



ABC Engineering

Transportation Impact Study Level II

Unity Apartments Battlefield, Missouri

I hereby certify this report was prepared by me or under my direct supervision, and I am a duly Licensed Professional Engineer under the laws of the State of Missouri.

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Date:

Executive Summary

Background:

The Unity Apartments development is proposed for the northwest corner of the Weaver Road/Unity Avenue intersection in Battlefield, Missouri. The purpose of this study is to determine the traffic impacts associated with the build out of the proposed development on the study roads and intersections where significant impact is anticipated.

Results:

The principal findings of this study are:

- The proposed development is expected to generate 832 new trips during an average weekday, 57 new trips during the weekday a.m. peak hour and 81 new trips during the weekday p.m. peak hour.
- The amount of parking proposed for the development is projected to meet peak period demand according to national and local data.
- The Weaver Road and Highway 99 corridors are “nearing congestion” range and are expected to experience traffic growth regardless of this development.
- The Weaver Road/Smith Avenue intersection is expected to have long queues on the northbound approach, starting with the 2020 No Build scenario, primarily due to the nearby proposed convenience store and coffee shop development.
- Little to no operational differences occur at the proposed site driveways or the Weaver Road/Unity Avenue intersection when comparing the Weaver Road access driveway restrictions as a 3/4-access or a right in/right out only access.
- The proposed site driveway to Weaver Road has characteristics favoring a 3/4-access over right in/right out only access.
- No indoor or outdoor bicycle parking locations are shown within the development.

Recommendations:

The following items are recommended based on the analyses contained in this study:

- Continue monitoring of future volumes on Highway 99 and Weaver Road.
- Provide two northbound lanes on Smith Avenue at the Weaver Road intersection, which are necessary for future operations with or without the proposed development.
- Operate the proposed access driveway to Weaver Road under 3/4-access, eliminating the exiting left turn movement.
- Provide pavement markings for the designated parking lot crossing in the southeast corner of the lot.
- Provide well lit, outdoor, bicycle parking spaces and an indoor bicycle room for short-term and long-term bicycle parking. A bicycle maintenance station is also recommended at either location to further promote bicycle travel.
- Encourage all loading and truck activity to occur outside of peak periods (7:00 am to 9:00 a.m. and 4:00 to 6:00 p.m.).
- Trim the tree canopy for those trees within the right-of-way on Unity Avenue.

This study is based on a concept development plan titled “Unity Apartments” and dated Month Day, Year. Assuming the general characteristics of the proposed development remain approximately the same as documented, minor changes in the final design are not expected to alter the results or recommendations of this study.



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1. Introduction

a. Purpose of Report

The Unity Apartments are proposed for the northwest corner of the Weaver Road/Unity Avenue intersection in Battlefield, Missouri. The 189-unit development will be built on currently vacant land.

The purpose of this study is to determine the transportation impacts of the proposed development and whether improvements are necessary to mitigation any determined impacts. This report satisfies the City of Battlefield's requirements and follows the general guidelines for this type of evaluation. Based on the preliminary assessment for the site, attached, and discussions with the City, this document is a Tier 2, Level I Transportation Impact Study.

b. Study Objectives Summary

Based on the Transportation Impact Study guidelines, the objectives of this study are as follows:

- i. Document how the study intersections and roadways currently operate.
- ii. Forecast the amount of traffic expected to be generated by the proposed development.
- iii. Examine the relationship to the existing area transportation or comprehensive plans.
- iv. Determine how the study intersections and roadways will operate in the future with and without the proposed development.
- v. Evaluate the parking needs.
- vi. Examine the multi-modal facilities.
- vii. Analyze the sight distance at each access driveway.
- viii. Complete a site review from a transportation perspective.
- ix. Recommend appropriate mitigation measures if poor operations are identified.

