936.00	750	\$35,400.00	750	\$35,400.00	750	\$35,400.00
6091052	Curb and Gutter Type B	LF	\$29.52	0	\$0	50	\$1,476.00	1,160	\$34,243.20	3,200	\$94,464.00	4,570	\$134,906.40	1,400	\$41,328.00
6181000	Mobilization (5%)	LS	-	1	\$14,691.98	1	\$251,389.76	1	\$236,233.96	1	\$153,076.97	1	\$198,258.89	1	\$85,330.92
6274000	Contractor Furnished Surveying and Staking (1.09%)	LS	-	1	\$3,202.85	1	\$54,802.97	1	\$51,499.00	1	\$33,370.78	1	\$43,220.44	1	\$18,602.14
DRAINAGE	Item	Unit	Price												
7279901	MISC. {Drainage System}	LS	-	0	\$0	1	\$37,500.00	1	\$86,100.00	1	\$256,100.00	1	\$328,100.00	1	\$108,100.00
LIGHTING	Item	Unit	Price												
9019901	MISC. {Lighting}	LS	-	0	\$0	1	\$144,000.00	1	\$156,000.00	1	\$171,000.00	1	\$246,000.00	1	\$93,000.00
SIGNALS															
9029901	MISC. {Signals}	EA	\$250,000	1	\$250,000.00	2	\$500,000.00	1	\$250,000.00	2	\$500,000.00	2	\$500,000.00	0	\$0
9029901	MISC. {RR Xing Signal}	EA	\$100,000	0	\$0	0	\$0	0	\$0	1	\$100,000	1	\$100,000.00	0	\$0
SIGNING															
9039901	MISC. {Signing}	LS	-	1	\$2,000.00	1	\$6,000.00	1	\$9,000.00	1	\$16,000.00	1	\$17,000.00	1	\$10,000.00
TRAFFIC CONTROL															
6069901	MISC. {Traffic Control} (2.5%)	LS	-	1	\$6,452.34	1	\$116,638.08	1	\$208,628.27	1	\$138,288.85	1	\$158,131.59	1	\$73,182.61
PAVEMENT MARKING															
6209901	MISC. {Pavement Marking}	LS	-	1	\$5,000.00	1	\$12,500.00	1	\$17,500.00	1	\$21,500.00	1	\$23,000.00	1	\$10,000.00
TEMP. EROSION CONTROL															
8069901	MISC. {Temporary Erosion Control} (1%)	LS	-	1	\$2,580.94	1	\$46,655.23	1	\$43,016.12	1	\$40,679.02	1	\$48,616.11	1	\$14,636.52
CONTINGENCY															
2019901	MISC. {10% Contingency}	LS	-	1	\$26,712.70	1	\$457,072.28	1	\$429,516.28	1	\$278,321.76	1	\$360,470.71	1	\$155,147.13
CONSTRUCTION TOTALS:					\$311,734.53		\$5,333,987.85		\$5,012,412.09		\$3,247,987.13		\$4,206,657.08		\$1,810,551.45
					Concept 1		Concept 2		Concept 3		Concept 4		Concept 7		Concept 8

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R/W	Item	Unit	Price	Concept 1		Concept 2		Concept 3		Concept 4		Concept 7		Concept 8	
				Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension
	Right-of-way	AC		0		8.764		8.590		0.287		2.525		0	
	Temporary Construction Entrance	AC		0		0.329		0.265		0.072		0		0	
	Number of Parcels Impacted	EA		0		8		8		26		7		0	
	Total R/W Cost			\$0	\$0	\$3,135,000	\$3,135,000	\$3,135,000	\$3,135,000.00	\$155,000	\$155,000.00	\$185,000	\$185,000.00	\$0	\$0

UTILITIES	Item	Unit	Price	Concept 1		Concept 2		Concept 3		Concept 4		Concept 7		Concept 8	
				Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension
	Utility (2%)	LS	-	1	\$6,234.69	1	\$106,679.76	1	\$100,248.24	1	\$64,959.74	1	\$84,133.14	1	\$36,211.03

ENGINEERING & COORDINATION	Item	Unit	Price	Concept 1		Concept 2		Concept 3		Concept 4		Concept 7		Concept 8	
				Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension	Qty.	Extension
	P.E. (20%)				\$62,346.91		\$1,066,797.57		\$1,002,482.42		\$649,597.43		\$841,331.42		\$362,110.29
	C.E. (15%)				\$46,760.18		\$800,098.18		\$751,861.81		\$487,198.07		\$630,998.56		\$271,582.72
	RR Coordination (5%)				\$0.00		\$0.00		\$0.00		\$162,399.36		\$210,332.85		\$0.00

ROUNDED CONCEPT TOTAL:				\$430,000 Concept 1	\$10,440,000 Concept 2	\$10,000,000 Concept 3	\$4,770,000 Concept 4	\$6,160,000 Concept 7	\$2,480,000 Concept 8
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Appendix C  
Traffic Memorandum



# Traffic Appendix

Highway 125 Feasibility Study

Missouri Department of Transportation

*Strafford, MO*

February 8, 2022

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## Introduction

HDR Engineering, Inc. (HDR) was retained to perform a Feasibility Study for the Highway 125 corridor between Highway DD and Peachtree Lane in Strafford, MO. Centered near the intersection of Highway 125 with I-44, Strafford is a small community about 10 miles northeast of Springfield, MO. The study corridor is shown in **Figure 1**.

**Figure 1. Study Area**



The purpose of this analysis was to evaluate the feasibility of design changes along the corridor for their effectiveness at improving congestion, safety, and connectivity. Eleven (11) key study intersections were selected for analysis:

1. Highway 125 and Highway DD
2. Highway 125 and Evergreen Street
3. I-44 Westbound Ramp and Highway 125
4. I-44 Eastbound Ramp and Highway 125
5. Highway 125 and Chestnut Street
6. Highway 125 and Highway OO
7. Highway 125 and Jefferson Street
8. Highway 125 and Washington Avenue/Olive Street
9. Highway 125 and Old Orchard Drive
10. Highway 125 and Pinecrest Avenue
11. Highway 125 and Peachtree Lane

This memo summarizes the traffic operations analysis for the Existing and Future No-Build conditions, as well as each of the improvement concepts considered for the Highway 125 Feasibility Study.



## Existing Conditions

### Existing Road Network and Intersection Geometry

Highway 125 is a supplementary route through southwestern Missouri. At the north end of the study corridor, Highway 125 is classified as a major collector. At the I-44 Westbound Ramp, the Highway 125 classification changes to minor arterial. The minor arterial classification remains through the west end of the study corridor. Of the crossroads that intersect with Highway 125 in the study corridor, Highway DD and Washington Avenue/Olive Street are major collectors while the other roadways are all classified as local roads.

Highway 125 is a two-lane facility (one lane in each direction) through most of the study area. Only the section between Evergreen Street and the eastbound I-44 ramp terminal is widened out to four lanes. There are a couple of spot locations where Highway 125 has a three-lane section, with one through lane in each direction separated by a two-way left-turn lane (TWLTL). One of these sections is located between the eastbound I-44 ramp terminal and Highway OO, and the other extends from Jefferson Street to Washington Avenue.

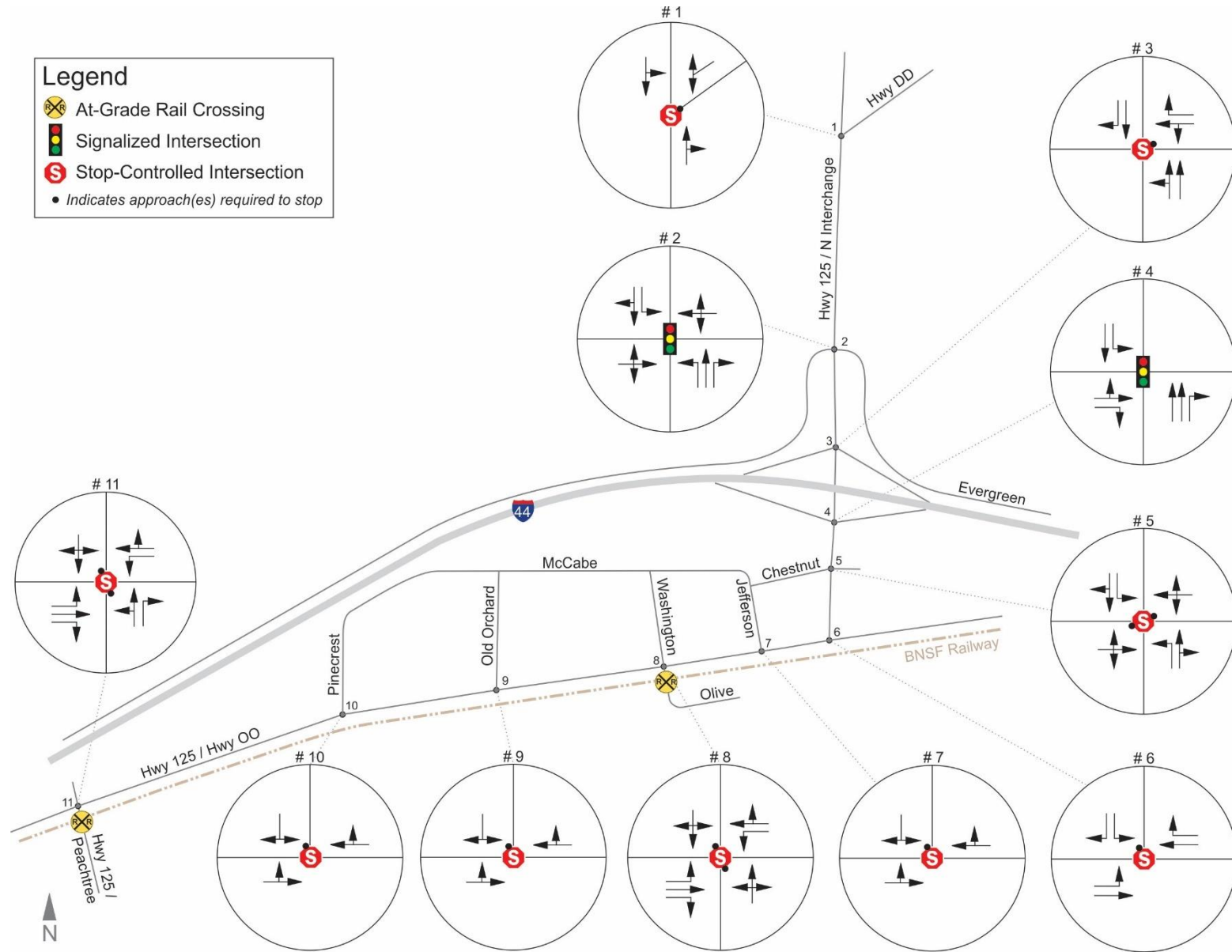
Highway 125 has a posted speed limit of 45 MPH from Highway DD to Evergreen Street. From Evergreen Street to Old Orchard Drive, the posted speed limit decreases to 35 MPH. To the west of Old Orchard Drive, the posted speed limit increases back up to 45 MPH and increases again to 55 MPH near Pinecrest Drive. The 55 MPH posted speed is then maintained through the west end of the study corridor. Roadway speed limits for the intersection cross-streets are outlined in **Table 1**.

**Table 1. Posted Speed Limits along Study Area Crossroads**

Road	Posted Speed Limit
Highway DD	55 MPH
Evergreen Street	40 MPH
I-44 Ramps	40 MPH
Chestnut Street	-
Jefferson Street	20 MPH
Washington Avenue/Olive Street	20 MPH/30 MPH
Old Orchard Drive	30 MPH
Pinecrest Avenue	20 MPH
Peachtree Lane/Highway 125	55 MPH (45 MPH NB just before Highway OO intersection)

Two of the study area intersections are currently signalized: Highway 125 at Evergreen Street (#2) and the I-44 Eastbound Ramp terminal (#4). Each of the remaining nine intersections are currently stop-controlled, with Highway 125 generally operating with free-flow conditions. **Figure 2** illustrates the current lane geometry and traffic control for each of the study intersections.

**Figure 2. Existing Conditions (2021) Study Intersection Geometry and Traffic Control**





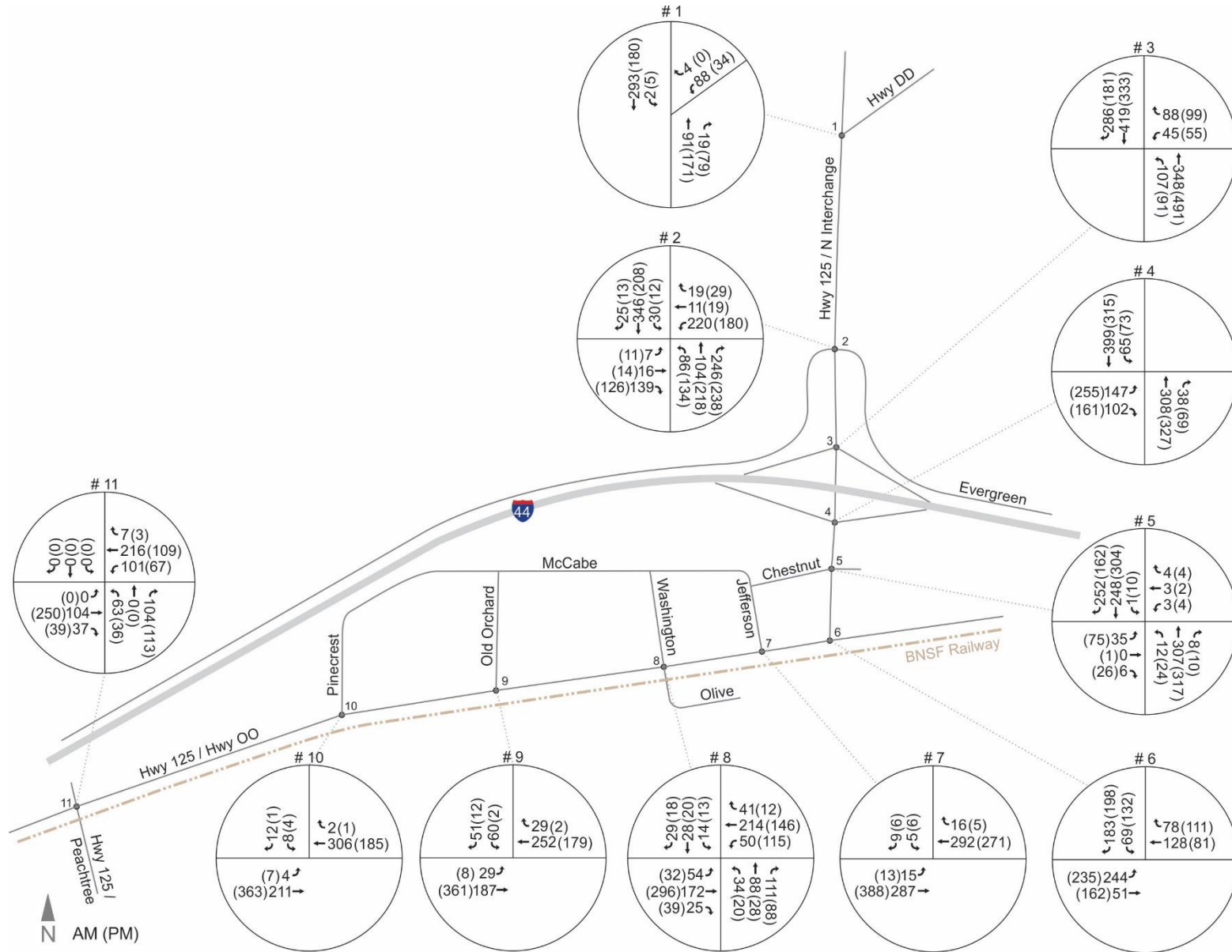
As shown in **Figure 2**, the BNSF railroad tracks run parallel to Highway 125 along its southern edge. There are currently two at-grade rail crossings within the study area: 1) on Highway 125 / Peachtree Lane, just south of Intersection #11, and 2) on Olive Street / Washington Avenue, just south of Intersection #8. Both crossings are less than 100 feet from the centerline of the adjacent intersection, and both locations have crossing signals and gates.

## Existing Volumes

Turning movement counts (TMC) for the intersections in the study area were collected on a typical weekday in September 2021 for a four-hour AM period (7:00-11:00), and a four-hour PM period (2:00-6:00). Based on these counts, the peak hour traffic volumes for the study area were determined to occur from 7:15-8:15 AM and 5:00-6:00 PM. School was in session on the day that these counts were performed. **Figure 3** illustrates the AM and PM peak-hour turning-movement volumes.

According to the vehicle classification of the traffic counts, heavy vehicle percentages are fairly high throughout the corridor. They are particularly high at the Highway 125 / Evergreen Street and Highway 125 / I-44 westbound ramps intersections, where trucks make up around 20% of the peak hour traffic. This is consistent with the surrounding land use, which includes several large truck travel centers / filling stations.

Figure 3. Existing Conditions (2021) Peak-Hour Turning-Movement Volumes





## Existing Operational Analysis

Intersection capacity analyses were performed using the traffic modeling software Synchro, Version 11. This software package is based on methodologies from the Highway Capacity Manual 6<sup>th</sup> Edition (HCM 6<sup>th</sup> Edition) and is accepted by MoDOT for the analysis of signalized intersections.

The traffic-carrying ability of a roadway is described by Level of Service (LOS), ranging from A to F. **Table 2** defines the traffic flow conditions and approximate driver comfort level at each LOS for signalized and unsignalized intersections.

**Table 2. HCM LOS Thresholds for Intersections**

Traffic Flow Conditions	LOS	Delay (sec/veh) at Intersections	
		Signalized	Unsignalized
Progression is extremely favorable, and most vehicles do not stop at all	A	0-10	0-10
Good progression, some delay	B	10-20	10-15
Fair progression, some delay	C	20-35	15-25
Unfavorable progression, congestion becomes apparent	D	35-55	25-35
Poor progression, significant delay	E	55-80	35-50
Poor progression, extreme delay	F	>80, or v/c >1.00	>50, or v/c > 1.00

Delay thresholds associated with LOS at an intersection differ between those that are signalized and unsignalized. The HCM 6<sup>th</sup> Edition explains that drivers expect to be serviced in a systematic and orderly pattern at a signalized intersection and are therefore willing to accept greater thresholds of delay associated with LOS. Conversely, service at an unsignalized intersection generally depends on gap acceptance and driver aggression, which are latently random. As a result, drivers at unsignalized intersections are expected to exhibit lower thresholds of delay associated with LOS. A signalized intersection is described by a single, hourly-flow-rate-weighted LOS, whereas two-way stop-controlled intersections are assigned multiple LOS, for each movement with conflicting traffic streams, i.e., major street left turns and all side-street movements. For two-way stop-controlled intersections, the worst of these LOS values is used to characterize the intersection operations. MoDOT desires that all intersections operate at LOS D or better.

Using the methodologies described above, the existing peak hour volumes, lane geometry, traffic control, and signal timings (provided by MoDOT) were analyzed to determine the peak-hour LOS and associated delays for each of the study intersections. **Table 3** shows the LOS results for the 2021 existing conditions.

**Table 3. Existing Conditions (2021) Intersection Results Summary**

Intersection	Traffic Control*	AM Peak Hour		PM Peak Hour	
		LOS	Delay	LOS	Delay
1 Highway 125 and Highway DD	TWSC	B	12.5 (WB)	B	11.0 (WB)
2 Highway 125 and Evergreen Street	Signal	C	27.4	C	22.5
3 Highway 125 and I-44 Westbound Ramps	TWSC	<b>F</b>	<b>94.4 (WB)</b>	<b>F</b>	<b>61.4 (WB)</b>
4 Highway 125 and I-44 Eastbound Ramps	Signal	B	16.5	C	21.9
5 Highway 125 and Chestnut Street	TWSC	C	23.3 (EB)	C	20.8 (EB)
6 Highway 125 and Highway OO	TWSC	C	23.3 (SB)	D	28.0 (SB)
7 Highway 125 and Jefferson Street	TWSC	B	11.9 (SB)	B	12.5 (SB)
8 Highway 125 and Washington Avenue	TWSC	D	33.1 (NB)	C	19.9 (SB)
9 Highway 125 and Old Orchard Drive	TWSC	C	15.3 (SB)	B	10.1 (SB)
10 Highway 125 and Pinecrest Avenue	TWSC	B	11.9 (SB)	B	13.3 (SB)
11 Highway 125 and Peachtree Lane	TWSC	C	21.4 (NB)	B	16.5 (NB)

\*For Two-Way Stop Controlled (TWSC) intersections, the LOS and Delay for the worst approach is reported.

As seen in **Table 3**, most intersections in the study corridor generally operate with acceptable delays. Only the intersection of Highway 125 and the I-44 westbound ramps is shown to have a poor level of service (LOS F during both peak hours). As noted, because this intersection is stop-controlled, the LOS for the worst approach is reported rather than for the whole intersection. The free-flowing movements along Highway 125 experience little to no delays.

The intersection of Highway 125 and Evergreen Street is shown to operate at an acceptable overall LOS C during both the AM and PM peak hours; however, according to the more detailed Synchro reports, the westbound approach experiences longer delays and poor levels of service (LOS E) during the AM and PM peak hours.



## Future No-Build Conditions

### Volume Forecasts

To understand how the study area can be expected to operate in the future without implementing any roadway improvements, a future No-Build analysis was conducted. This analysis looks at traffic volumes on the existing roadway network for two future horizon years: 2024 (opening year) and 2044 (design year).

The volume forecasts used for the No-Build analyses were developed as follows. First, site project trips from the approved *Strafford Industrial Park Traffic Impact Assessment (CJW Transportation Consultants, 2019)* were extracted and added to the existing counts by tracing the site trips through the applicable study intersections. These project site trips are shown for each study intersection in **Attachment 1**, at the end of this memo. This methodology assumes full build-out of contemplated industrial and residential development identified in the CJW traffic study, which may not occur by 2024.

Next, a compounding growth rate of 2 percent per year was applied to those adjusted existing counts to project out to each horizon year. The 2-percent growth rate assumption was derived from the forecasts produced by the Ozarks Transportation Organization's (OTO) travel demand model. On average, traffic volumes on the model area network within the study area are projected to increase by 2 percent annually between the base and horizon years. The forecast volumes for horizon years 2024 and 2044 are shown in **Figure 4** and **Figure 5**, respectively.

Figure 4. Projected 2024 No-Build AM/PM Peak-Hour Turning-Movement Volumes

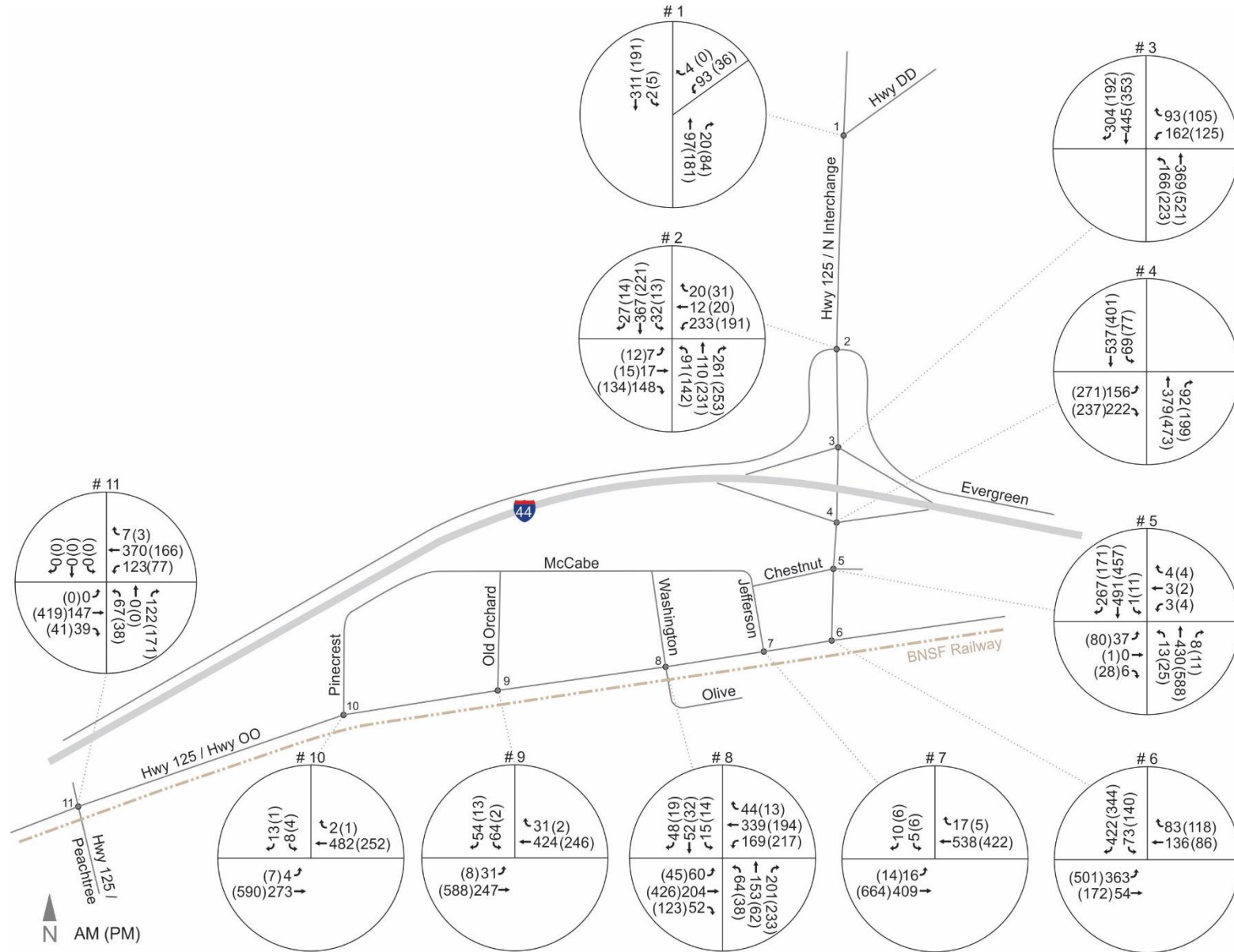
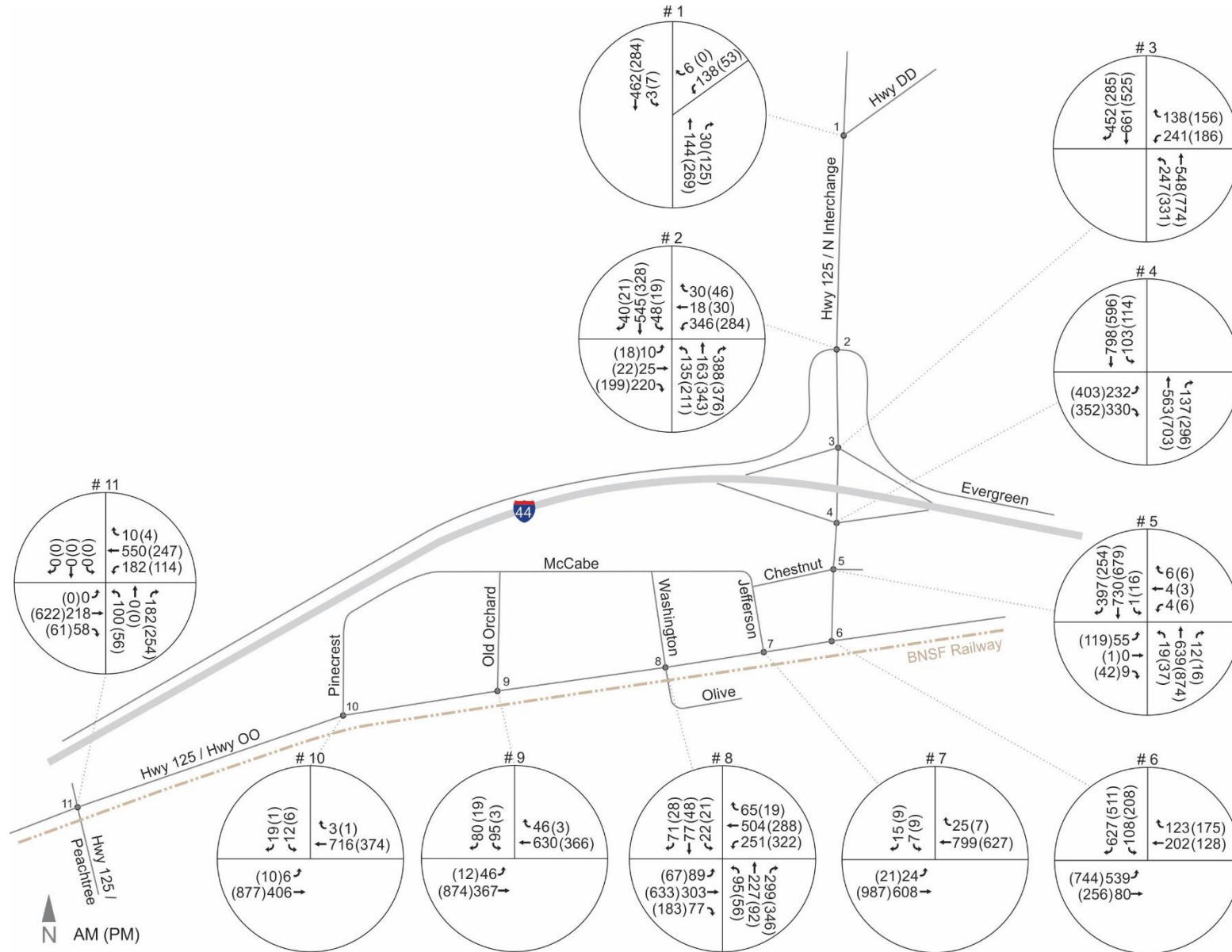




Figure 5. Projected 2044 No-Build AM/PM Peak-Hour Turning-Movement Volumes



## No-Build Operational Analysis

The No-Build operational analysis was performed using the same methodologies outlined for existing conditions. The only modification was that traffic signal timings were optimized for all future conditions. No-Build operations were analyzed with both 2024 and 2044 horizon year volumes. **Table 44** provides the LOS and delay results for each year.

**Table 4. No-Build Operational Results**

Intersection	Traffic Control*	AM Peak Hour				PM Peak Hour			
		2024		2044		2024		2044	
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
1 Highway 125 and Highway DD	TWSC	B	12.9 (WB)	C	19.7 (WB)	B	11.2 (WB)	B	13.5 (WB)
2 Highway 125 and Evergreen Street	Signal	C	22.6	D	43	B	13.8	B	18.7
3 Highway 125 and I-44 Westbound Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	F	>300 (WB)	F	>300 (WB)
4 Highway 125 and I-44 Eastbound Ramps	Signal	C	24.6	C	33.9	C	26.1	D	36.7
5 Highway 125 and Chestnut Street	TWSC	F	72.5 (EB)	F	>300 (EB)	C	24.4 (EB)	F	>300 (EB)
6 Highway 125 and Highway OO	TWSC	F	52.6 (SB)	F	>300 (SB)	F	>300 (SB)	F	>300 (SB)
7 Highway 125 and Jefferson Street	TWSC	B	16.3 (SB)	D	28.6 (SB)	C	18.1 (SB)	E	36.8 (SB)
8 Highway 125 and Washington Avenue	TWSC	F	>300 (NB)	F	>300 (NB)	F	>300 (NB)	F	>300 (NB)
9 Highway 125 and Old Orchard Drive	TWSC	C	24.9 (SB)	F	234.6 (SB)	B	11.3 (SB)	B	14.7 (SB)
10 Highway 125 and Pinecrest Avenue	TWSC	C	15 (SB)	C	24.2 (SB)	C	18.4 (SB)	E	35.1 (SB)
11 Highway 126 and Peachtree Lane	TWSC	E	44.3 (NB)	F	>300 (NB)	D	26.6 (NB)	F	100 (NB)

\*For Two-Way Stop Controlled (TWSC) intersections, the LOS and Delay for the worst approach is reported.

By 2024, five study intersections are expected to have approaches exhibiting unacceptable levels of service (LOS E or F). By 2044, that number would increase to seven intersections. Only the two intersections that are currently signalized (Evergreen Street and the I-44 Eastbound Ramp terminal), and two of the more minor unsignalized intersections (Highway DD and Old Orchard Drive) are expected to be able to maintain acceptable operations by 2044, under the No-Build conditions.



## Future Build Conditions

To address the issues uncovered in the Existing and Future No-Build traffic operations analyses, eight concepts, some with multiple variations, were developed and considered. Several concepts were dismissed and/or modified as the study progressed. The sections below describe the improvements included in each concept and the analysis results (where applicable). Several of the concepts propose to convert certain intersections to roundabouts. Operational analysis of roundabouts was conducted using the SIDRA software package, Version 8.

Each scenario that was analyzed considered both the 2024 Opening Year and the 2044 Design Year. The forecast volumes developed for the future No-Build analyses were used for the Build Concept analyses, except where adjustments were needed based on proposed geometric changes. These volume adjustments are noted, where applicable, in the sections below.

### Concept 1

Concept 1 contains a single improvement, as shown in **Figure 6**:

- Signalization of the Highway 125 and I-44 westbound ramp terminal intersection.

**Figure 6. Concept 1 Layout**



This improvement is a near-term priority, given that the westbound approach at that intersection is operating at LOS F under the existing conditions. As shown in **Table 5**, signalization would dramatically improve operating conditions to LOS C or better for both the opening and design years. However, while Concept 1 addresses an immediate need, it does not address the foreseeable operational issues at other study area intersections, as indicated by the No-Build analyses. Therefore, Concept 1 was not carried forward as a standalone project. Rather, signalization at the I-44 westbound ramp terminal was included in Concepts 2/2A and 3/3A.

**Table 5. Concept 1 Operational Results**

Intersection		No-Build				Concept 1					
		Control Type	AM Peak Hour		PM Peak Hour		Control Type	AM Peak Hour		PM Peak Hour	
			LOS	Delay	LOS	Delay		LOS	Delay	LOS	Delay
Opening Year 2024											
3	Hwy 125 & I-44 WB Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	Signal	A	9.7	B	10.1
Design Year 2044											
3	Hwy 125 & I-44 WB Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	Signal	C	31.3	B	16.6

*For TWSC intersections, the LOS and Delay (in seconds) is reported for the worst movement.*

A traffic signal warrant analysis for this recommended traffic signal improvement is provided in **Attachment 2**. Results of the analysis shows that a traffic signal appears warranted using 2021 traffic volumes.

## Concept 2/2A

Concepts 2 and 2A would include the following improvements:

- Signalizing the Highway 125 / I-44 Westbound Ramp intersection.
- Relocating the intersection of Highway 125 and Evergreen Street approximately 500 feet north (about 1350 feet north of the existing I-44 Westbound Ramp terminal intersection). The relocated intersection would be signalized.
- Realigning Evergreen Street, on the east side of Highway 125, to the east side of the existing McDonalds and Love's Travel Stop properties. The existing section of Evergreen Street would "T" into the new alignment and be retained as an outer road to provide access to existing businesses. The existing Highway 125 / Evergreen Street intersection would be reduced to right-in/right-out access on the east side of Highway 125 only.

The difference between Concepts 2 and 2A is the alignment of Evergreen Street on the west side of Highway 125. Concept 2 would retain much of the existing road, while Concept 2A would realign Evergreen Street further west around the west side of the existing TA Travel Center. See **Figures 7 and 8** for a visual comparison.



Figure 7. Concept 2 Layout

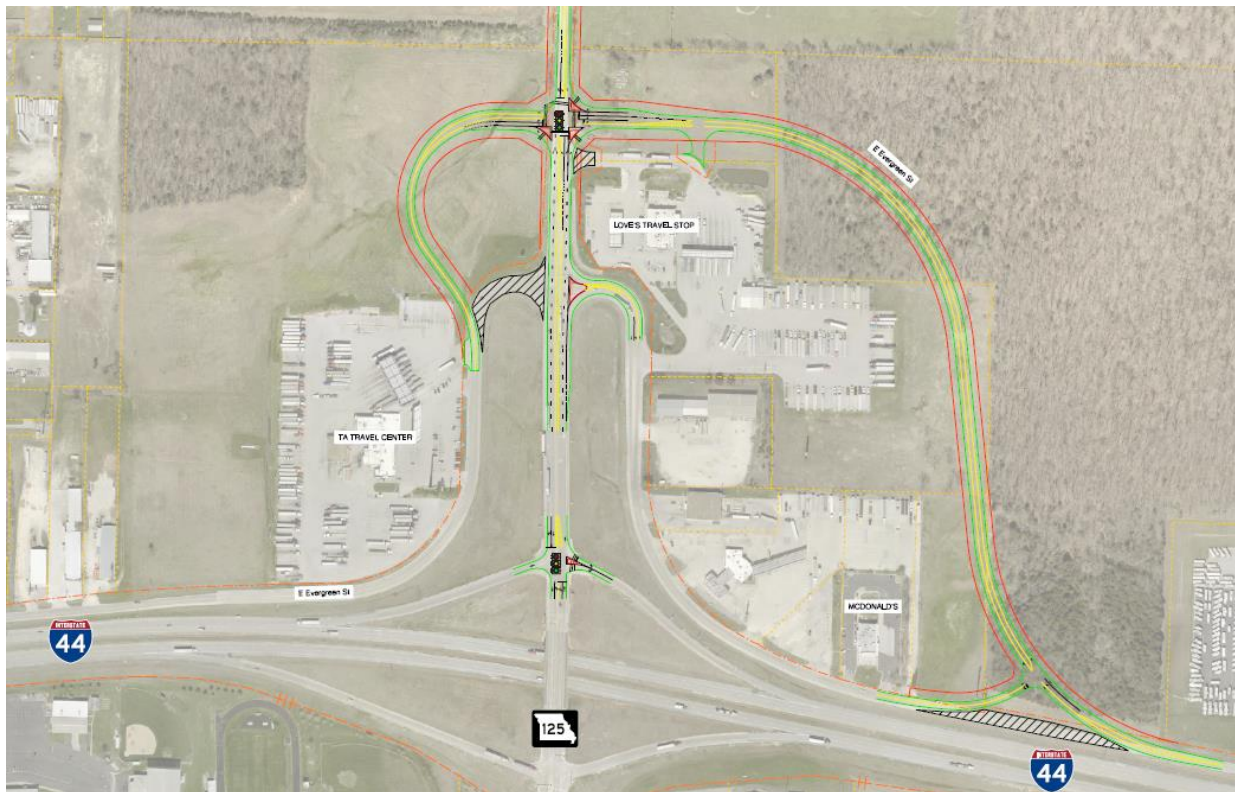


Figure 8. Concept 2A Layout



Ultimately, Concept 2A was eliminated from further consideration after discussions with stakeholders, in which it was discovered that future expansion plans of the TA Travel Center would be precluded under the Evergreen realignment scenario. Therefore, only Concept 2 was carried forward into analysis. The results of the Concept 2 operational analysis are included in **Table 6**, along with No-Build results for comparison.

**Table 6. Concept 2 Operational Results**

Intersection		No-Build				Concept 2					
		Control Type	AM Peak Hour		PM Peak Hour		Control Type	AM Peak Hour		PM Peak Hour	
			LOS	Delay	LOS	Delay		LOS	Delay	LOS	Delay
Opening Year 2024											
2	Hwy 125 & Evergreen	Signal	C	22.6	B	13.8	Signal	B	18.3	B	14.4
3	Hwy 125 & I-44 WB Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	Signal	C	27.2	A	8.0
Design Year 2044											
2	Hwy 125 & Evergreen	Signal	D	43.0	B	18.7	Signal	D	43.2	C	28.6
3	Hwy 125 & I-44 WB Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	Signal	D	42.9	B	14.0

*For TWSC intersections, the LOS and Delay (in seconds) is reported for the worst movement.*

As shown, under Concept 2, signalization at the I-44 westbound ramp terminal would (as with Concept 1) improve operations to acceptable levels through the 2044 design year. Conversely, the signal at the relocated Evergreen Street would exhibit slightly worsening levels of service under Concept 2, when compared to No-Build. This is likely due to the signalization of the westbound ramp terminal, which results in three somewhat closely spaced traffic signals along Highway 125 (from Evergreen Street to the Eastbound ramp terminal). The cycle lengths for all three intersections were analyzed as an optimized system, resulting in longer cycle lengths and additional delays at Evergreen Street than there would be if it were to be optimized on its own. Additionally, moving the Evergreen Street intersection to the north would cause some minimal shifting of volumes due to maintaining the right-in/right-out access on the east side of Highway 125, see **Attachment 3**, at the end of this memo. While slightly worse than No-Build, the level of service at Highway 125 and Evergreen Street for Concept 2 is still expected to perform at acceptable levels through the design year (LOS D or better).



### Concept 3/3A

Concepts 3 and 3A are very similar to 2/2A with the exception that the relocated Evergreen Street intersection would be constructed as a roundabout rather than a signalized intersection. Specifically Concepts 3/3A would include the following:

- Signalizing the Highway 125 / I-44 Westbound Ramp terminal intersection.
- Relocating the intersection of Highway 125 with Evergreen Street approx. 500 feet north (about 1350 feet north of the existing I-44 Westbound Ramp terminal intersection).
- Constructing a roundabout at the relocated Highway 125 / Evergreen Street intersection.
- Realigning Evergreen Street, on the east side of Highway 125, to the east side of the existing McDonalds and Love's Travel Stop properties. The existing section of Evergreen Street would "T" into the new alignment and be retained as an outer road to provide access to existing businesses. The existing Highway 125 / Evergreen Street intersection would be reduced to right-in/right-out access on the east side of Highway 125 only.

The difference between Concepts 3 and 3A is the same as for 2/2A: the proposed alignment of Evergreen Street on the west side of Highway 125, see **Figures 9 and 10**.

Ultimately, for the same reasons that Concept 2A was eliminated, Concept 3A was removed from consideration. Concept 3 was carried forward, and the operational analysis results are included in **Table 7**, along with No-Build results for comparison.