The roadways corridors studied in this document include those surrounding the proposed site as well as two additional nearby corridors. The added corridors, as requested by the City, are important corridors for the area and other specific development in the area. The study corridors are:

- Weaver Road
- Highway 99
- Smith Avenue
- Trucker Avenue
- Unity Avenue

Discussions with the City expanded the list of study intersections from those based solely on the Transportation Impact Study guidelines. Two additional intersections

beyond the original list identified in the Preliminary Transportation Assessment reflect other specific developments in the surrounding area and the desire for a combined look at operations. The study intersections for this report include:

- Weaver Road/Highway 99
- Weaver Road/Smith Avenue
- Weaver Road/Trucker Avenue
- Weaver Road/Unity Avenue

However, it should be noted traffic expected from the proposed development will have minor impacts on other corridors and intersections beyond those studied here. Furthermore, this study does not account for the existing roadway conditions such as pavement quality or appropriate drainage.



2. Development Site

a. Existing Site

The address of the proposed development is 4046 Weaver Road in Battlefield, Missouri. The area is currently vacant, but zoned for Multi-Family.

b. Proposed Development

The site will consist of one residential building, providing apartment units. The building is planned for 189 units, which is sub-divided into 40 studio units, 90 one-bedroom units, 55 two-bedroom units, and 4 three-bedroom units. The current site plan also identifies 281 total vehicle parking stalls, which are split into 105 surface spaces, 140 underground garage spaces, and 36 garage spaces within an auxiliary building.

The current site plan has several changes from the concept evaluated in the Preliminary Transportation Assessment, including:

- A reduction in total parking spaces.
- Revision of the building and surface parking layout.
- Adjustment of the Weaver Road access driveway location. The new location would allow for joint access if and when development occurs directly west of the proposed site.
- Update of site sidewalks.

The site plan used in this study is provided in the Appendix.

The proposed development is anticipated for construction next year. Full occupancy is expected quickly once the new building is open. For the purposes of this report, the study year is one full year after opening in 20XX.



3. Existing Conditions

a. Corridor Characteristics

As mentioned, the proposed site is located on the northwest corner of the Weaver Road/Unity Avenue intersection. Table 1 shows the characteristics of the key roadway corridors around this site and within the study area.

Table 1 – Study Corridor Characteristics

Name	Designation ¹	Classification ²	Speed Limit	Daily Traffic Volume ³	Lanes	Fixed Route Transit ⁴	Ped/Bicycle Facilities
Weaver Road	CR 185	Minor Arterial	40 mph	11,900 14,400	3 Undivided	None	Sidewalks, Both Sides
Highway 99	SH 99	Principal Arterial	50 mph	22,400 27,600	4 Divided	None	None
Smith Avenue	CR 199	Collector	35 mph	1,450	2 Undivided	None	None
Trucker Avenue	CR 222	Collector	30 mph	1,400	2 Undivided	None	Sidewalk, East Side
Unity Avenue	-	Local Road	30 mph	1,100	2 Undivided	None	Sidewalk, East Side

¹ SH = State Highway, CR = County Road

² Battlefield – Greene County Comprehensive Plans and amendments

³ Vehicles per day

⁴ Number of routes around the proposed site followed by the frequency of transit service during the peak periods

b. Transit

Transit service does not yet extend to this area.

c. Pedestrians/Bicycles

Sidewalks are provided on one or both sides of the corridor directly around the proposed development. The existing signals at the intersections of Weaver Road/Highway 99 and Weaver Road/Unity Avenue provide appropriate ADA facilities with countdown timers. This network provides for good pedestrian access around the site.

The nearby Highway 99 and Smith Road corridors both lack pedestrian amenities. As volumes in the area increase, the lack of facilities on these roadways are a concern.

Bicycle travel must occur either on-street within the vehicle mix or on sidewalks. The lack of bicycle facilities impedes their use in this area.

d. Traffic Volumes

Intersection video was collected at the existing study intersections under normal weekday conditions in Month, Year. Using these videos, 48-hour turning movement counts were obtained at the study intersections. The data from the two days was averaged to provide the base traffic for a “typical weekday”.

The average a.m. and p.m. peak hours were found to be from 7:15 to 8:15 a.m. and 4:30 to 5:30 p.m. The “typical day” counts from these two peak hours were used at the study intersections for analysis. The turning movement count data from the counts are contained in fifteen-minute intervals in the Appendix.