**Table 7. Concept 3 Operational Results**

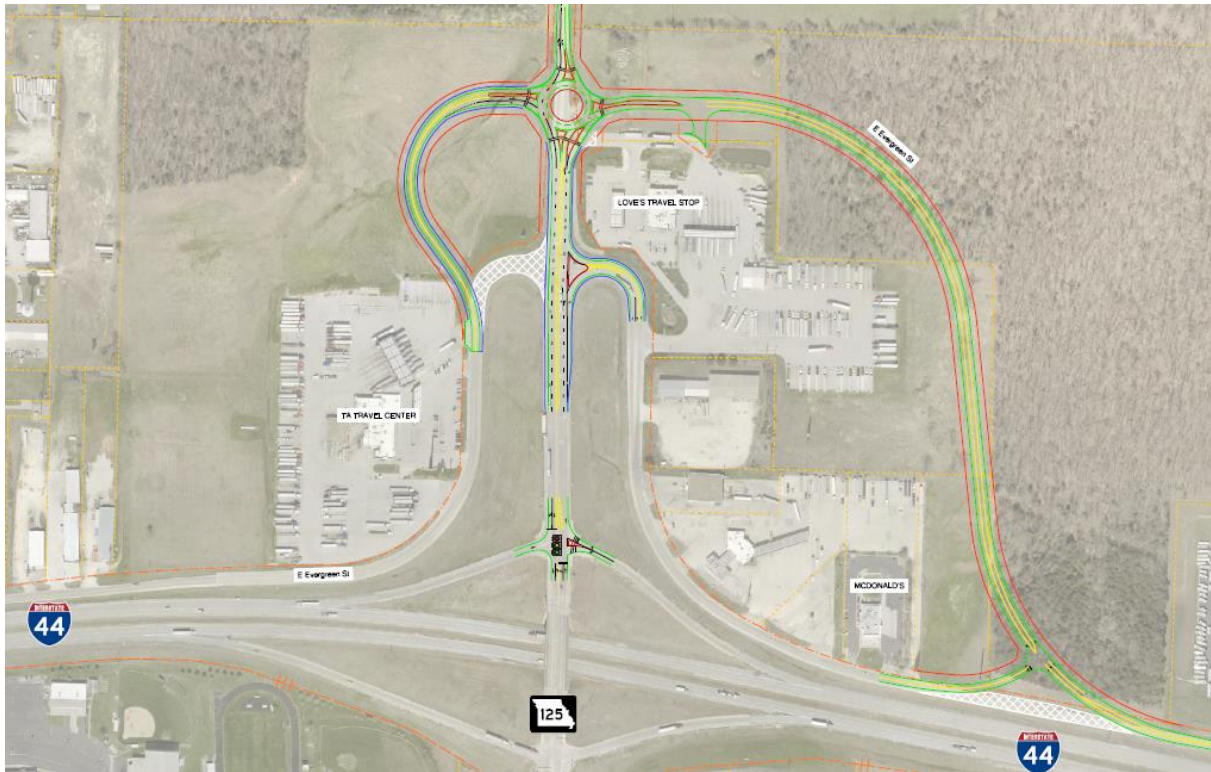
Intersection		No-Build				Concept 3					
		Control Type	AM Peak Hour		PM Peak Hour		Control Type	AM Peak Hour		PM Peak Hour	
			LOS	Delay	LOS	Delay		LOS	Delay	LOS	Delay
Opening Year 2024											
2	Hwy 125 & Evergreen	Signal	C	22.6	B	13.8	Rdbt	A	9.0	A	9.0
3	Hwy 125 & I-44 WB Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	Signal	A	9.7	B	10.1
Design Year 2044											
2	Hwy 125 & Evergreen	Signal	D	43.0	B	18.7	Rdbt	B	11.7	B	12.4
3	Hwy 125 & I-44 WB Ramps	TWSC	F	>300 (WB)	F	>300 (WB)	Signal	C	31.3	B	16.6

*For TWSC intersections, the LOS and Delay (in seconds) is reported for the worst movement.*

By installing a roundabout, rather than a signal, at the relocated Evergreen Street intersection, operations are expected to improve to LOS A for the opening year and be retained at LOS B through the design year. Additionally, by not including the Evergreen Street intersection as part of the coordinated signal system with the I-44 interchange intersections, the westbound ramp

terminal is able to operate with a shorter cycle length, thereby improving operations slightly as compared to Concept 2.

**Figure 9. Concept 3 Layout**



**Figure 10. Concept 3A Layout**





## Concept 4/4A

The major features of Concepts 4/4A include:

- Widening Highway 125 to provide a continuous three-lane section between the Highway OO intersection and the Washington Avenue / Olive Street intersection.
- Signalizing the Highway 125 at Washington Avenue intersection.
- Signalizing the Highway 125 at Highway OO intersection.
- Converting the Highway 125 and Chestnut Street intersection to  $\frac{3}{4}$ -access (Concept 4) or a roundabout (Concept 4A).
- For Concept 4A only, constructing a roundabout at the I-44 Eastbound Ramp terminal.

The difference between Concepts 4 and 4A is confined to the Highway 125 intersections with Chestnut Street and the I-44 eastbound ramps. Concept 4 would convert the Chestnut Street intersection to a  $\frac{3}{4}$ -access, while Concept 4A would convert it to a roundabout. Concept 4A would also include a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal intersection. See **Figures 11 and 12** for a visual comparison.

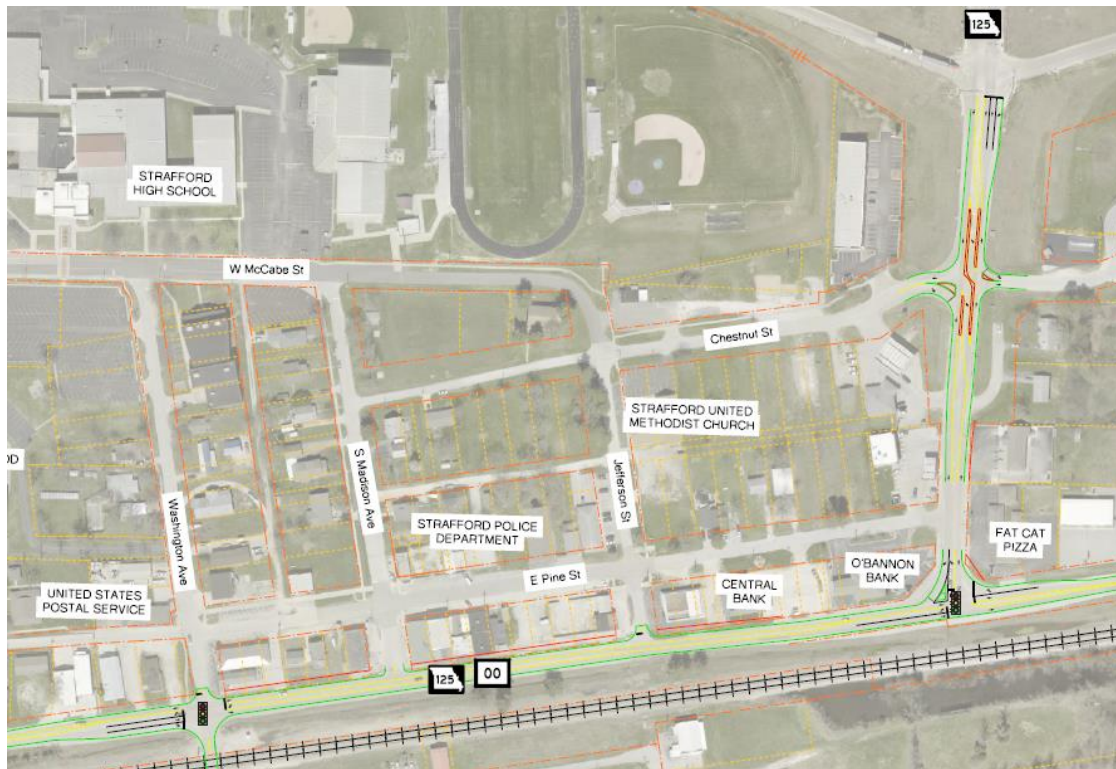
Ultimately, Concept 4 was eliminated from further analysis due to the access issues posed by restricting movements at the Highway 125 and Chestnut Street intersection. The operational results of Concept 4A are included in **Table 7**, along with No-Build results for comparison.

**Table 7. Concept 4A Operational Results**

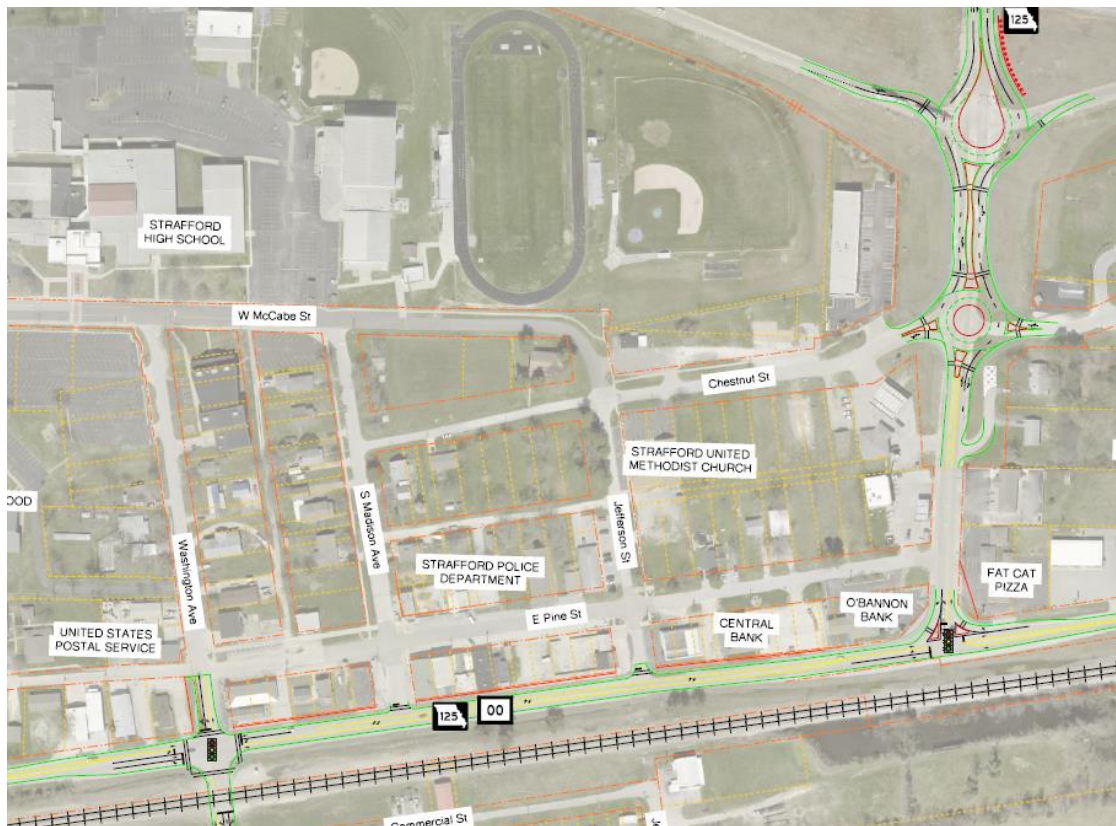
Intersection	No-Build					Concept 4A				
	Control Type	AM Peak Hour		PM Peak Hour		Control Type	AM Peak Hour		PM Peak Hour	
		LOS	Delay	LOS	Delay		LOS	Delay	LOS	Delay
Opening Year 2024										
4 Hwy 125 & I-44 EB Ramps	Signal	C	24.6	C	26.1	Rdbt	A	6.5	A	7.3
5 Hwy 125 & Chestnut	TWSC	F	72.5 (EB)	C	24.4 (EB)	Rdbt	A	4.3	A	5.5
6 Hwy 125 & Hwy OO	TWSC	F	52.6 (SB)	F	>300 (SB)	Signal	C	28.0	C	31.0
7 Hwy 125 & Jefferson St	TWSC	B	16.3 (SB)	C	18.1 (SB)	TWSC	B	13.8 (SB)	B	13.8 (SB)
8 Hwy 125 & Washington Ave	TWSC	F	>300 (NB)	F	>300 (NB)	Signal	C	33.5	D	35.4
Design Year 2044										
4 Hwy 125 & I-44 EB Ramps	Signal	C	33.9	D	36.7	Rdbt	A	8.4	B	10.2
5 Hwy 125 & Chestnut	TWSC	F	>300 (EB)	F	>300 (EB)	Rdbt	A	4.5	A	5.6
6 Hwy 125 & Hwy OO	TWSC	F	>300 (SB)	F	>300 (SB)	Signal	C	33.9	C	26.6
7 Hwy 125 & Jefferson St	TWSC	D	28.6 (SB)	E	36.8 (SB)	TWSC	C	19.1 (SB)	C	18.8 (SB)
8 Hwy 125 & Washington Ave	TWSC	F	>300 (NB)	F	>300 (NB)	Signal	D	43.2	D	51.8

For TWSC intersections, the LOS and Delay (in seconds) is reported for the worst movement.

**Figure 11. Concept 4 Layout**



**Figure 12. Concept 4A Layout**





As the table shows, conversion of the I-44 eastbound ramp terminal and the Chestnut Street intersection to roundabouts would be expected to improve conditions at both intersections to LOS A/B through the design year. Additionally, installing signals at the Highway OO and Washington Avenue intersections would be expected to result in acceptable operations (LOS D or better) for both locations through the design year. At the Jefferson Street intersection, no operational improvement is shown because the addition of left turn lanes on the major approaches would not be expected to improve conditions on the side street, which is where the LOS is being reported.

A traffic signal warrant analysis for the recommended traffic signal improvements at Highway 125 at Washington/Olive and Highway OO is provided in **Attachment 2**. Results of the analysis shows that, using 2021 traffic volumes, a traffic signal appears to be warranted at Highway 125 / Highway OO, but not warranted at Highway 125 / Washington. However, using 2024 forecast volumes, which include site trips generated by the approved Strafford Industrial Park development, the warrant analysis indicates that a traffic signal would likely be warranted at Highway 125 / Washington by the opening year horizon.

For ease of public consumption, as Concept 4A moves forward through the public involvement vetting and project selection process, it will be re-designated as simply Concept 4.

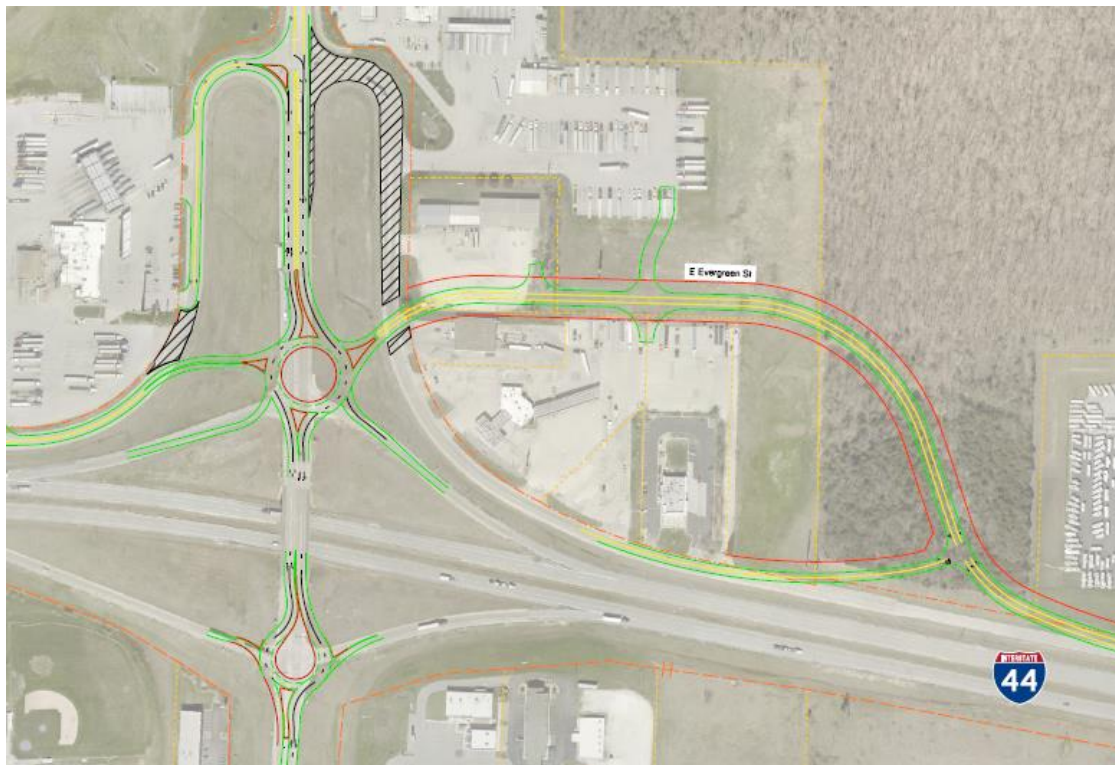
## Concept 5/5A

The major features of Concepts 5 and 5A, pictured in **Figures 13 and 14**, include:

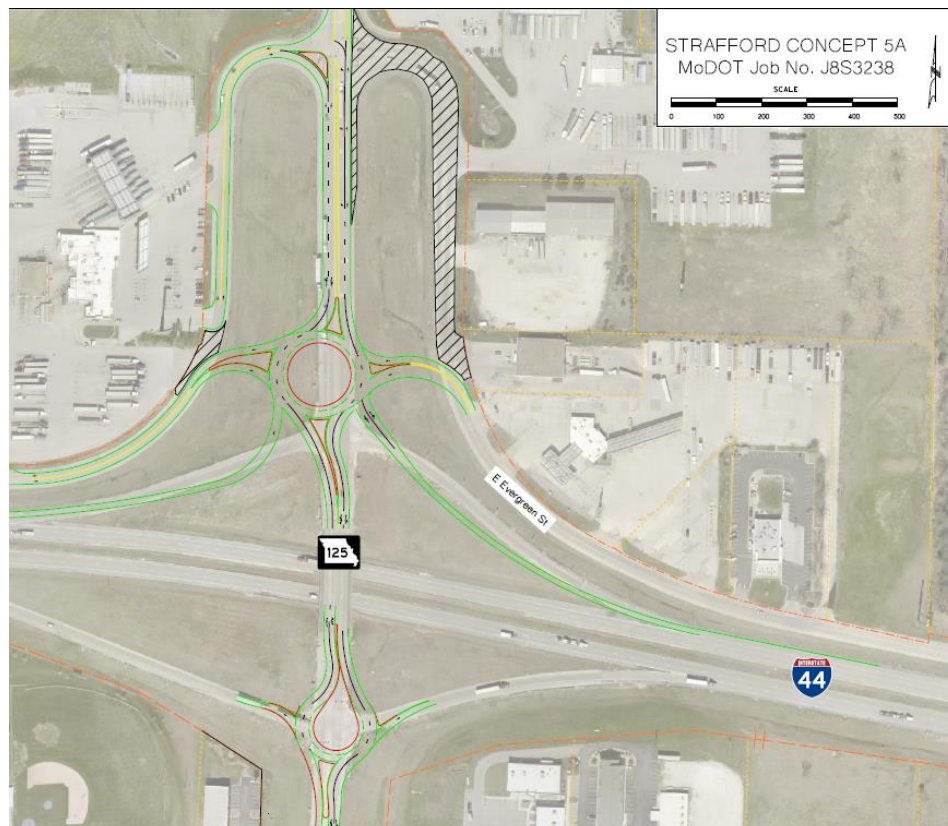
- Constructing a roundabout at the I-44 Westbound Ramp terminal.
- Constructing a roundabout at the I-44 Eastbound Ramp terminal.
- Aligning Evergreen Street to intersect with the I-44 Westbound Ramp terminal, creating a six-leg roundabout.
- Converting the west side of the existing Highway 125 / Evergreen Street intersection to a  $\frac{3}{4}$ -access driveway serving the TA Travel Center.
- Concept 5 would realign Evergreen Street on the east side of Highway 125 to the north, running between the XVIII Wheelers Truck Wash and JR All Metal Polishing. Concept 5A would keep the east side of Evergreen Street on its current alignment.

For several reasons, including difficulty providing access to existing businesses, extensive right-of-way takings, and complications in terms of constructability, both Concepts 5 and 5A were eliminated from consideration and no operational analysis was performed.

**Figure 13. Concept 5 Layout**



**Figure 14. Concept 5A Layout**





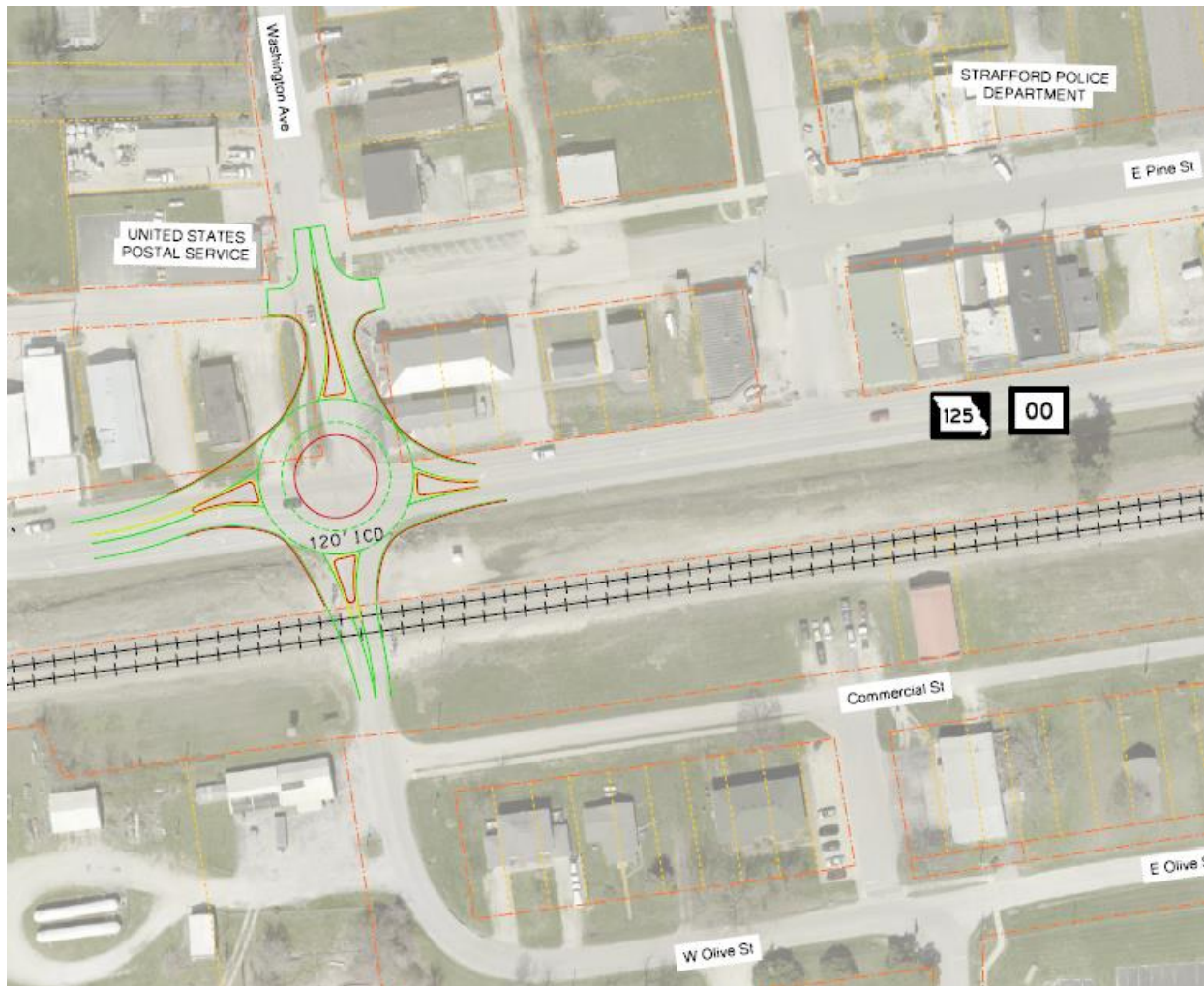
## Concept 6

Concept 6 was intended to focus on the operational issues at the Highway 125 and Washington Avenue / Olive Street intersection, and included the following improvements, pictured in **Figure 15**:

- Construct a roundabout at Highway 125 and Washington Avenue/Olive Street.
- Convert to right-in/right-out access at Pine Street to/from Washington Avenue.

Like Concepts 5/5A, Concept 6 was eliminated from further consideration due to expected right-of-way impacts and restrictions to vehicular movements.

**Figure 15. Concept 6 Layout**



## Concept 7/7A

The major features of Concepts 7/7A include:

- Signalization of the Highway 125 and Highway 00 intersection.
- New railroad crossing directly south of Highway 125 and Highway 00 intersection connecting to Bumgarner Boulevard and Birchwood Street.
- Signalization of the Highway 125 and Washington Avenue/Olive Street intersection.
- Closure of existing railroad crossing on Washington Avenue/Olive Street just south of Highway 125.
- Conversion of Highway 125 and Chestnut Street to  $\frac{3}{4}$ -access (Concept 7) or a roundabout (Concept 7A).
- For Concept 7A only, construction of a roundabout at the I-44 Eastbound Ramp terminal.

**Figure 16. Concept 7 Layout**

The difference between the 7 and 7A concepts is confined to the Highway 125 intersections with Chestnut Street and the I-44 eastbound ramps. Concept 7 would convert the Chestnut Street intersection to a  $\frac{3}{4}$ -access, while Concept 7A would convert it to a roundabout. Concept 7A would also include a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal intersection. See **Figures 16 and 17** for a visual comparison.

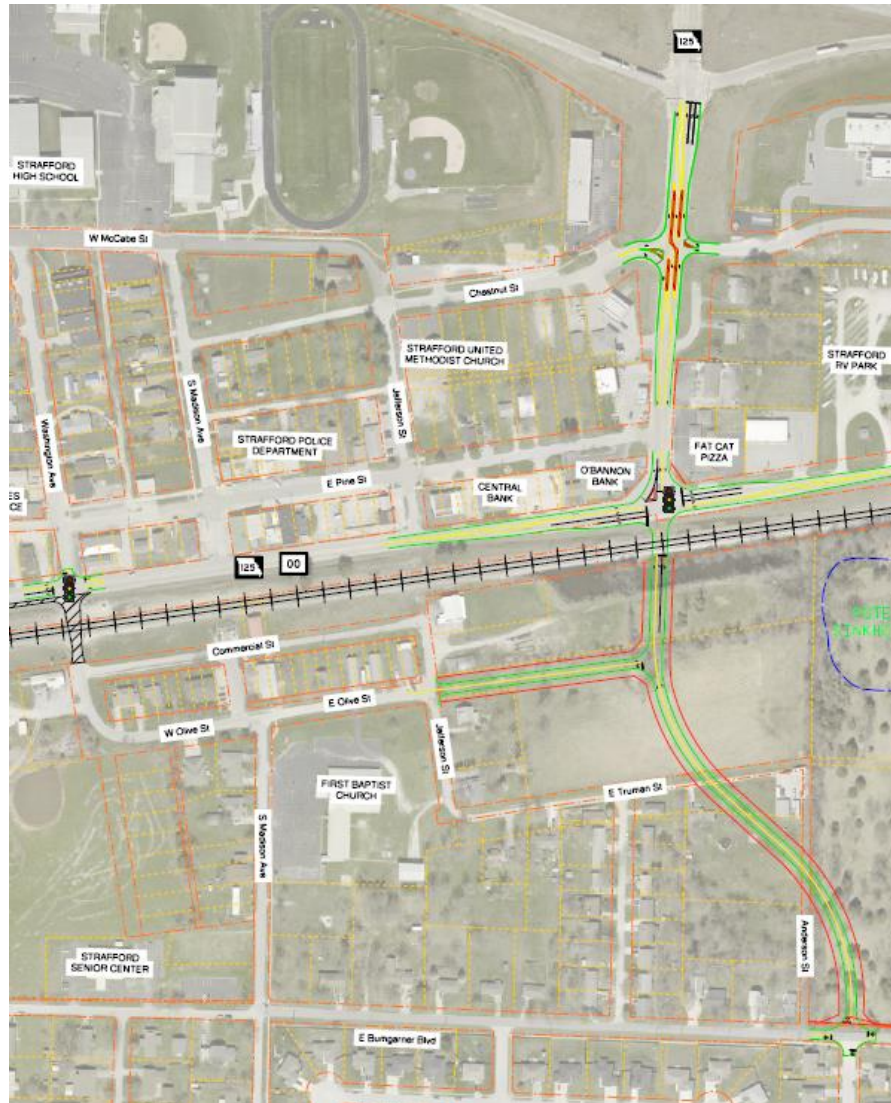




Figure 17. Concept 7A Layout



Concept 7 was eliminated from further analysis due to the access issues posed by restricting movements at the Highway 125 and Chestnut Street intersection. The operational results of Concept 7A are included in **Table 8**; however, it should be noted that these results do not present a fair comparison to the No-Build because Concept 7A was not analyzed with the adjusted baseline volumes that include the Strafford Industrial Park site trips. By the time it was determined that those development site trips should be included as part of the baseline volumes, the City of Strafford had indicated that Concept 7A was not preferred. Because it was determined that Concept 7A would be unlikely to be selected, the volumes were not modified, and the analysis was not updated.

The volumes that were used for the Concept 7A analysis, which exclude the industrial park development trips but include a fair bit of reassignment due to the closure of Olive Street and the new extension of Highway 125 south to Bumgarner Boulevard, are included for reference in **Attachment 4**, at the end of this memo.

As indicated in the table, the improvements included in Concept 7A are expected to provide acceptable operations, at each of the applicable intersections, through the design year. However, should this Concept be determined as viable at some point in the future, the analysis should be updated to ensure acceptable operations could still be maintained with the additional industrial park site trips.

**Table 8. Concept 7A Operational Results**

		Concept 7A				
		AM Peak Hour			PM Peak Hour	
		Control Type	LOS	Delay	LOS	Delay
<i>Opening Year 2024</i>						
4	Hwy 125 & I-44 EB Ramps	Roundabout	A	6.5	A	7.3
5	Hwy 125 & Chestnut	Roundabout	A	4.3	A	5.5
6	Hwy 125 & Hwy OO	Signal	C	23.4	B	16.9
7	Hwy 125 & Jefferson St	TWSC	B	11.8 (SB)	B	11.1 (SB)
8	Hwy 125 & Washington Ave	Signal	B	11.8	A	7.4
<i>Design Year 2044</i>						
4	Hwy 125 & I-44 EB Ramps	Roundabout	A	8.4	B	10.2
5	Hwy 125 & Chestnut	Roundabout	A	4.5	A	5.6
6	Hwy 125 & Hwy OO	Signal	C	24.9	B	19.7
7	Hwy 125 & Jefferson St	TWSC	B	14.9 (SB)	B	13.5 (SB)
8	Hwy 125 & Washington Ave	Signal	D	41.1	A	9.0

*For TWSC intersections, the LOS and Delay (in seconds) is reported for the worst movement.*

Like Concepts 4/4A, Concept 7A will be redesignated as Concept 7 as the project moves forward through the public involvement vetting and project selection processes.



## Concept 8

Concept 8 is a more focused concept, including just the following improvements:

- Construct a roundabout at the I-44 eastbound ramp terminal.
- Construct a roundabout at the Highway 125 and Chestnut Street intersection.

These improvements are pictured in **Figure 18**.

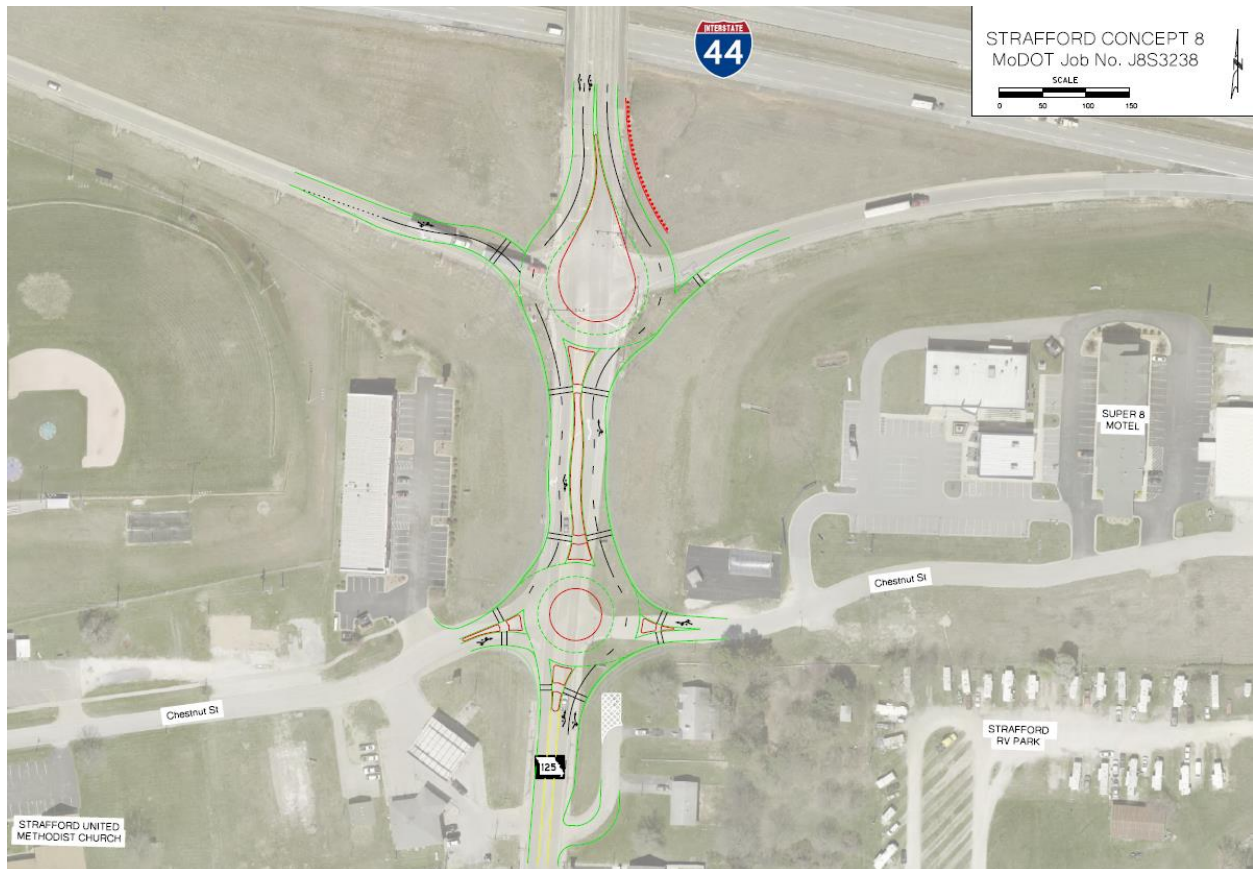
Like Concept 1, Concept 8 was ultimately determined not to provide enough benefit to the Highway 125 study corridor to be a standalone project. However, as described in the sections above, these improvements were included in both Concepts 4A and 7A. The forecasted operations directly at the two impacted intersections are much improved, with both roundabouts expected to operate at LOS A or B through the 2044 design year, as shown in **Table 9**.

**Table 9. Concept 8 Operational Results**

Intersection		No-Build				Concept 8					
		Control Type	AM Peak Hour		PM Peak Hour		Control Type	AM Peak Hour		PM Peak Hour	
			LOS	Delay	LOS	Delay		LOS	Delay	LOS	Delay
Opening Year 2024											
4	Hwy 125 & I-44 EB Ramps	Signal	C	24.6	C	26.1	Rdbt	A	6.5	A	7.3
5	Hwy 125 & Chestnut	TWSC	F	72.5 (EB)	C	24.4 (EB)	Rdbt	A	4.3	A	5.5
Design Year 2044											
4	Hwy 125 & I-44 EB Ramps	Signal	C	33.9	D	36.7	Rdbt	A	8.4	B	10.2
5	Hwy 125 & Chestnut	TWSC	F	>300 (EB)	F	>300 (EB)	Rdbt	A	4.5	A	5.6

*For TWSC intersections, the LOS and Delay (in seconds) is reported for the worst movement.*

**Figure 18. Concept 8 Layout**





## Attachments

to Traffic Memorandum

1. Strafford Industrial Park Site Trips
2. Traffic Signal Warrant Analyses
3. Volume Reassignment for Evergreen Street Relocation (Concepts 2 and 3)
4. Concept 7A Volume Reassignment

## Attachment 1: Strafford Industrial Park Site Trips

AM Opening Day				PM Opening Day			
	↙	↓	↘		↙	↓	↘
	0	0	0		0	0	0
↗ 0	3. Highway 125/I-44 WB Ramp			0	↖		
→ 0	0	0	←	→ 0	0	0	←
↘ 0	114	↖		↘ 0	67	↖	
	52	0	0		126	0	0
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	0	114	0		0	67	0
↗ 0	4. Highway 125/I-44 EB Ramp			0	↖		
→ 0	0	0	←	→ 0	0	0	←
↘ 114	0	0	↖	↘ 67	0	0	↖
	0	52	52		0	126	126
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	0	228	0		0	134	0
↗ 0	5. Highway 125/Chestnut Street			0	↖		
→ 0	0	0	←	→ 0	0	0	←
↘ 0	0	0	↖	↘ 0	0	0	↖
	0	104	0		0	252	0
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	228	0	0		134	0	0
↗ 104	6. Highway 125/Route 00			252	↖		
→ 0	0	0	←	→ 0	0	0	←
↘ 0	0	0	↖	↘ 0	0	0	↖
	0	0	0		0	0	0
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	0	0	0		0	0	0
↗ 0	7. Highway 125/Jefferson Street			0	↖		
→ 104	0	0	←	→ 252	0	0	←
↘ 0	0	0	↖	↘ 0	0	0	↖
	0	0	0		0	0	0
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	17	22	0		0	11	0
↗ 3	8. Highway 125/Washington Avenue/Olive			11	↖		
→ 21	0	0	←	→ 112	0	0	←
↘ 25	116	↖		↘ 82	39	↖	
	28	60	83		17	32	140
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	0	0	0		0	0	0
↗ 0	9. Highway 125/Old Orchard Drive			0	↖		
→ 49	0	0	←	→ 205	0	0	←
↘ 0	0	0	↖	↘ 0	0	0	↖
	0	0	0		0	0	0
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	0	0	0		0	0	0
↗ 0	10. Highway 125/Pinecrest Avenue			0	↖		
→ 49	0	0	←	→ 205	0	0	←
↘ 0	0	0	↖	↘ 0	0	0	↖
	0	0	0		0	0	0
	↖	↑	↗		↖	↑	↗
	↙	↓	↘		↙	↓	↘
	0	0	0		0	0	0
↗ 0	11. Highway 125/Route 00/Peachtree			0	↖		
→ 37	0	0	←	→ 154	0	0	←
↘ 0	16	↖		↘ 0	0	0	↖
	0	0	12		0	0	51
	↖	↑	↗		↖	↑	↗



## Attachment 2: Traffic Signal Warrant Analysis

Concepts 1, 2/2A, and 3/3A include signalization at the Highway 125 / I-44 Westbound Ramp terminal. Concepts 4/4A and 7/7A include signalization at the Highway 125 / Highway OO and Highway 125 / Washington Avenue intersections. Using the existing conditions traffic volume data, a traffic signal warrant analysis was conducted for each intersection where a traffic signal is proposed. Given the data available for this study, the applicable MUTCD traffic signal warrants are Warrants 1, 2, and 3. These signal warrants were evaluated using the raw 2021 traffic counts to determine if signals are needed under existing conditions. The results of the signal warrant analysis can be seen in **Table 1**.

**Table 1: Traffic Signal Warrant Analysis Results**

MUTCD Warrant	Warrant Met?		
	Hwy 125 / I-44 WB Ramp	Hwy 125 / Hwy OO	Hwy 125 / Washington
Warrant 1, Eight-Hour Vehicular Volume	<b>MET</b>	<b>NOT MET</b>	<b>NOT MET</b>
Warrant 2, Four-Hour Vehicular Volume	<b>MET</b>	<b>MET</b>	<b>NOT MET</b>
Warrant 3, Peak Hour	<b>MET</b>	<b>MET</b>	<b>NOT MET*</b>
Warrant 4, Pedestrian Volume	N/A	N/A	N/A
Warrant 5, School Crossing	N/A	N/A	N/A
Warrant 6, Coordinated Signal	N/A	N/A	N/A
Warrant 7, Crash Experience	N/A	N/A	N/A
Warrant 8, Roadway Network	N/A	N/A	N/A
Warrant 9, Intersection Near a Grade Crossing	N/A	N/A	N/A

\* MET with 2024 traffic volumes

The sections below describe the signal warrant analysis for each concept in detail.

### Concepts 1, 2/2A, 3/3A

Concepts 1, 2/2A, and 3/3A include the signalization of the Highway 125 / I-44 Westbound Ramp terminal intersection.

The Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition, states that “the investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants.”

**Warrant 1 – 8-Hour Warrant appears to be SATISFIED** at the Highway 125 / I-44 Westbound Ramp terminal intersection. The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is considered met if for each of any 8 hours of an average day the vehicles per hour given in both 70 percent columns of Condition A in **Table 2** exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection. According to the MUTCD, the 70 percent traffic volumes columns may be used instead of the 100 percent columns, if the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street. This warrant is considered met if for each of any 8 hours of an average day the vehicles per hour given in both 70 percent columns of Condition B in **Table 2** exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

**Table 2: Eight-Hour Warrant Hwy 125 / I-44 WB Ramp**

Time	Condition A		Condition B		Volumes	
	70% Major (420)	70% Minor (105)	70% Major (630)	70% Minor (53)	Major	Minor
7:00	Yes	Yes	Yes	Yes	1,160	139
8:00	Yes	Yes	Yes	Yes	767	124
9:00	Yes	Yes	Yes	Yes	694	124
10:00	Yes	Yes	Yes	Yes	699	123
14:00	Yes	Yes	Yes	Yes	837	132
15:00	Yes	Yes	Yes	Yes	1,040	144
16:00	Yes	Yes	Yes	Yes	998	127
17:00	Yes	Yes	Yes	Yes	1,097	154
	Total Hours Met	8	Total Hours Met	8		

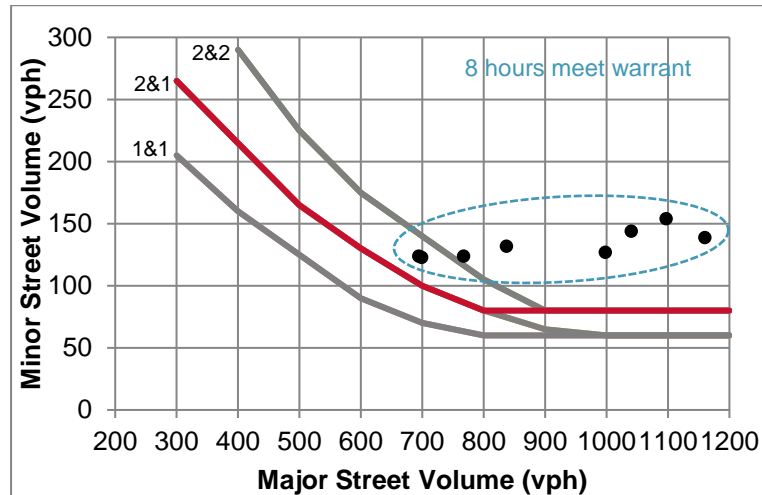
Based on this analysis of Warrant 1 – Condition A, the *installation of a traffic signal at the Highway 125 / I-44 Westbound ramp terminal intersection would be warranted.*

**Warrant 2 – 4-Hour Warrant appears to be SATISFIED** at the Highway 125 / I-44 Westbound Ramp terminal intersection. The Four-Hour Vehicular Volume signal warrant is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is considered met if, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in **Figure 1** for the existing combination of approach lanes. In this scenario, because Highway 125 has two approach lanes and the westbound off-ramp is a single-lane ramp, the red-highlighted 2&1 curve is the applicable one.