4. Forecasted Traffic

a. Site Traffic Forecasting

A trip generation analysis was performed for the development site based on the methods published in the *Institute of Transportation Engineers (ITE) Trip Generation Manual, 10th Edition*. Trip generation rates are provided by the same ITE manual as well as local data collected by Spack Consulting.

The ITE manual compiles studies from across the country to provide a national average traffic for various land uses. Spack Consulting collects current average traffic volumes for various land uses in the regional area for use in our studies. Local data is considered more relevant than the ITE national data as it is generally newer and accounts for our area's specific characteristics and driving habits. Per the procedure in the *Trip Generation Manual*, local trip generation data is used when possible and supplemented with national ITE data when local data is not available.

The resultant new trips generated by the proposed development are shown in Table 2.

Table 2 – Proposed Development New Trip Generation

Land Use Code – Source ¹	Description & Size	Daily		AM Peak Hour		PM Peak Hour	
		In	Out	In	Out	In	Out
221 - ITE	Mid-Rise Multi-Family Housing (189 Units)	514	514	18	50	51	32
221 - Local	Mid-Rise Multi-Family Housing (189 Units)	416	416	9	50	55	26
Use		416	416	9	50	55	26

¹ Local = Trip generation data collected by Spack Consulting in this regional area.

As shown, the trip generation based on local data is lower than the trip generation forecasts based on the national ITE dataset. Both are relatively close for peak hour volumes on a typical weekday. Since local data is recommended to be used when available, this study uses those volumes for the analysis of this report.

A trip distribution pattern was developed for the generated traffic going to and from the proposed development. This pattern is based on the existing traffic volumes, site access, competing land uses, access to the regional transportation system, and other completed traffic studies. The general trip distribution pattern for this study is:

- 30% of the generated traffic to/from the east.
- 10% of the generated traffic to/from the west.
- 20% of the generated traffic to/from the south.
- 40% of the generated traffic to/from the north.

As mentioned earlier, the site is proposed with two access driveways, one to Unity Avenue and one to Weaver Road. The Unity Avenue driveway will provide full access. The driveway to Weaver Road is an access onto a Minor Arterial and should not provide full access based on typical spacing guidelines and the safety improvement by eliminating the outbound left turn movement (the most dangerous movement from a side-street under stop sign control). Instead, this driveway is initially studied as a 3/4-access driveway, allowing all entering movements but only right turn exiting movements.

Traffic generated by the site development was assigned to the area roadways per this distribution pattern and the assumed access plan as discussed above.

b. Non-site Traffic Forecasting

Based on ITE's *Transportation Impact Analyses for Site Development*, the impacts of the proposed development are studied in the year 20XX and 20XX+20 under the assumption that all 189 units will be occupied by this time. To forecast future traffic volumes in the study area outside of the proposed development's traffic, specific other developments around the site and the general growth in traffic are considered.

A previous Transportation Impact Study, dated Month Day, Year, provided the expected traffic for the proposed convenience store (C-store) and coffee shop development located in the southeast corner of the Highway 99 and Weaver Road intersection. For the purposes of this study, the following was assumed:

- Full access at the intersection of Weaver Road and Smith Avenue.
- Right in/right out only access remains to Highway 99.
- Other uses in this area stay in place and in business.

A separate residential site is another specific development with expected construction to occur soon. Located along Weaver Road, but west of Highway 99, this development includes 30 single family homes. A Transportation Impact Study was not prepared for this development. However, our local data was used to determine the expected trips to/from the site.

Table 3 presents the new trip generation for these two developments.



Table 3 – Other Development New Trip Generation

Land Use Code – Source ¹	Description & Size	Daily		AM Peak Hour		PM Peak Hour	
		In	Out	In	Out	In	Out
TIS ¹	C-Store, & Coffee (16 VFP, 1.5 KSF)	727	727	51	48	56	54
Local ²	Single Family Housing (30 Units)	139	139	5	15	16	11
Total		866	866	56	63	72	65

¹ Transportation Impact Study for the proposed development dated Month Day, Year.