On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.

**Figure 1: Four-Hour Warrants Hwy 125 / I-44 Ramp**



Based on this analysis of Warrant 2, the *installation of a traffic signal at the Highway 125 / I-44 Westbound Ramp terminal intersection would be warranted.*

**Warrant 3 – Peak Hour Warrant – Category B appears to be SATISFIED** at the Highway 125 / I-44 Westbound Ramp terminal intersection. The Peak Hour signal warrant is intended for use at locations where traffic conditions are such that for a minimum of 1 hour of an average day, the minor street traffic suffers undue delay when entering or crossing the major street. The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of Category A or Category B are met. According to the MUTCD, the peak hour warrant should only be applied in unusual cases; near facilities that attract or discharge large numbers of vehicles over a short time. The study intersection is influenced by the nearby Strafford High School and Elementary School, which produce heavy traffic movements before and after school hours. Due to the proximity of the school, this warrant minimally meets this criterion. Therefore, the peak hour warrant was examined for the study intersection.

Category A for this warrant is considered met if ALL three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and,
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour (vph) for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and,
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

Total stop time delay was calculated in the 2021 Existing Conditions Synchro models with the studied intersections modeled as two-way stop-controlled intersections. Results from this analysis are provided in **Table 3**.

**Table 3: Stopped Time Delay during 2021 Peak Hour**

Peak	Intersection	Movement	Volume	Delay (sec/veh)	Total Stopped Time Delay (vehicle-hrs)
AM	Highway 125 / I-44 WB ramp	WB Left	45	94.4	1.18
PM	Highway 125 / I-44 WB ramp	WB Left	55	61.4	0.94

**Note:** Methodology - HCM 6<sup>th</sup> Edition

Results of all three Category A conditions are shown in **Table 4**.

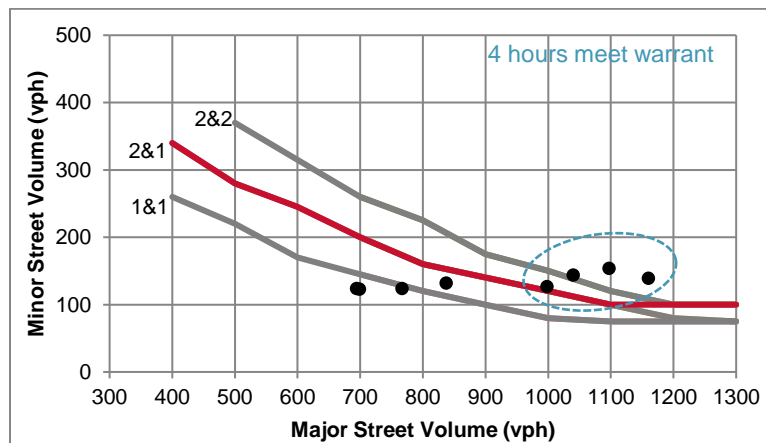
**Table 4: Warrant 3 – Category A Results**

Peak	Intersection	Stopped Time Delay (>4 veh-hrs)	Minor Street Volume (>100 vph)	Total Entering Volume (>650 vph)	Met?
AM	Highway 125 / I-44 WB ramp	1.18	45	1293	No
PM	Highway 125 / I-44 WB ramp	0.94	55	1250	No

Category A does not meet minimum warrant requirements. Therefore, Category B was evaluated.

Category B for this warrant is considered met if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in **Figure 2** for the existing combination of approach lanes. In this scenario, because Highway 125 has two approach lanes and the westbound off-ramp is a single-lane ramp, the red-highlighted 2&1 curve is the applicable one.

**Figure 2: Peak Hour Warrant Hwy 125 / I-44 Ramp**



Based on this analysis of Warrant 3 – Category B, the *installation of a traffic signal at the Highway 125 / I-44 Westbound Ramp terminal intersection would be warranted.*



### Concept 4/4A and 7/7A

Concepts 4/4A and 7/7A include the signalization of the intersections at Highway 125 / Highway OO and Highway 125 / Washington Avenue. Traffic signal warrant analyses followed the same methodology described above for Concepts 1, 2/2A, and 3/3A.

#### *Highway 125 / Highway OO Intersection*

**Warrant 1 – 8-Hour Warrant appears to be NOT SATISFIED** at the Highway 125 / Highway OO intersection. The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is considered met if for each of any 8 hours of an average day the vehicles per hour given in both 70 percent columns of Condition A in **Table 5** exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street. This warrant is considered met if for each of any 8 hours of an average day the vehicles per hour given in both 70 percent columns of Condition B in **Table 5** exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

According to the MUTCD, the 70 percent traffic volumes columns may be used instead of the 100 percent columns, if the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied, and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. According to the MUTCD, the 56 percent traffic volumes columns may be used if the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

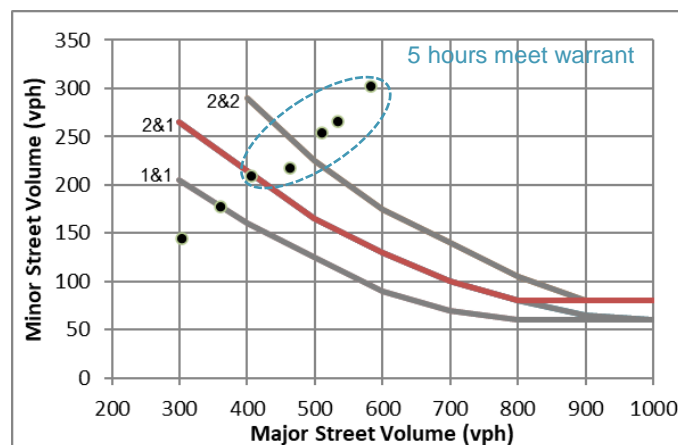
It is noted that while traffic counts were being conducted, the count equipment malfunctioned and the 10:00 – 11:00 AM data for this intersection was lost. Therefore, only seven (7) hours were evaluated, and it was determined that only 4 total combined hours met the minimum thresholds for Warrant 1. If the additional hour of lost data were included, this warrant would still not be met.

**Table 5: Eight-Hour Warrant Hwy 125 / Hwy OO**

Time	Condition A		Condition B		Combination A		Combination B		Volumes	
	70% Major (420)	70% Minor (105)	70% Major (630)	70% Minor (53)	56% Major (336)	56% Minor (84)	56% Major (504)	56% Minor (42)	Major	Minor
7:00	Yes	Yes	No	Yes	Yes	Yes	No	Yes	463	217
8:00	No	Yes	No	Yes	Yes	Yes	No	Yes	360	178
9:00	No	Yes	No	Yes	No	Yes	No	Yes	303	144
14:00	No	Yes	No	Yes	Yes	Yes	No	Yes	406	209
15:00	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	534	266
16:00	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	510	254
17:00	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	582	302
	Total Hours Met	4	Total Hours Met	0	Total Hours Met	4	Total Hours Met	3		

Based on this analysis of Warrant 1 – Condition A, Condition B, Combination A, and Combination B the *installation of a traffic signal at the Highway 125 / Highway OO would not be warranted.*

**Warrant 2 – 4-Hour Warrant appears to be SATISFIED** at the Highway 125 / Highway OO intersection. The Four-Hour Vehicular Volume signal warrant is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is considered met if, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in **Figure 3** (for each of the two intersections) for the existing combination of approach lanes. In this scenario, because Highway 125 has one left-turn lane and one through lane (two total lanes) and the southbound approach has one left-turn lane with separate right-turn lane (one total lane excluding the right-turn lane), the red-highlighted 2&1 curve is the applicable one. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.

**Figure 3: Four-Hour Warrant Hwy 125 / Hwy OO**

Based on this analysis of Warrant 2, the *installation of a traffic signal at the Highway 125 / Highway OO would be warranted.*



**Warrant 3 – Peak Hour Warrant – Category B appears to be SATISFIED** at the Highway 125 / Highway OO intersection. The Peak Hour signal warrant is intended for use at locations where traffic conditions are such that for a minimum of 1 hour of an average day, the minor street traffic suffers undue delay when entering or crossing the major street. The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of Category A or Category B are met. According to the MUTCD, the peak hour warrant should only be applied in unusual cases; near facilities that attract or discharge large numbers of vehicles over a short time. The study intersection is near the Strafford High School and Elementary School, which produce heavy traffic movements before and after school hours. Recently, an Industrial Park and residential subdivision have been approved for development just southwest of the study intersection. Due to the proximity of the school and nature of the approved developments, this warrant minimally meets this criterion. Therefore, the peak hour warrant was examined for the study intersection.

Category A for this warrant is considered met if ALL three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and,
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour (vph) for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and,
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

Total stop time delay was calculated in the 2021 Existing Conditions Synchro models with the studied intersections modeled as two-way stop-controlled intersections. Results from this analysis are provided in **Table 6**.

**Table 6: Stopped Time Delay during 2021 AM and PM Peak Hour**

Peak	Intersection	Movement	Volume	Delay (sec/veh)	Total Stopped Time Delay (vehicle-hrs)
AM	Hwy 125 / Hwy OO	SB	69	23.3	0.45
PM	Hwy 125 / Hwy OO	SB	132	28	1.03

**Note:** Methodology - HCM 6<sup>th</sup> Edition

Results from Category A evaluation are shown in **Table 7**.

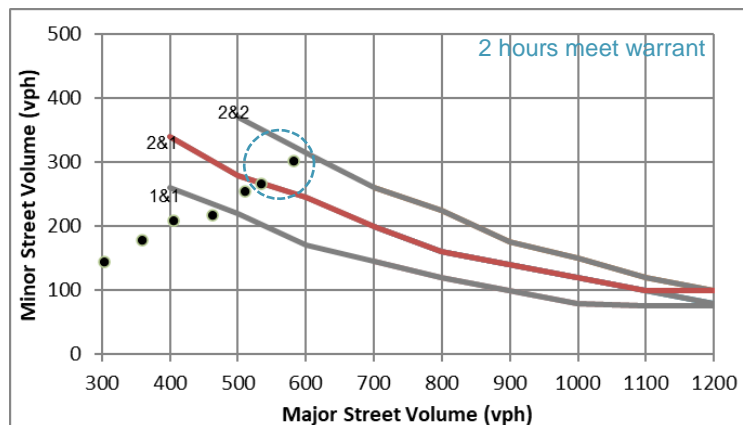
**Table 7: Warrant 3 – Category A Results**

Peak	Intersection	Stopped Time Delay (>4 veh-hrs)	Minor Street Volume (>100 vph)	Total Entering Volume (>650 vph)	Met?
AM	Hwy 125 / Hwy OO	0.45	69	753	No
PM	Hwy 125 / Hwy OO	1.03	132	919	No

Based on this analysis of Warrant 3 – Category A, the *installation of a traffic signal at the Highway 125 / Highway OO intersection would not be warranted*.

Category B for this warrant is considered met if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in **Figure 4** (for each of the two intersections) for the existing combination of approach lanes. In this scenario, because Highway 125 has one left-turn lane and one through lane (two total lanes) and the southbound approach has one left-turn lane with separate right-turn lane (one total lane excluding the right-turn lane), the red-highlighted 2&1 curve is the applicable one.

**Figure 4: Peak Hour Warrant Hwy 125 / Hwy OO**



Based on this analysis of Warrant 3 – Category B, the *installation of a traffic signal at the Highway 125 / Highway OO intersection would be warranted*.



**Highway 125 / Washington Avenue Intersection**

**Warrant 1 – 8-Hour Warrant** appears to be **NOT SATISFIED** at the Highway 125 / Washington Avenue intersection. The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is considered met if for each of any 8 hours of an average day the vehicles per hour given in both 70 percent columns of Condition A in **Table 8** exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street. This warrant is considered met if for each of any 8 hours of an average day the vehicles per hour given in both 70 percent columns of Condition B in **Table 8** exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

According to the MUTCD, the 70 percent traffic volumes columns may be used instead of the 100 percent columns, if the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied, and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. According to the MUTCD, the 56 percent traffic volumes columns may be used if the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

**Table 8: Eight-Hour Warrant Hwy 125 / Washington Avenue**

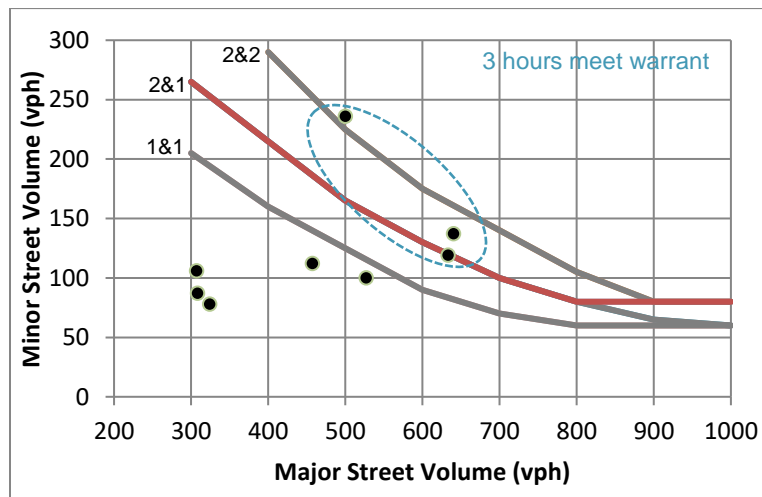
Time	Condition A		Condition B		Combination A		Combination B		Volumes	
	70% Major (420)	70% Minor (105)	70% Major (630)	70% Minor (53)	56% Major (336)	56% Minor (84)	56% Major (504)	56% Minor (42)	Major	Minor
7:00	Yes	Yes	No	Yes	Yes	Yes	No	Yes	500	236
8:00	No	No	No	Yes	No	Yes	No	Yes	308	87
9:00	No	Yes	No	Yes	No	Yes	No	Yes	307	106
10:00	No	No	No	Yes	No	No	No	Yes	324	78
14:00	Yes	Yes	No	Yes	Yes	Yes	No	Yes	457	112
15:00	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	633	119
16:00	Yes	No	No	Yes	Yes	Yes	Yes	Yes	527	100
17:00	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	640	137
	Total Hours Met	4	Total Hours Met	2	Total Hours Met	5	Total Hours Met	3		

Based on this analysis of Warrant 1 – Condition A, Condition B, Combination A, and Combination B the *installation of a traffic signal at the Highway 125 / Washington Avenue would not be warranted.*

However, 7 hours in Combination A are satisfied and if volume counts were taken on another day or during another hour, the minimum 8 hours could be met and possibly satisfy Warrant 1 – Combination A.

**Warrant 2 – 4-Hour Warrant** appears to be **NOT SATISFIED** at the Highway 125 / Washington Avenue intersection. The Four-Hour Vehicular Volume signal warrant is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is considered met if, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in **Figure 5** (for each of the two intersections) for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours. Although only 3 hours are plotted above the applicable curve for Hwy 125 / Washington Avenue intersection, two additional points are very near the threshold, therefore a volume count on a different day could possibly have 5 hours plotted above the applicable curve. In this scenario, because Highway 125 has one left-turn lane and one through/right lane (two total lanes) and the Washington approaches have a single lane, the red-highlighted 2&1 curve is the applicable one.

**Figure 5: Four-Hour Warrant Hwy 125 / Washington Ave**



Based on this analysis of Warrant 2, the *installation of a traffic signal at the Highway 125 / Washington Avenue intersection would not be warranted.*

However, 3 hours in Warrant 2 are satisfied and if volume counts were taken on another day or during another hour, the minimum 4 hours could be met and possibly satisfy Warrant 2.

**Warrant 3 – Peak Hour Warrant – Category B** appears to be **NOT SATISFIED** at the Highway 125 / Washington Avenue intersection. The Peak Hour signal warrant is intended for use at locations where traffic conditions are such that for a minimum of 1 hour of an average day, the minor street traffic suffers undue delay when entering or crossing the major street. The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of



Category A or Category B are met. According to the MUTCD, the peak hour warrant should only be applied in unusual cases; near facilities that attract or discharge large numbers of vehicles over a short time. The study intersection is near the Strafford High and Elementary Schools that produce heavy traffic movements before and after school hours. Recently, an Industrial Park and residential subdivision have been approved for development just southwest of the study intersection. Due to the proximity of the school and nature of the approved developments, this warrant minimally meets this criterion. Therefore, the peak hour warrant was examined for the study intersection.

Category A for this warrant is considered met if ALL three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and,
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour (vph) for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and,
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

Total stop time delay was calculated in the 2021 Existing Conditions Synchro models with the studied intersections modeled as two-way stop-controlled intersections. Results from this analysis are provided in **Table 9**.

**Table 9: Stopped Time Delay during 2021 AM and PM Peak Hour**

Peak	Intersection	Movement	Volume	Delay (sec/veh)	Total Stopped Time Delay (vehicle-hrs)
AM	Hwy 125 / Washington Ave	NB	233	33.1	2.14
PM	Hwy 125 / Washington Ave	NB	136	17.8	0.67

**Note:** Methodology - HCM 6<sup>th</sup> Edition

Results from Category A evaluation are shown in **Table 10**.

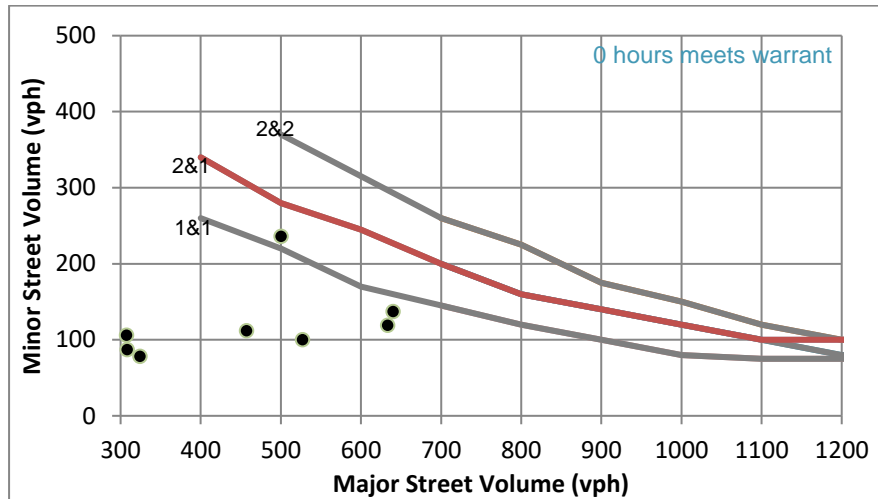
**Table 10: Warrant 3 – Category A Results**

Peak	Intersection	Stopped Time Delay (>4 veh-hrs)	Minor Street Volume (>100 vph)	Total Entering Volume (>650 vph)	Met?
AM	Hwy 125 / Washington Ave	2.14	233	1293	No
PM	Hwy 125 / Washington Ave	0.67	136	827	No

Based on this analysis of Warrant 3 – Category A, the *installation of a traffic signal at the Highway 125 / Washington Avenue intersection would not be warranted.*

Category B for this warrant is considered met if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in **Figure 6** (for each of the two intersections) for the existing combination of approach lanes.

**Figure 6: Peak Hour Warrant Hwy 125 / Washington Ave**





Category A for this warrant is considered met if ALL three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and,
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour (vph) for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and,
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

Total stop time delay was calculated in the 2024 No-Build Synchro models with the studied intersections modeled as two-way stop-controlled intersection. Results from this analysis are provided in **Table 11**.

**Table 11: Stopped Time Delay during 2024 AM and PM Peak Hour**

Peak	Intersection	Movement	Volume	Delay (sec/veh)	Total Stopped Time Delay (vehicle-hrs)
AM	Hwy 125 / Washington Ave	NB	418	1051.2	122.06
PM	Hwy 125 / Washington Ave	NB	333	309.6	28.64

**Note:** Methodology - HCM 6<sup>th</sup> Edition

Results from Category A evaluation are shown in **Table 12**.

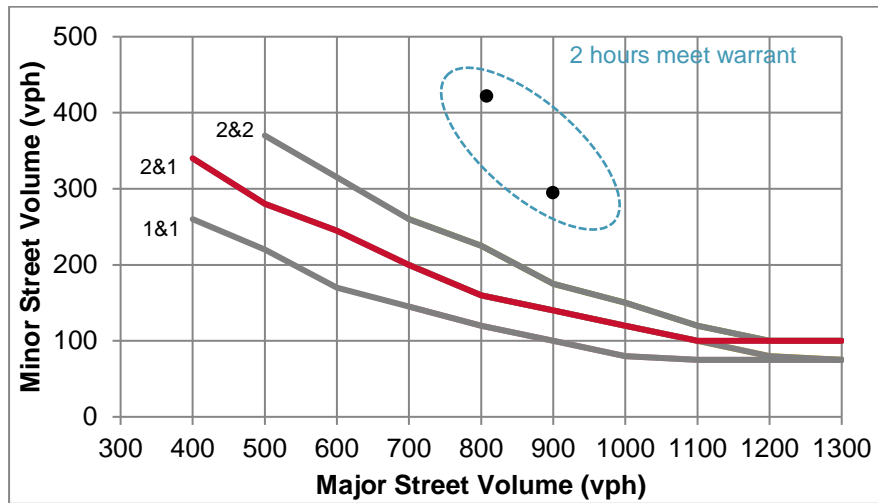
**Table 12: Warrant 3 – Category A Results**

Peak	Intersection	Stopped Time Delay (>4 veh-hrs)	Minor Street Volume (>100 vph)	Total Entering Volume (>650 vph)	Met?
AM	Hwy 125 / Washington Ave	122.06	418	1401	<b>Yes</b>
PM	Hwy 125 / Washington Ave	28.64	333	1417	<b>Yes</b>

Based on this analysis of Warrant 3 – Category A, the *installation of a traffic signal at the Highway 125 / Washington Avenue intersection would be warranted*.

Category B for this warrant is considered met if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in **Figure 7** (for each of the two intersections) for the existing combination of approach lanes.

Figure 7: Peak Hour Warrant Hwy 125 / Washington Ave



Based on this analysis of Warrant 3 – Category B, the *installation of a traffic signal at the Highway 125 / Washington Avenue intersection would be warranted.*



### Attachment 3: Volume Reassignment for Evergreen Street Relocation

2024										2044										
AM Opening Day					PM Opening Day					AM Future No Build					PM Future No Build					
← ↓ → 0 311 2					← ↓ → 0 191 5					← ↓ → 0 462 3					← ↓ → 0 284 7					
↗ 0	1. Highway 125/Route DD				4	↖	↗ 0	1. Highway 125/Route DD				0	↖	↗ 0	1. Highway 125/Route DD				0	↖
→ 0					0	←	→ 0					0	←	→ 0					0	←
↘ 0					93	↖	↘ 0					36	↖	↘ 0					53	↖
0 97 20					0 181 84					0 144 30					0 269 125					
↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					
← ↓ → 27 367 32					← ↓ → 14 221 13					← ↓ → 40 545 48					← ↓ → 21 328 19					
↗ 7	2. Highway 125/Evergreen Street (NEW)				0	↖	↗ 12	2. Highway 125/Evergreen Street (NEW)				0	↖	↗ 18	2. Highway 125/Evergreen Street (NEW)				0	↖
→ 17					12	←	→ 15					20	←	→ 22					30	←
↘ 148					233	↖	↘ 134					191	↖	↘ 199					284	↖
91 130 235					142 262 228					135 193 349					211 389 338					
↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					
← ↓ → 0 748 0					← ↓ → 0 546 0					← ↓ → 0 1111 0					← ↓ → 0 811 0					
↗ 0	2. Highway 125/Evergreen Street (OLD)				20	↖	↗ 0	2. Highway 125/Evergreen Street (OLD)				31	↖	↗ 0	2. Highway 125/Evergreen Street (OLD)				46	↖
→ 0					0	←	→ 0					0	←	→ 0					0	←
↘ 0					0	↖	↘ 0					0	↖	↘ 0					0	↖
0 436 26					0 601 25					0 648 39					0 893 38					
↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					
← ↓ → 304 445 0					← ↓ → 192 353 0					← ↓ → 452 661 0					← ↓ → 285 525 0					
↗ 0	3. Highway 125/I-44 WB Ramp				93	↖	↗ 0	3. Highway 125/I-44 WB Ramp				105	↖	↗ 0	3. Highway 125/I-44 WB Ramp				156	↖
→ 0					2	←	→ 0					0	←	→ 0					0	←
↘ 0					48	↖	↘ 0					58	↖	↘ 0					86	↖
114 369 0					97 521 0					169 548 0					144 774 0					
↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					↖ ↑ ↗					

## Attachment 4: Concept 7A Volume Reassignment

2024																
AM Opening Day						PM Opening Day										
<div>↙ ↓ ↘ 0 423 69</div>						<div>↙ ↓ ↘ 0 334 77</div>										
↗ 156	4. Highway 125/I-44 EB Ramp					0	↖	↗ 271	4. Highway 125/I-44 EB Ramp					0	↖	
→ 0						0	←	→ 1						0	←	→ 0
↘ 108						0	↙	↘ 170						0	↙	↘ 0
<div>0 327 40 ↖ ↑ ↗</div>						<div>0 347 73 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 267 263 1</div>						<div>↙ ↓ ↘ 171 323 11</div>										
↗ 37	5. Highway 125/Chestnut Street					4	↖	↗ 80	5. Highway 125/Chestnut Street					4	↖	
→ 0						3	←	→ 1						2	←	→ 0
↘ 6						3	↙	↘ 28						4	↙	↘ 0
<div>13 326 8 ↖ ↑ ↗</div>						<div>25 336 11 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 133 61 73</div>						<div>↙ ↓ ↘ 88 122 140</div>										
↗ 124	6. Highway 125/Route OO					83	↖	↗ 156	6. Highway 125/Route OO					118	↖	
→ 34						94	←	→ 134						36	←	→ 0
↘ 44						42	↙	↘ 50						50	↙	↘ 0
<div>129 135 20 ↖ ↑ ↗</div>						<div>51 92.9 38 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 10 0 5</div>						<div>↙ ↓ ↘ 6 0 6</div>										
↗ 16	7. Highway 125/Jefferson Street					17	↖	↗ 14	7. Highway 125/Jefferson Street					5	↖	
→ 194						336	←	→ 331						167	←	→ 0
↘ 0						0	↙	↘ 0						0	↙	↘ 0
<div>0 0 0 ↖ ↑ ↗</div>						<div>0 0 0 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 31 0 45</div>						<div>↙ ↓ ↘ 19 0 35</div>										
↗ 57	8. Highway 125/Washington Avenue/Olive					137	↖	↗ 34	8. Highway 125/Washington Avenue/Olive					43	↖	
→ 160						213	←	→ 305						126	←	→ 0
↘ 0						0	↙	↘ 0						0	↙	↘ 0
<div>0 0 0 ↖ ↑ ↗</div>						<div>0 0 0 ↖ ↑ ↗</div>										

2044																
AM Future Build						PM Future Build										
<div>↙ ↓ ↘ 0 629 103</div>						<div>↙ ↓ ↘ 0 496 114</div>										
↗ 232	4. Highway 125/I-44 EB Ramp					0	↖	↗ 403	4. Highway 125/I-44 EB Ramp					0	↖	
→ 0						0	←	→ 1						0	←	→ 0
↘ 160						0	↙	↘ 253						0	↙	↘ 0
<div>0 486 59 ↖ ↑ ↗</div>						<div>0 516 108 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 397 391 1</div>						<div>↙ ↓ ↘ 254 480 16</div>										
↗ 55	5. Highway 125/Chestnut Street					6	↖	↗ 119	5. Highway 125/Chestnut Street					6	↖	
→ 0						4	←	→ 1						3	←	→ 0
↘ 9						4	↙	↘ 42						6	↙	↘ 0
<div>19 484 12 ↖ ↑ ↗</div>						<div>37 499 16 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 198 90 108</div>						<div>↙ ↓ ↘ 131 181 208</div>										
↗ 185	6. Highway 125/Route OO					123	↖	↗ 232	6. Highway 125/Route OO					175	↖	
→ 50						139	←	→ 199						54	←	→ 0
↘ 65						63	↙	↘ 74						74	↙	↘ 0
<div>192 200 30 ↖ ↑ ↗</div>						<div>76 138 56 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 15 0 7</div>						<div>↙ ↓ ↘ 9 0 9</div>										
↗ 24	7. Highway 125/Jefferson Street					25	↖	↗ 21	7. Highway 125/Jefferson Street					7	↖	
→ 288						499	←	→ 492						248	←	→ 0
↘ 0						0	↙	↘ 0						0	↙	↘ 0
<div>0 0 0 ↖ ↑ ↗</div>						<div>0 0 0 ↖ ↑ ↗</div>										
<div>↙ ↓ ↘ 46 0 67</div>						<div>↙ ↓ ↘ 28 0 52</div>										
↗ 85	8. Highway 125/Washington Avenue/Olive					204	↖	↗ 51	8. Highway 125/Washington Avenue/Olive					64	↖	
→ 238						317	←	→ 453						187	←	→ 0
↘ 0						0	↙	↘ 0						0	↙	↘ 0
<div>0 0 0 ↖ ↑ ↗</div>						<div>0 0 0 ↖ ↑ ↗</div>										



Appendix D  
Safety Analysis Memo

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# Safety Appendix

Highway 125 Feasibility Study

Missouri Department of Transportation

*Strafford, MO*

February 8, 2022



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## Introduction

HDR Engineering, Inc. (HDR) was retained to perform a Feasibility Study for the Highway 125 corridor between Highway DD and Peachtree Lane in Strafford, MO. Centered near the intersection of Highway 125 with I-44, Strafford is a small community about 10 miles northeast of Springfield, MO. The study corridor is shown in **Figure 1**.

**Figure 1. Study Area**



The purpose of this analysis was to evaluate the feasibility of design changes along the corridor for their effectiveness at improving congestion, safety, and connectivity. Eleven (11) key study intersections were selected for analysis:

1. Highway 125 and Highway DD
2. Highway 125 and Evergreen Street
3. I-44 Westbound Ramp and Highway 125
4. I-44 Eastbound Ramp and Highway 125
5. Highway 125 and Chestnut Street
6. Highway 125 and Highway OO
7. Highway 125 and Jefferson Street
8. Highway 125 and Washington Avenue/Olive Street
9. Highway 125 and Old Orchard Drive
10. Highway 125 and Pinecrest Avenue
11. Highway 125 and Peachtree Lane

This memo specifically addresses the safety components of the analysis including historic crash assessments and predictive safety analyses.



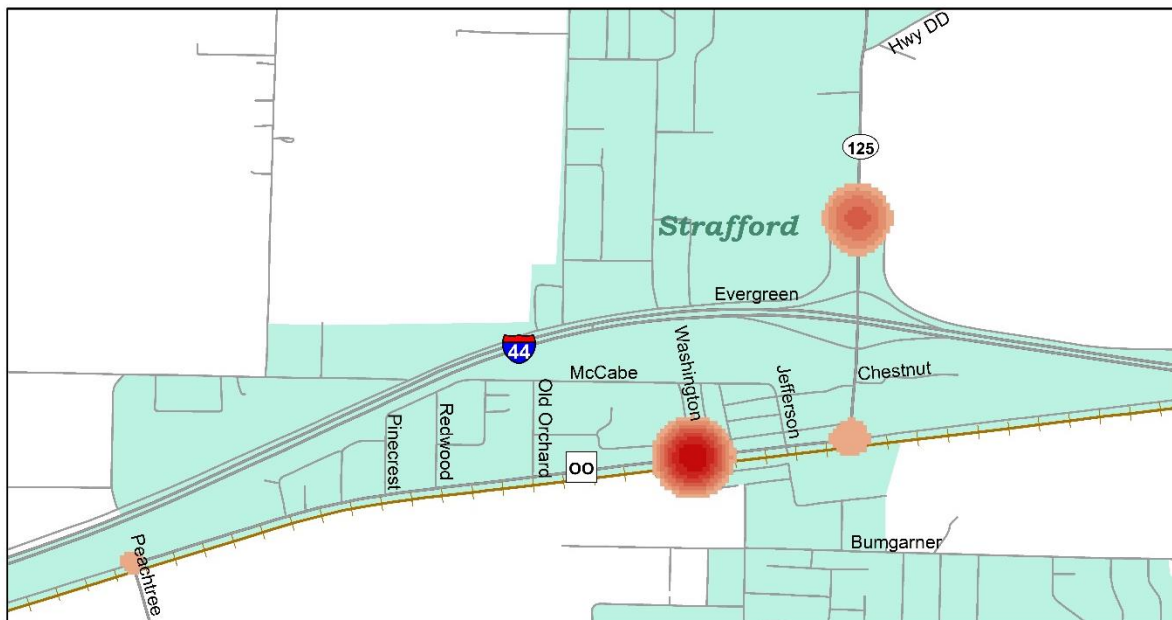
## Historic Safety

Historic crash data was obtained for the 11 study area intersections for the five-year period from 2016-2020. The crash analysis focused on intersections; no segment-level analysis was conducted. During the five-year analysis period, there were 187 total crashes reported. Of those, two crashes reported serious injuries and another 44 involved minor injuries. The remaining 141 crashes resulted in property damage only. There were no fatalities reported within the study area during the five-year analysis period.

As shown in **Figure 2**, crashes tended to cluster most often at four of the study intersections:

1. Highway 125 and Washington Avenue / Olive Street – 62 crashes
2. Highway 125 and Evergreen Street – 40 crashes
3. Highway 125 and Highway OO – 22 crashes
4. Highway 125 and Peachtree Lane – 20 crashes

**Figure 2: Crash Hot Spots, 2016-2020**



The most severe crashes, the two resulting in serious injuries, occurred at two of the high-frequency, hot spot intersections: one at Evergreen Street and one at Highway OO.

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The types of crashes experienced at each of the study intersections varied, influenced by the geometry and traffic control present. **Figure 3**, on the following page, shows the crash types and amounts at the four hot spot intersections.

At the Highway 125 and Washington Avenue intersection, which is stop-controlled on the minor leg approaches, the predominant crash type is right-angle crashes (36). This type of crash suggests that drivers are turning onto Highway 125 when there are inadequate gaps in the mainline traffic flow. This occurs when drivers become impatient waiting for a break in traffic, due to un-metered flows on Highway 125. It should be noted that Washington Avenue is one of the most direct routes for Strafford High School traffic to access (and cross) Highway 125.

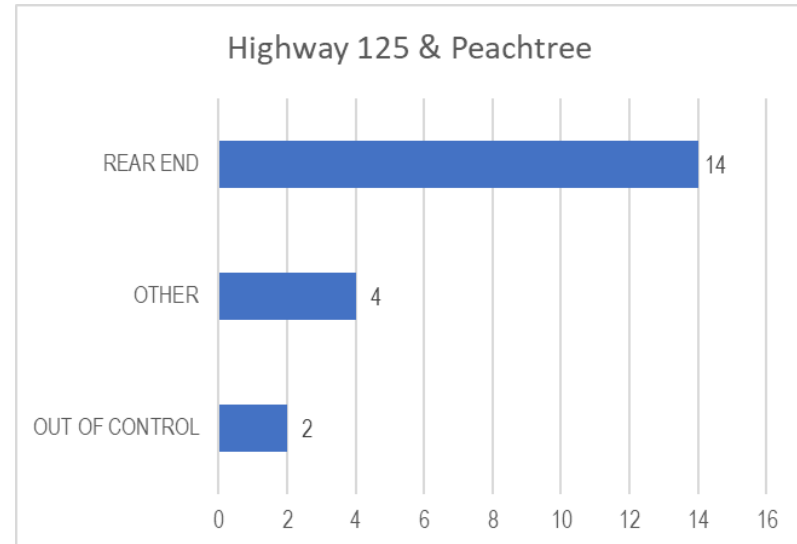
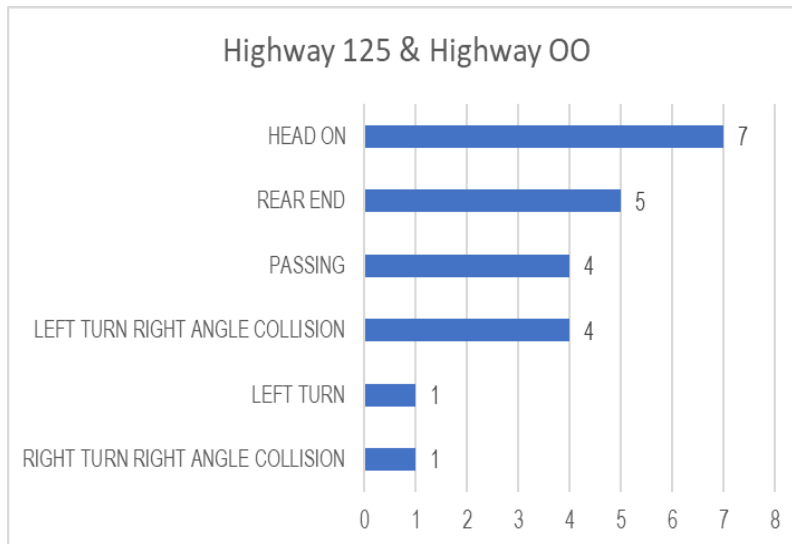
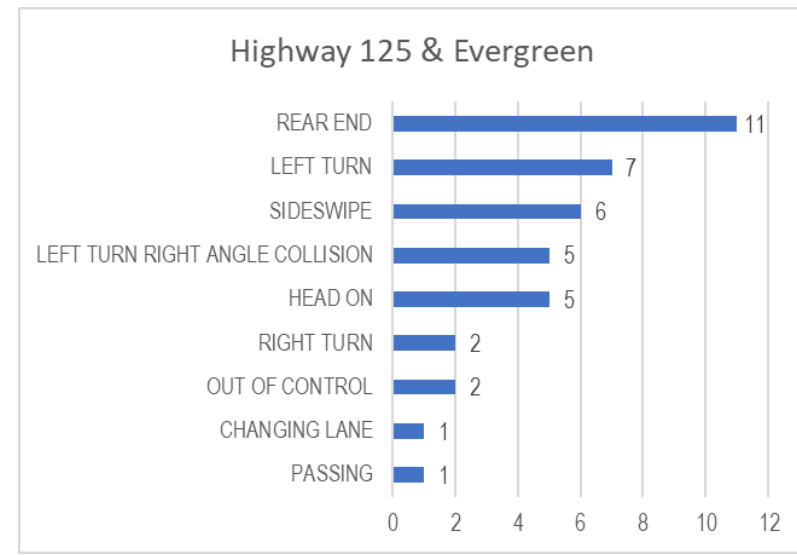
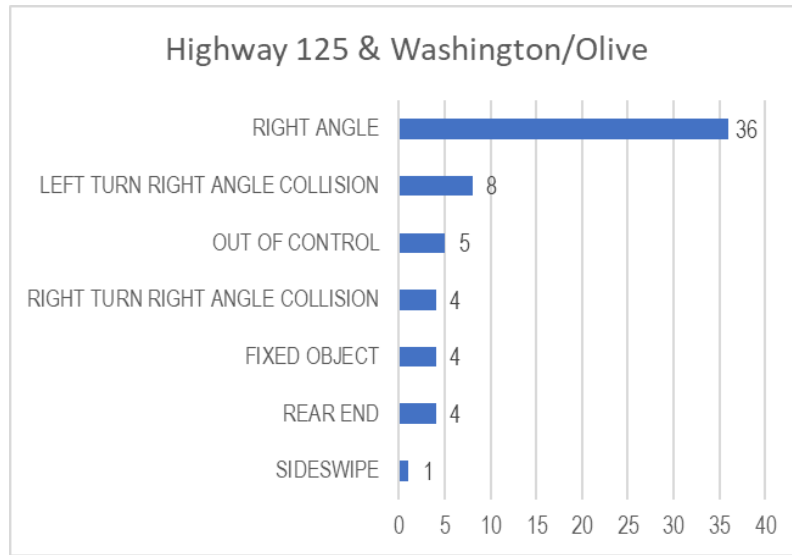
At Highway 125 and Evergreen Street, which is signalized, the most common crash types were rear-end (11) and left turn (7). Rear-end crashes are often associated with traffic slowing or coming to an unexpected stop, as can be the case when drivers approach a yellow or red light (or the back of a queue). The number of left turn crashes may have been influenced by the existing signal phasing, which allows for permitted left turns.

The most common crash type at the Highway OO intersection is head-on crashes (7). There are left turn lanes present along Highway 125 near this intersection, separating the through traffic flows from each other, and presumably helping prevent head-on collisions. It is possible that these crashes have been miscoded and are in fact right-angle crashes between westbound through vehicles and eastbound left-turning vehicles. However, this is only speculation.

The intersection of Highway 125 with Peachtree Lane experienced mostly rear-end crashes (14), despite being unsignalized. At this location, the rear-end crashes may have been caused by vehicles stopping at the railroad crossing, located just south of the intersection. Another possible cause is the geometry of the sweeping northbound right-turn, which could contribute to rear-end crashes because drivers must look back over their shoulders to see whether there is oncoming traffic as they merge onto Highway 125.