² Local = Trip generation data collected by Spack Consulting in this regional area.

The C-store and coffee shop traffic was distributed to the roadways as presented in its traffic impact study. The residential traffic was distributed according to the trip distribution percentages identified earlier for the proposed apartments.

To account for non-specific background traffic around the study area, several sources were considered, including:

- Historic traffic data on the study roadways.
- Growth as identified in area transportation or comprehensive plans.
- Previous traffic studies in the surrounding area.

Based on this information, a growth rate of approximately one percent per year was calculated. This growth rate was applied to all movements in the study network except for those accessing the development since those movements will only be increased with the development's forecast trip generation.

Applying this background growth rate to the existing traffic volumes and adding the traffic from the other specific developments establish the 20XX No-Build forecast.

c. Total Traffic

Traffic forecasts were developed for the 20XX Build scenario by adding the traffic generated by the proposed development to the 20XX No-Build forecast volumes. The 20XX+20 scenarios assumed a one percent growth rate for background traffic. The resultant peak hour forecasts are provided in the capacity analysis files in the Appendix.

5. Relationship to Existing Planning

a. Vision 20/20

The Vision 20/20 Citizens group and its Transportation Focus Group worked to identify principles and policies for the Springfield-Greene County Transportation Plan. These principles serve as a summary of the transportation values of the community and provided guidance for the development of this document. The following transportation planning principles were considered to ensure the proposed development fits within the long-term transportation goals:

1. Economy and Quality of Life: Direct regional transportation investments and implement the Land Use and Growth Management Plan and strategies to support the economy and quality of life in the Springfield-Greene County urban area.
2. Plan Consistency: Make regional transportation investments consistent with this Transportation Plan.
3. Roadway Efficiency: Ensure that the Springfield-Greene County urban area roadway system is built and designed to maximize system efficiency, serve travel demand, provide for user safety, and integrate and enhance other travel modes.
4. Access Control: Provide an access-controlled roadway system, where necessary and feasible, based on land use, traffic demand, safety and cost.
5. Road Right-of Ways: Define and officially map rights-of-way for planned future highways and arterials within planned corridors, and where necessary, acquire right-of-way prior to development.
6. Transit: Promote the use of transit through incentives.
7. Travel Demand: Reduce the need for additional roadway capacity and maximize energy efficiency during peak hours through ridesharing, conventional transit, pedestrian and bicycle use, improved land use patterns, development site design, and Transportation System and Demand Management (TSM/TDM) strategies.
8. Bicycle and Pedestrian Systems: Develop and maintain safe, high-quality, continuous, barrier-free bicycle and pedestrian systems to function as integral parts of the area's transportation system.
9. Freight: Maintain a competitive freight transportation system including the region's commercial motor carriers, railroads, air cargo carriers, and intermodal connections in order to provide effective linkages to state, national and international markets. Design appropriate roadways to accommodate trucks and encourage the Missouri Legislature and MODOT to improve highway connections to other major cities, especially Kansas City and Memphis. Support airport development and the improvement of rail connections, trucking connections, inter-city bus, and the development of intermodal center.

10. Planning Coordination: The planning decisions and implementation of transportation programs and projects should be consistent with federal, state and regional environmental regulations, standards, programs and policies.
11. Public Participation: Promote public participation in formulating transportation policy and implementing transportation decisions.
12. Paratransit: Encourage the provision of paratransit and not-for-profit transportation services within the Springfield area, particularly to the populations not served by the transit system.

As subsequent sections of this document will show, the entire transportation system is evaluated for potential improvements. Thus, the proposed development and suggested mitigation conforms to the principles of this planning document.

b. Ozarks Transportation Organization Major Thoroughfare Plan

The proposed development does not alter the surrounding roadway system, which already matches the thoroughfare plan. Access points around the development, while new, were examined with typical spacing guidelines and safety in mind. This resulted in full access on Unity Avenue, but restricted access on Weaver Road.