**Figure 3: Crash Types, Four Highest Crash Intersections**



Crash rates for each study intersection were also calculated based on the historic five-year crash data. Crash rates represent the number of crashes that occur in a given location during specified time period, divided by a measure of exposure. For intersections, the exposure is typically expressed as Ten Million Entering Vehicles (TMEV). **Table 1** displays the calculated crash rates for each of the study intersections. As shown, the intersection of Highway 125 and Washington Avenue has a significantly higher crash rate (43.55) than any other study intersection. An additional four intersections have relatively high crash rates (between 13.2 and 18.7). As expected, the intersections with high crash rates also have the highest number of crashes, identified and discussed in the prior section.

**Table 1: Crash Rates**

Intersection	Total Crashes (2016-2020)	Total Entering Vehicles (Daily)	TMEV/Year	Crash Rate (Crashes/TMEV)
1 Hwy 125 & Hwy DD	4	4,800	0.876	4.57
2 Hwy 125 & Evergreen	40	11,700	2.135	<b>18.73</b>
3 Hwy 125 & WB Ramps	7	12,100	2.208	3.17
4 Hwy 125 & EB Ramps	9	10,750	1.962	4.59
5 Hwy 125 & Chestnut	2	8,600	1.570	1.27
6 Hwy 125 & Hwy OO	22	7,600	1.387	<b>15.86</b>
7 Hwy 125 & Jefferson	8	5,850	1.068	7.49
8 Hwy 125 & Washington/Olive	62	7,800	1.424	<b>43.55</b>
9 Hwy 125 & Old Orchard	13	5,400	0.986	<b>13.19</b>
10 Hwy 125 & Pinecrest	no data	--	--	--
11 Hwy 125 & Peachtree	20	5,900	1.077	<b>18.57</b>

TMEV = Ten Million Entering Vehicles



## Predictive Safety

In addition to examining historical crash data, a predictive safety analysis was conducted to examine how potential improvements could help reduce crashes at the study intersections in the future. The methods presented in the *2014 Supplement to the Highway Safety Manual* (HSM), as well as FHWA's *Crash Modification Factor (CMF) Clearinghouse* were utilized for this analysis.

As described in the *Strafford Alternatives Analysis Report*, a number of conceptual improvements were considered and eventually narrowed down to four alternatives that were carried forward for predictive safety analysis. In the sections below, each of those four concepts are described along with their potential safety benefits. Concepts 2 and 3 focus on the intersections on the north side of I-44, while Concepts 4 and 7 (originally introduced as 4A and 7A but renamed after original Concepts 4 and 7 were eliminated) focus on the intersections to the south.

### Concept 2

As shown in **Figure 4**, Concept 2 proposes the following:

- Signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Relocation of the Highway 125 and Evergreen Street signalized intersection to the north. The relocated intersection would be signalized.
- Realignment of Evergreen Street on the east side of Highway 125.

The signalization of a four-leg, stop-controlled intersection is a treatment with a defined crash modification factor (CMF) of 0.614<sup>1</sup>, meaning it can be expected to reduce crashes by about 39%. The other elements included in Concept 2, however, have less clearly defined impacts upon safety. Relocating Evergreen Street to the north, moving it away from the functional area of the I-44 interchange, is likely to have a safety benefit, although a specific crash reduction amount is unknown. According to the *Highway Safety Manual* (HSM), it is generally accepted that reducing the number of access points within the functional area of an intersection (or interchange) reduces the potential for crashes<sup>2</sup>.

Conversely, the addition of an intersection within the study area could be expected to increase the number of crashes. By maintaining right-in/right-out access to businesses along the east side of Highway 125 at the existing Evergreen Street intersection, this Concept essentially creates an additional intersection within the study area. However, with the restricted turning movements and expected low volumes at that location, any increased crashes are expected to be nominal.

---

<sup>1</sup> *Safety Evaluation of Signal Installation With and Without Left Turn Lanes on Two Lane Rural and Suburban Areas*, Srinivasan Et. Al., 2014.

<sup>2</sup> *Highway Safety Manual*, Appendix 14A – Treatments without CMFs, 14A.3.1.1.

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Figure 4: Concept 2 Layout



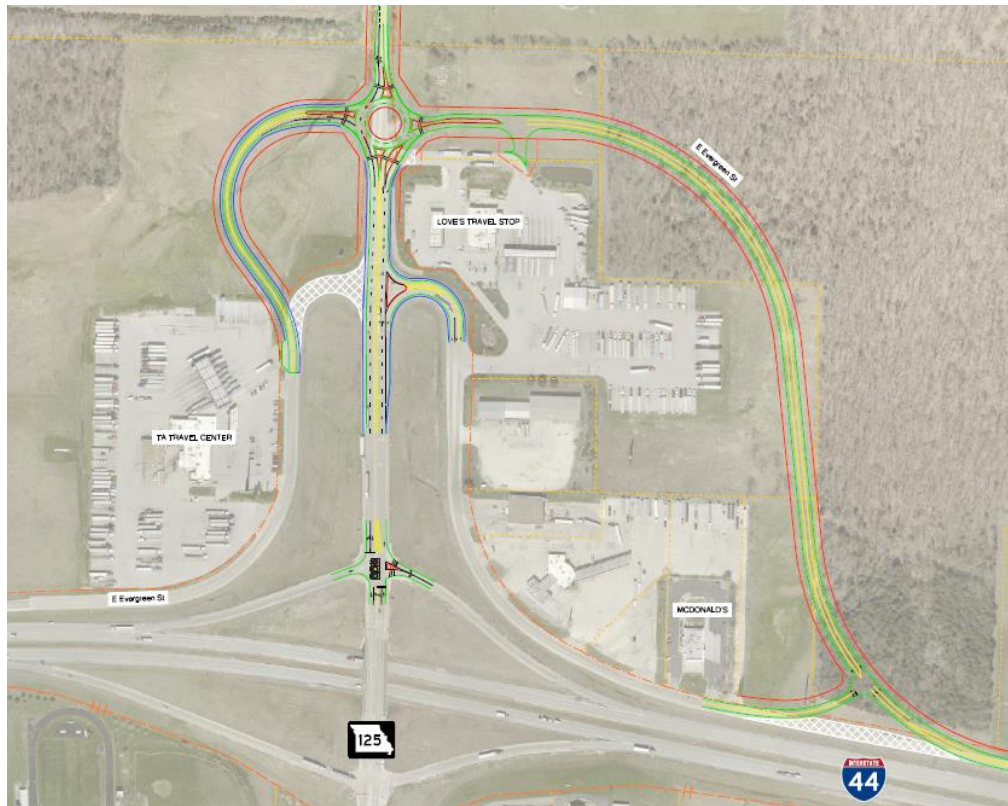


## Concept 3

As shown in **Figure 5**, Concept 3 proposes the following:

- Signalization of the Highway 125 and I-44 Westbound Ramp terminal intersection.
- Relocation of the Highway 125 and Evergreen Street intersection to the north.
- Construction of the relocated Highway 125 and Evergreen Street intersection as a roundabout.
- Realignment of Evergreen Street on the east side of Highway 125.

**Figure 5: Concept 3 Layout**



The safety implications of the proposed treatments included in Concept 3 are the same as described for Concept 2, but with one additional safety benefit for converting a signalized intersection to a modern roundabout. A 2011 study<sup>3</sup> places a CMF of 0.79 (a 21% crash reduction) on projects that convert a signalized intersection to a modern roundabout. However, most research on the safety of roundabouts is applicable to single-lane roundabouts. Since the configuration proposed under Concept 3 would include multiple lanes on some approaches, the full safety potential may not be reached, particularly early on, before drivers become familiar with the intersection layout. Certain safety benefits can still be expected, however; for example, by eliminating traditional left turns at the intersection, the possibility of left-turn crashes would be removed. The yield conditions of a roundabout may also help reduce the number of rear-end collisions, as drivers will expect traffic to slow down when approaching the roundabout.

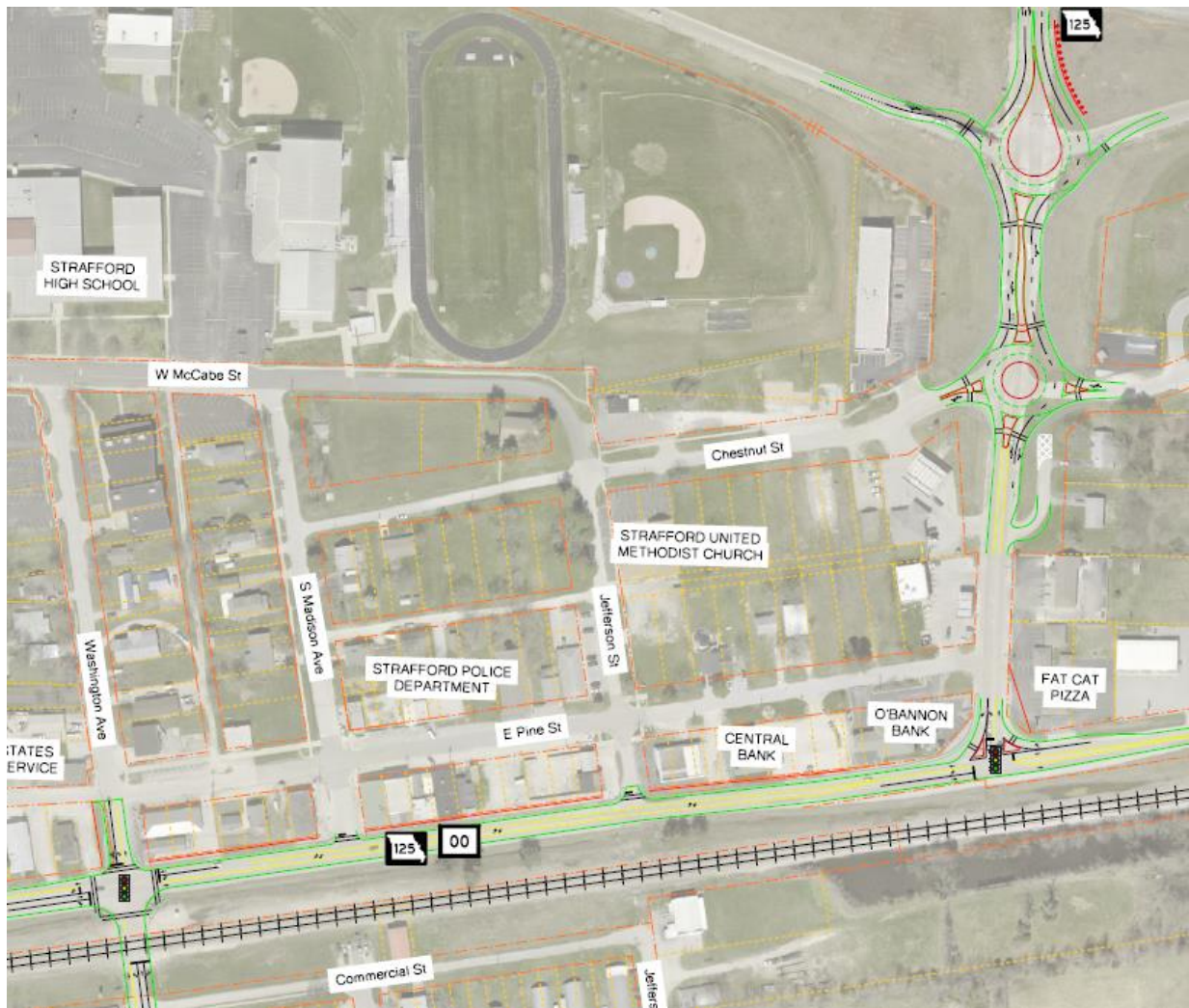
<sup>3</sup> *Evaluation of Safety Strategies at Signalized Intersections*, Srivivasan, Et. Al., 2011.

## Concept 4

As shown in **Figure 6**, Concept 4 (originally designated as 4A) includes the following:

- Widen Highway 125 to provide a continuous three-lane section between the Highway OO intersection and the Washington Avenue / Olive Street intersection (portions of this segment are already 3 lanes).
- Signalization of the Highway 125 at Washington Avenue intersection.
- Signalization of the Highway 125 at Highway OO intersection.
- Construction of a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal.
- Construction of a roundabout at the Highway 125 and Chestnut Street intersection.

**Figure 6: Concept 4 Layout**





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Constructing a three-lane section along Highway 125 would have safety benefits both by creating a buffer between opposing traffic flows, and by separating left-turning vehicles to eliminate slowing or stopping in the through traffic lane. A study on the safety effectiveness of turn lanes<sup>4</sup> details a CMF of 0.52 (a 48% crash reduction) for providing left turn lanes on both major-road approaches to an intersection, as would be the new configuration at the Highway 125 / Jefferson Street intersection.

There are widely accepted CMFs for installing a traffic signal (0.61 at a 4-leg intersection and 0.72 at a 3-leg intersection). Therefore, both of the intersections for which signals are proposed in Concept 4 should experience a safety benefit. As described previously, the Highway 125 and Washington Avenue intersection reported the most crashes (and highest crash rate) during the five-year analysis period, including a high incidence of right-angle crashes. Signalization at this intersection should improve safety by lowering the instances of these crashes.

This concept also has two applicable CMFs for construction of a roundabout: one for conversion of a signal to a roundabout, as discussed under Concept 3; and one for conversion of a stop-controlled intersection to a roundabout, which provides a crash reduction factor of 0.81, according to *NCHRP Report 572*. While multi-lane roundabouts (as proposed under this concept) have not shown as great a safety benefit as single lane roundabouts, especially when driver-familiarity is low, certain crash types can still be expected to be reduced.

## Concept 7

As shown in **Figure 7**, Concept 7 (originally designated as 7A) proposes the following:

- Construction of a roundabout at the Highway 125 and I-44 Eastbound Ramp terminal.
- Construction of a roundabout at the Highway 125 and Chestnut Street intersection.
- Signalization of the Highway 125 / Washington Avenue intersection, and closure of the south leg to eliminate the at-grade rail crossing.
- Signalization of the Highway 125 / Highway OO intersection, and addition of a 4-leg extending south to Bumgarner Boulevard. This creates a new at-grade rail crossing just south of Highway 125.

Concept 7 includes many of the same elements as Concept 4, and therefore has similar safety benefits. However, one improvement that is not included in Concept 7 is widening of Highway 125, and therefore safety benefits at the Jefferson Street intersection would not be realized. Additionally, by constructing the new extension of Highway 125 south to Bumgarner Boulevard, new intersections and roadway mileage would be added to the study area, subsequently causing the potential for increased crashes.

Concept 7 proposes the closure of one at-grade railroad crossing on Olive Street, but also proposes creating a new a crossing along the proposed southern extension of Highway 125, essentially offsetting any safety benefits.

---

<sup>4</sup> *Safety Effectiveness of Intersection Left- and Right-Turn Lanes*, Harwood Et. Al., 2002.

**Figure 7: Concept 7 Layout**



**Table 2**, on the following page, provides a summary of the predictive safety analysis for the treatments that could be numerically assessed based on their CMF values. For each of the four concepts, the table describes the proposed treatments and their applicable intersections, as well as CMF specifics from the Clearinghouse and the annual crash reduction that could be expected as a result of implementing the proposed improvements.



**Table 2: Predictive Safety Evaluation**

Intersection		Historic 5-Year Crashes				Proposed Treatment	CMF Clearinghouse ID*	CMF Value	Crashes Reduced Per Year			
		Fatal / Serious Injury	Minor Injury	PDO	Total				Fatal / Serious Injury	Minor Injury	PDO	Total
<b>Concept 2</b>	Hwy 125 & I-44 WB Ramps	0	0	7	7	Install Signal (4-leg)	ID 7982	0.614	--	--	0.54	<b>0.54</b>
<b>Concept 3</b>	Hwy 125 & Evergreen	1	9	30	<b>40</b>	Convert to Roundabout from Signal	ID 4252	0.792	0.04	0.37	1.25	<b>1.66</b>
	Hwy 125 & I-44 WB Ramps	0	0	7	7	Install Signal (4-leg)	ID 7982	0.614	--	--	0.54	<b>0.54</b>
<b>Concept 4</b>	Hwy 125 & I-44 EB Ramps	0	1	8	<b>9</b>	Convert to Roundabout from Signal	ID 4252	0.792	--	0.04	0.33	<b>0.37</b>
	Hwy 125 & Chestnut	0	1	1	<b>2</b>	Convert to Roundabout from Stop-Control	ID 240	0.810	--	0.04	0.04	<b>0.08</b>
	Hwy 125 & Hwy OO	1	7	14	<b>22</b>	Install Signal (3-leg)	ID 7981	0.716	0.06	0.40	0.80	<b>1.25</b>
	Hwy 125 & Jefferson	0	4	4	<b>8</b>	Provide Left-Turn Lanes on Major Approaches	ID 268	0.520	--	0.38	0.38	<b>0.77</b>
	Hwy 125 & Washington	0	16	46	<b>62</b>	Install Signal (4-leg)	ID 7982	0.614	--	1.24	3.55	<b>4.79</b>
	Hwy 125 & I-44 EB Ramps	0	1	8	<b>9</b>	Convert to Roundabout from Signal	ID 4252	0.792	--	0.04	0.33	<b>0.37</b>
<b>Concept 7</b>	Hwy 125 & Chestnut	0	1	1	<b>2</b>	Convert to Roundabout from Stop-Control	ID 240	0.810	--	0.04	0.04	<b>0.08</b>
	Hwy 125 & Hwy OO	1	7	14	<b>22</b>	Install Signal (4-leg)	ID 7982	0.614	0.08	0.54	1.08	<b>1.70</b>
	Hwy 125 & Washington	0	16	46	<b>62</b>	Install Signal (3-leg)	ID 7981	0.716	--	0.91	2.61	<b>3.52</b>

\*Each of the CMFs proposed in this evaluation are defined in the Clearinghouse as being applicable to all crash types and all crash severities.

Using severity-based, per-event crash costs, shown in **Table 3**, the cost savings of the proposed treatments can be derived for the lifetime of each Concept, assuming a design year of 2044. The cost savings calculations are adjusted by a discount rate which considers traffic volume increases over time, which incrementally increases the number of estimated crashes per year, and considers inflation, which incrementally reduces the monetary benefit of the crash reductions each year.

**Table 3: Crash Cost Parameters, per event**

Severity	
Property Damage Only	\$ 10,500
Minor Injury	\$ 150,300
Combined Serious Injury / Fatality	\$ 2,487,497

*Source: MoDOT*

As shown in **Table 4**, the concepts focusing on the southern part of the study area (Concepts 4 and 7) offer a greater monetary safety benefit than do the concepts focusing on the northern area. Based solely on CMFs, and not considering any anecdotal crash reductions, Concept 4 provides the greatest safety benefit, at over \$12M, for the lifetime of the project.

**Table 4: Lifetime Safety Benefit, through 2044 Design Year (\$2021)**

Concept 2	\$133,879
Concept 3	\$4,212,315
Concept 4	\$12,031,752
Concept 7	\$10,959,346



Appendix E  
Request for Environmental Services

# DRAFT

## APPENDIX E

This RES has been completed, only administrators may edit this document now, they will contact you if any information changes.

Date Completed: 02/01/2022

Completed By: Charlotte Drinkard

### Request for Environmental Services Form#:2022-12-00450

☐ Alternative Project Delivery Method (such as Design/Build)

#### ▼Project Information

Stage:	Location/Conceptual	Previous RES(s):	2022-09-00254
Job Number (w/o 'J'):	8S3238	District:	Southwest
		County:	GREENE
TIP Number:		Rte/Street:	MO 125
Letting Date:	01/01/2024	PS&E Due Date:	10/26/2023
Location:	Intersection improvements at various locations in Strafford.		
TMS Project Description - termini (no stations):	Intersection improvements at various locations in Strafford.		
Describe RES project improvements in full detail:	To improve traffic operations, MoDOT is considering improvements for eight intersections on Highway 125 in Strafford Missouri. There are currently nine alternatives being considered. Alternatives 3, 4A, and 7A represent all possible impacts to environmental resources since the remaining six alternatives are only parts of these three alternatives. Therefore, only alternatives 3, 4A, and 7A are included in the figures for impact considerations.		

These users will receive a notification when Environmental Services completes the current stage, the person who created this form as well as the person who submits it will also receive notification.

Project Manager:	Kristi Bachman - 417-829-8040	TP Designer:	Cameron Sooy - 417-895-7612
District Contact:	Melanie Belote - 417-829-8043	District Contact:	None selected
Contact:	None selected		
Date Desired:	02/02/2022	Submit Date:	01/03/2022
Desired A-Date:	01/01/2024		
Created By:	Ian Waters - (12/17/2021 10:12:11 AM) - 816-347-1346	Submitted By:	Ian Waters - (1/3/2022 12:00:00 AM) - 816-347-1346
<b>Program Year:</b>			
Preliminary Engineering:	2022	Right of Way:	2024
Construction:	2024		
Has the district documented that the project has: 1. Independent utility, 2. Logical termini, and 3. Does not restrict consideration of alternatives for other reasonably foreseeable transportation improvements?:	<input checked="" type="radio"/> Yes <input type="radio"/> No		
Changes to project since last RES submittal? If yes, explain:	No, Preliminary concepts have been developed and impacts to resources are more defined. <input type="checkbox"/> Design/Build <input type="checkbox"/> Alternate Technical Concepts		



# DRAFT

## APPENDIX E

☐ Project breakout from previous or larger project? *If checked explain:*

### Acres - From all sources (e.g. donated from public or private entities):

Additional R/W (acres): 8

Temp Easement (acres): 0

Permanent Easement (acres): 0

ROW may be needed, but, not yet determined? Yes

Acres of Tree Clearing: 8.5 acres

DO NOT CLEAR TREES W/O MODOT'S PRIOR WRITTEN APPROVAL.

Is ANY Federally-owned land impacted by the project? ☐ Yes ☒ No

### Land Disturbance / Stormwater:

Will project involve 1 acre of land disturbance: ☒ Yes ☐ No ☐ Unknown

Define project type (see definitions below): ☒ New Development ☐ Redevelopment ☐ Maintenance

*Projects with one acre or greater land disturbance activities must comply with the Land Disturbance Permit requirements.*

**New Development** - Projects (with land disturbance greater than or equal to 1 acre) that are constructed where there was previously no transportation facility.

**Redevelopment** - Non-maintenance work performed to or on an existing public transportation facility which provides for an increased number of thru lanes of travel unless the work can be accommodated without increasing the width of the existing pavement. Widening of an existing road that does not result in an additional thru lane does not constitute redevelopment. Widening to add shoulders does not constitute a thru lane unless the total widening is greater than or equal to 10 feet.

**Maintenance** - Projects that do not meet the criteria of redevelopment or new development.

Was coordination with adjacent MS4 communities conducted? ☐ Yes ☒ No

If yes, please provide a short description of the coordination:

### Number of Displacements(do not include partial takes that do not displace):

Residential: ☐ Yes ☒ No

Commercial: ☐ Yes ☒ No

No. of People:

Residences:

No. of Employees:

Businesses:

### Any Public Involvement planned or completed:

None.

### Average Daily Traffic:

ADT Construction Year: TBD

ADT Design Year: 1,180 - 5,294

**Traffic Impacts:**Road Closure Planned: ☐ Yes ☒ NoBridge Closure Planned: ☐ Yes ☒ No

Days/Months Closed:

Detour > 25 mi rural ☐ Yes ☒ NoDetour > 5 mi urban ☐ Yes ☒ No  
(inside MPO)Detour Info (including  
use of local roads):**Bicycle / Pedestrian Consideration**Pedestrian facilities  
considered: YesBicycle facilities  
considered: Yes**National Flood Insurance Program (NFIP) and Hydraulic Design Data:**

- ☐ Project is in a FEMA-identified zone "subject to 100-year flooding": *If so, what zone?:* FEMA Map shows "Limit of Study" nearby.

Project is in a FEMA-defined "floodway"

No

- ☐ Project involves land purchased through FEMA Hazard Mitigation Grant Program (Flood buyout property)

*If checked, give details:*

- ☐ Is highway improvement located within 4 miles of an existing airport?

**Known Concerns: Provide information you have about these resources that you have observed in the area.**

**Parkland:** There is an adjacent sports complex west of Route 125 and south of I-44. The concepts will not impact these parks. See Figure 4.

**Wetland/404 Permit:** A wetland delineation has not been performed in the project corridor. National Wetland Inventory (USFWS) and National Hydrologic Dataset (USGS) shows no water features within the proposed concepts, however aerial imagery depicts what may be erosional ditches north of I-44 and west of Route 125. There is also an intermittent stream in the forest north of I-44 and west of Route 125, and depending on where the upper stream limits are located, may be impacted by concepts 3. Impact to jurisdictional waters of the U.S. are possible. See Figure 5.

**Land Disturbance / Stormwater:** Dependent on the preferred alternative, land disturbance is likely to be minimal except where new alignments are proposed.

**Farmland:** Majority of the project corridor is on prime farmland according to NRCS Soil Database. Concepts 3 and 7 would negatively impact this resource. See Figure 6.

**Threatened & Endangered Species:** According to USFWS IPAC review (Attachment A), there are three bat species that could be potentially affected, the Gray bat, Northern Long-eared bat, and Indiana bat. Habitat may exist in the forest east of Route 125 and north of I-44 where Concept 3 is located. Two fish, the Niangua Darter and Ozark Cavefish, are listed in the IPAC for the project area, along with designated critical habitat for the Niangua Darter. The Niangua Darter prefers clear, medium streams and do not occur in Osage tributaries that are greater than or equal to three stream orders in size. The Ozark Cavefish prefers to inhabit caves or springs. Neither of these habitats exist in the project area therefore no impacts are likely. Monarch butterfly has been recently listed as a candidate species. They are found in a wide variety of habitats: fields and grasslands, roadsides, and urban and suburban plantings. Monarch butterfly is a candidate proposed for listing. Neither section 7 of the Endangered Species Act nor the implementing regulations for section 7 contain requirements for federal agencies with respect to candidate species.

**Migratory Birds: Are there birds nesting on the structure?** Unknown, Migratory bird nests may exist within the forest east of Route 125 and I-44 which Concept 3 would impact.

**Hazardous Waste:** Missouri's E-Start database shows storage tanks near the current road alignments, but none where the new alignments are anticipated for the proposed concepts. See Figure 7.



**Cultural Resources:** Missouri State Historic Preservation office database shows no NHRP listed or Historic Districts within the concepts corridors. See Figure 8.













District Comments:

#### Project Attachments:

**\*\*NOTE: If making updates to an attachment, please use a different filename than the original.**

**\*\*The combined size of attachments in one upload must be less than 100MB**

Attachments:

-  [Strafford\\_Alternatives.kmz](#)
-  [HazardousWaste\\_Figure7.pdf](#)
-  [Farmland\\_Figure6.pdf](#)
-  [WatersoftheUS\\_Figure5.pdf](#)
-  [Parks\\_PublicLands\\_Figure4.pdf](#)
-  [FEMA\\_Figure3.pdf](#)
-  [Strafford\\_Concepts\\_Figure2.pdf](#)
-  [Locations\\_Figure1.pdf](#)
-  [ROW\\_AttachmentC.docx](#)
-  [ADT\\_AttachmentB.docx](#)
-  [Strafford\\_IPAC\\_AttachmentA.pdf](#)
-  [CulturalResources\\_Figure8.pdf](#)

#### Required Information to be attached for each RES stage:

- **Loc/Concp.:** Location map (county map) & topographic map or aerial photo showing project limits – pre-plan sheets or other preliminary maps showing alternatives, if available
- **Prel. Plan:** Prel. Plan sheets
- **R/W:** R/W Plan sheets
- **Final Design:** Final Plans [Location map (county map) & topographic map or aerial photo showing project limits if this is first RES submittal]

## RES Environmental Screenings

### Farmland Impact

Status Information:

Status Changed By:

Kyle Grayson

Clearance Date:

☒ N/A ☐ Pending ☐ Cleared

Environmental

Response:

This project is located within the city limits of Strafford. Therefore, any ROW or easements needed for the project are considered "land committed to other uses" and farmland will not be further evaluated.

Environmental Action:

None

District Action:

None

Attachments:

- ☒ Farmland Impact Submitted - Mark submitted when this review is ready to be sent to district staff.

Last Updated: Kyle Grayson - 1/21/2022 10:26:56 AM

## Floodplain/Regulatory Floodway

Status Information: Status Changed By: Kyle Grayson ☒ N/A ☐ Pending ☐ Cleared Clearance Date:

Environmental Response: FEMA FIRMs indicate no floodplain or regulatory floodway in the project limits.

Environmental Action: None

District Action: None

## Attachments:

☒ Floodplain/Regulatory Floodway Submitted - *Mark submitted when this review is ready to be sent to district staff.*  
Last Updated: Kyle Grayson - 1/21/2022 10:27:40 AM

## Land Disturbance / Stormwater

Status Information: Status Changed By: Caleb Knerr ☐ N/A ☒ Pending ☐ Cleared Clearance Date:

Environmental Response: According to a 1/19/2021 review of MoDOT's MS4 Urban Areas ArcGIS layer, the project is inside the TS4 area. Option 4A in the KMZ attached to the RES would be considered maintenance (likely meets the 1 acre threshold). Option 3 and 7A would be considered new development (new roadway where none previously existed) and would require considerations of permanent post-construction stormwater treatment BMPs. More information on alternative selection, BMP location, type, and function required.

Environmental Action: Obtain more project details.

District Action: Please provide details on which alternative will be selected. If alternative 3 and 7A, please provide BMP's location, type, and function.

TS4 Area: ☐ Yes ☐ No ☒ Partial

Is the project in a TMDL watershed? ☐ Yes ☒ No

## Attachments:

☒ Land Disturbance / Stormwater Submitted - *Mark submitted when this review is ready to be sent to district staff.*  
Last Updated: Caleb Knerr - 1/19/2022 10:49:19 AM

## FEMA/SEMA Buyout

Status Information: Status Changed By: Kyle Grayson ☒ N/A ☐ Pending ☐ Cleared Clearance Date:

Environmental Response: TMS Buyout layer indicates no FEMA/SEMA Buyout properties in the project limits.

Environmental Action: None

District Action: None

## Attachments:

☒ FEMA/SEMA Buyout Submitted - *Mark submitted when this review is ready to be sent to district staff.*  
Last Updated: Kyle Grayson - 1/21/2022 10:28:10 AM

### Socioeconomic Impact

Status Information:	Status Changed By: Caitie Wiechman	<input type="radio"/> N/A <input checked="" type="radio"/> Pending <input type="radio"/> Cleared	Comment Date:
Environmental Response:	The project does not require commercial or residential displacements, but new right of way are anticipated for this project that are subject to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. Road closures and detours will not be necessary during project construction. More information about any public involvement plans will be need to continue to assess socioeconomic impacts.		
Environmental Action:	Continue to assess impacts when more information is known about public involvement for this project.		
District Action:	Please provide additional information about all public involvement at the next RES submittal. Conduct the acquisition of affected properties in accordance with the procedures established in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. Provide sufficient public notice of construction work and traffic management plans consistent with MoDOT's public involvement policy and procedures.		

#### Attachments:

☒ Socioeconomic Impact Submitted - Mark submitted when this review is ready to be sent to district staff.

Last Updated: Caitlin Wiechman - 1/3/2022 9:52:31 AM

### Threatened & Endangered Species

Status Information:	Status Changed By: Caleb Knerr	<input type="radio"/> No Effect <input checked="" type="radio"/> Pending <input type="radio"/> Cleared	Clearance Date:
Environmental Response:	Consultation Code: 03E14000-2021-SLI-2596 September 28, 2021; 03E14000-2022-SLI-0759, January 19, 2022 Endangered Species Act Species List: Gray, Indiana, and Northern Long-eared bats; Niangua Darter and Ozark cavefish; Monarch Butterfly (candidate) Gray bats use caves year-round and are found primarily in the Ozark highlands, but may be wherever caves are found. Indiana and northern long-eared bats hibernate in caves during winter, and spend summers in forested habitat where they may use trees with suitable characteristics (cracks, crevices, peeling bark) for roosting. Review of MDC Heritage database (current to September 2021) and the MO Speleological Survey cave information (current to April 2019) indicate that there are no records within the project area. The closest cave records are over one mile away and there are no federal species records at these caves. There will be no impacts to caves. The closest gray bat records are over 5 miles away from the project area. The closest northern long-eared bat records are over 6 miles from the project area. The closest Indiana bat records are over 29 miles from the project area. There will be 8.5 acres of tree clearing from this project. There is tree clearing is beyond 300' from the roadway, therefore this project is outside of the USFWS FRA/FHWA Section 7 Rang-wide Programmatic consultation for Indiana and Northern long eared bats. This project will require informal consultation (NLAA) with submittal of a letter BA to USFWS with conservation measures (clearing of suitable roost trees in winter). A habitat assessment is required for marking suitable forested habitat. This project may affect but is not likely to adversely affect gray, Indiana, and northern long-eared bats. Niangua darter can be found in clear, silt-free Ozark creeks and small rivers with a gravel or rock substrate. There are no nearby records of this species and there will be no impacts to suitable habitat. This project will have no effect on Niangua darter. Ozark cavefish are found in cave streams and springs, and are affected by inputs to groundwater. This project does not cross mapped recharge areas. This project will not impact suitable habitat and there are no nearby records of this species near the project area according to a review of the MDC Natural Heritage database (NHD, updated September 2021). This project will have no effect on Ozark cavefish. Monarch butterflies are candidate species for USFWS federal listing. Healthy and abundant milkweed is needed for oviposition and larval consumption. Sufficient quality and quantity of nectar from flowers is needed for adult feeding throughout the breeding and migration seasons. Habitat that provides a specific roosting microclimate for overwintering: protection from the elements (e.g., rain, wind, hail, excessive radiation) and moderate temperatures that are warm enough to prevent freezing yet cool enough to prevent lipid depletion. Nectar and clean water sources located near roosting sites. Nectar and milkweed resources along the migration route when butterflies are present; the size and spatial arrangement of habitat patches are generally thought to be important aspects, but currently unknown. Roosting sites may also be important for monarchs along their fall migration route. Per guidance received from USFWS on 1/5/2021, conferencing for monarchs is not required unless MoDOT is receiving funding from the USFWS. Since that is not the case with this project, MoDOT has not made an effects determination for this species.		
Environmental Action:	Obtain Project details and field check once landowner permission has been received.		
District Action:	Please notify Environmental once landowner permission has been received. Anticipate winter tree clearing restrictions.		

#### Attachments:



[Official\\_Species\\_List\\_8S3238.pdf](#)



[Official\\_Species\\_List\\_8S3238\\_update.pdf](#)

☒ Threatened & Endangered Species Submitted - Mark submitted when this review is ready to be sent to district staff.

Last Updated: Caleb Knerr - 1/20/2022 10:12:51 AM



## ► Migratory Birds

Status Information: Status Changed By: Caleb Knerr ☐ N/A ☒ Pending ☐ Cleared Clearance Date:

Environmental Response: According to a 1/20/2022 review of TMS bridge data layer on ArcGIS, there are structures within the project limits that could have nesting migratory birds. There will be impacts to these structures. A field check is needed before determining whether or not there will be impacts to nesting migratory birds from the project.

Environmental Action: Field check.

District Action: None

## Attachments:

☒ Migratory Birds Submitted - *Mark submitted when this review is ready to be sent to district staff.*

*Last Updated: Caleb Knerr - 1/20/2022 10:13:10 AM*

## ► Hazardous Waste Impact

Status Information: Status Changed By: Ethan Musick ☐ N/A ☐ Pending ☒ Cleared Clearance Date: 02/01/2022

Environmental Response: A brownfield assessment site was identified within the project area and should be avoided if possible. Also a leaking underground storage tank site was identified with ongoing or incomplete investigation/corrective action and should be avoided if possible.

Environmental Action: a site visit was made on 1/19/2022 and no areas of concerns were noted.

District Action: If a hazardous waste site is encountered during the project, contact Ethan Musick, Hazardous Waste Specialist at (573) 508-6907.

## Attachments:

☒ Hazardous Waste Impact Submitted - *Mark submitted when this review is ready to be sent to district staff.*

*Last Updated: Ethan Musick - 2/1/2022 3:27:47 PM*

## Wetland Impact (Section 404/401)

Status Information:	Status Changed By:	Clearance Date:	
	Caleb Knerr	<input type="radio"/> N/A <input checked="" type="radio"/> Pending <input type="radio"/> Cleared	
Environmental Response:	On 1/20/2022 MoDOT Environmental staff reviewed ArcGIS USFWS NWI maps, Google Earth aerial imagery and Streetview, and USGS 24K topographic maps (Bassville and Strafford Quadrangles). According to a review of these resources, this project does cross one unmapped, likely ephemeral tributary to Little Sac River. This feature is likely not jurisdictional under the Clean Water Act. There are mapped PEMC, PUBGx and PUBFh wetlands in the project area. Based on the project description, there will likely be impacts to streams or wetlands from this project. A desktop review showed approximately 0.387 acres of wetland impacts from alternative 7A and 686 linear feet of stream (likely ephemeral) impacts from alternative 3. Additionally, there are 453 linear feet of roadside ditch/wetlands within alternative 3 that are likely non-jurisdictional under the Clean Water Act. It is uncertain if the wetland/stream features in the project area are considered jurisdictional. If these features are jurisdictional, wetland and/or stream mitigation could be required for alternatives 3 and 7A. Worst case scenario mitigation cost for wetlands is \$165,145.5 and worst case scenario mitigation cost for streams is \$95,559.732 A PCN is required for wetland impacts. project will likely be authorized under NWP 14 with PCN.		
Environmental Action:	Obtain more impact details once design and alternative selection progresses and field check for wetlands and streams		
District Action:	Please notify Environmental once landowner permission has been received. Please provide impacts information to wetland and stream features in the attached KMZ. Environmental will need to complete field work before determining boundaries of these wetlands and streams and whether or not these features are jurisdictional under the Clean Water act, requiring mitigation. Anticipate mitigation costs (above) if features are jurisdictional.		
Wetland Permit Information:	404 Permit Number NWP 14 PCN	Permit Submitted	Permit Received
	Permit Expiration	Compliance Certification Sent	Compliance Certification Received
Attachments:	<div>✕ Potential Wetlands and Streams (desktop review).kmz</div> <div>✕ Official_Species_List_8S3238.pdf</div> <div>✕ Official_Species_List_8S3238_update.pdf</div>		
<input checked="" type="checkbox"/> Wetland Impact Submitted - Mark submitted when this review is ready to be sent to district staff.			
Last Updated: Caleb Knerr - 1/20/2022 10:06:12 AM			

## Noise Impact

Status Information:	Status Changed By:	Clearance Date:	
	Matt Burcham	<input type="radio"/> N/A <input checked="" type="radio"/> Pending <input type="radio"/> Cleared	
Environmental Response:	Alternatives 3 and 7A have elements of new roadway on new alignment and would meet the criteria of a Type I project, which does require a noise analysis. There are very few noise sensitive receptors. There should be few if any noise impacts and no needed noise abatement.		
Environmental Action:	Possibly conduct noise analysis within environmental office.		
District Action:	Assist as needed.		
Attachments:	<input checked="" type="checkbox"/> Noise Impact Submitted - Mark submitted when this review is ready to be sent to district staff.		
Last Updated: Matthew Burcham - 1/3/2022 2:04:08 PM			

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## APPENDIX E

### ► Cultural Resources Impact (Section 106/Historic 4f)

Status Information:

☒ Pending ☐ Cleared ☐ ROW Cleared

Status Changed By:  
Travis Tesreau

Clearance Date:

A Date Cleared:

Environmental Action: Based on the information provided, this project will require an archaeological and architectural survey, along with a subsequent submittal to the SHPO. A project footprint, plan development, and landowner permission will be necessary for work to be scheduled. OO/125 is part of an Old Route 66 alignment.

District Action: Please inform the Historic Preservation Section as soon as landowner permission has been attained. This area will likely be slightly over surveyed if permission is granted to allow for later changes.

#### Attachments:

☐ Adverse Effect or Conditional No Adverse Effect

☐ Based on the review of the project location and description noted above, there are no identified historic 4(f) resources affected that would preclude the setting of an A-date.

Checked by:  on  de minimis  Approved on:

☒ Cultural Resources Impact Submitted - Mark submitted when this review is ready to be sent to district staff.

Last Updated: Travis Tesreau - 1/3/2022 1:40:52 PM

### ► Public Land Impact (Section 4f/6f)

Status Information:

Status Changed By:  
Caitie Wiechman

☐ N/A ☒ Pending ☐ Cleared

Clearance Date:

Environmental Response: According to Google Earth imagery and ArcMap GIS public land layers, the Delp Historic Route 66 Park is located adjacent to the project area (Alternative 4A) and the Strafford High School is located 0.03-mile west of the project area (Alternatives 4A and 7A). Additional information on if the Delp Historic Route 66 Park and recreational activities of Strafford High School will be impacted during project construction will be needed to continue to assess Section 4(f)/6(f) impacts.

Environmental Action: None at this time.

District Action: Continue to provide information about the specific impacts to the Strafford High School recreational amenities (sports fields) and the Delp Historic Route 66 Park as information becomes available. If new right of way or easements will be needed from these resource, additional time will be required to complete Section 4(f) documentation.

#### Attachments:

☒ Based on the review of the project location and description noted above, there are no identified 4(f) or 6(f) resources affected that would preclude the setting of an A-date.

Checked by: Caitie Wiechman on 01/03/2022

☒ Public Land Impact Submitted - Mark submitted when this review is ready to be sent to district staff.

Last Updated: Caitlin Wiechman - 1/3/2022 9:51:23 AM

### ► Other

Status Information:

☒ N/A ☐ Pending ☐ Cleared

Clearance Date:

Environmental Response: There are no additional resource impacts associated with this project.

District Action: None

#### Attachments:

☒ Other Screening Submitted - Mark submitted when this review is ready to be sent to district staff.

Last Updated: Charlotte Drinkard - 1/3/2022 12:53:37 PM



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## APPENDIX E

### NEPA Classification

NEPA Right-Of-Way Permission:	Pending	as determined or approved by:
NEPA Approval/Proceed to A-date Request:		Re-evaluation Date: Final Design Complete:
NEPA Classification:		
This project qualifies for the programmatic categorical exclusion under Item#:		All Environmental Issues Cleared:
Commitments and/or Comments to District:	A Programmatic Categorical Exclusion (PCE) NEPA classification is anticipated for this proposed project. The NEPA approval date will be given once Cultural Resources and Threatened & Endangered Species sections are cleared.	

#### Attachments:

Last Submitted: 02/01/2022 by [Charlotte Drinkard](#)