The Thoroughfare Plan does not identify future improvements or other necessary considerations for this report. The proposed development is therefore consistent with this planning document.

c. City of Battlefield Comprehensive Plan

The City of Battlefield provides a Comprehensive Plan that identifies the expected future for the transportation system. The following summarizes the transportation goals of this plan:

1. Promote an efficient transportation system.
2. Create a safe transportation network.

The evaluation contained in this report considered these goals, along with the objectives and strategies listed for each goal. Necessary improvements and mitigation are consistent with these goals and the Comprehensive Plan in general.



6. Traffic Evaluation

a. Corridor Vehicular Analysis

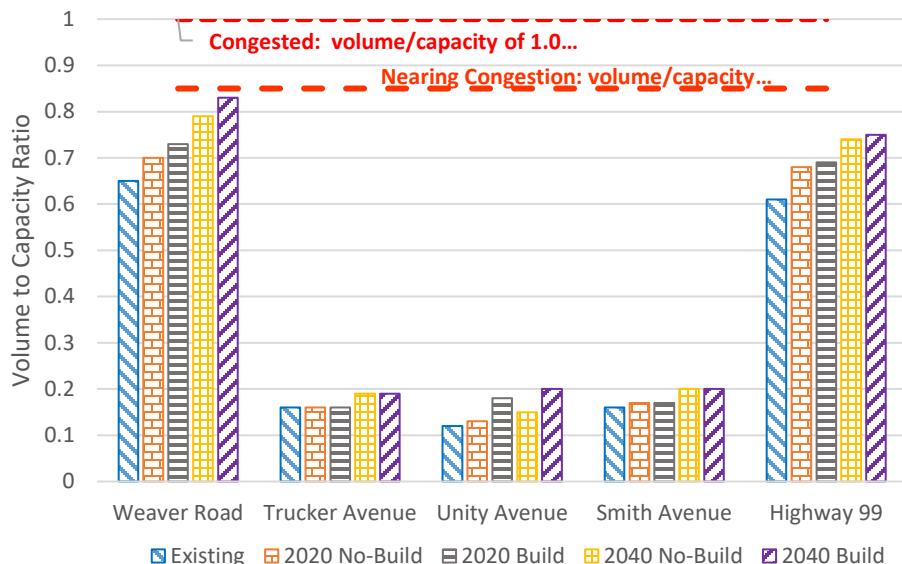
While many factors contribute to a road feeling congested, the two biggest factors are volume, how many vehicles are using the road, and capacity, how many vehicles the road can accommodate a day. Transportation professionals use these pieces of information to create a ratio of volume to capacity. For example, a road with a volume to capacity ratio of 1.0, where the traffic demand is nearly equal to the traffic supply, will feel congested to motorists.

Below is a rough guide of the daily traffic volumes different types of roads can accommodate based on Exhibits 16-16 and 12-39 of the *Highway Capacity Manual, 6th Edition*. If the Average Daily Traffic (ADT) volume on a roadway is below the threshold, then it is considered un-congested. If the daily volume falls inside the range, the road is almost congested, and if the daily volume is over the threshold the road is congested.

- 2-Lane (one in each direction with left turn lanes at busy intersections and coordinated signals), undivided street, are considered congested with a volume between 8,900 to 18,300 vehicles per day.
- 4-Lane, undivided street (two in each direction with left turn lanes at busy intersections and coordinated signals), – 18,600 to 36,800 vehicles per day.

To provide an initial planning level screening, Chart 1 provides volume to capacity ratios of the study corridors during each of the study years to determine if any of the roadway corridors are candidates for additional through lanes.

Chart 1 – Study Corridor Volume to Capacity



As seen in Chart 1, Weaver Road and Highway 99 are near the “nearing congestion” threshold (using planning level capacity levels) based on expected development of this proposed project and others in the area. For both corridors, these results suggest continued monitoring of future volumes. If volumes increase faster than forecasted here, there may be a need for appropriate access management to reduce conflicts, or intersection improvements like signal retiming and turn lanes to reduce or eliminate bottlenecks.

b. Intersection Vehicular Analysis

Individual intersections can perform poorly during peak periods while the overall roadway corridor is operating with an uncongested daily volume to capacity ratio lower than 1.0. Therefore, capacity analyses are performed for the study intersections to determine if they need improvements such as turn lanes or an upgrade in traffic control.

The existing and forecasted turning movement volumes along with the existing intersection configurations and traffic control were used to develop the average delay per intersection in each study scenario. The delay calculations were done in accordance with the *Highway Capacity Manual, 6th Edition* using the Vistro software package. The full calculations for each study scenario, including Level of Service (LOS) grades and queue lengths, are included in the Appendix. Also, included in the Appendix is a guide explaining the Level of Service grade concept.

The initial signal timings for the existing conditions were provided by Greene County staff. Based on information from prior studies, lane adjustments for the southbound Highway 99 left turn lanes to Weaver Road and the Weaver Road eastbound through lanes at Highway 99 were manually changed. In both cases, drivers tend to use the left-most of the two lanes as the Weaver Road corridor they are continuing toward merges from two to one lane.

The proposed access driveway to Weaver Road is also initially studied as 3/4-access, allowing all entering movements but only right turn exiting movements. The access driveway to Unity Avenue will provide full access movements.

Chart 2 (a.m. peak hour) and Chart 3 (p.m. peak hour) show the average peak hour delay per traffic signal-controlled intersection for each study scenario. The LOS D/E boundary of 55 seconds of delay per vehicle is considered the threshold between acceptable and unacceptable traffic signal operation.

Chart 2 – A.M. Peak Hour Delays: Signal Controlled Intersections

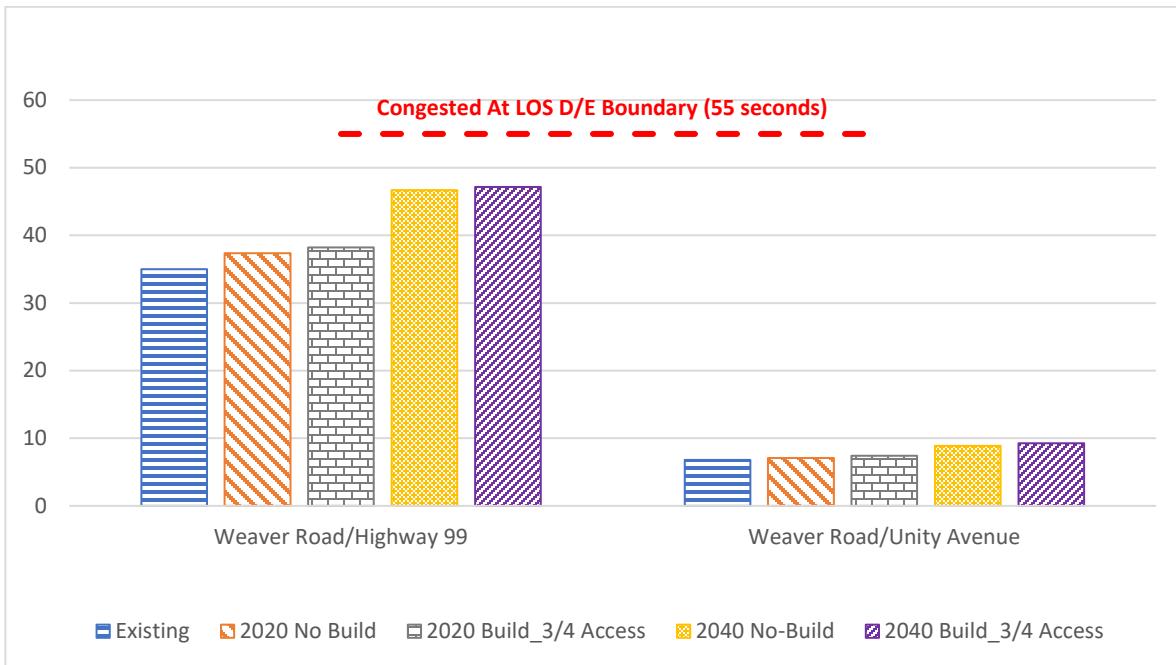


Chart 3 – P.M. Peak Hour Delays: Signal Controlled Intersections

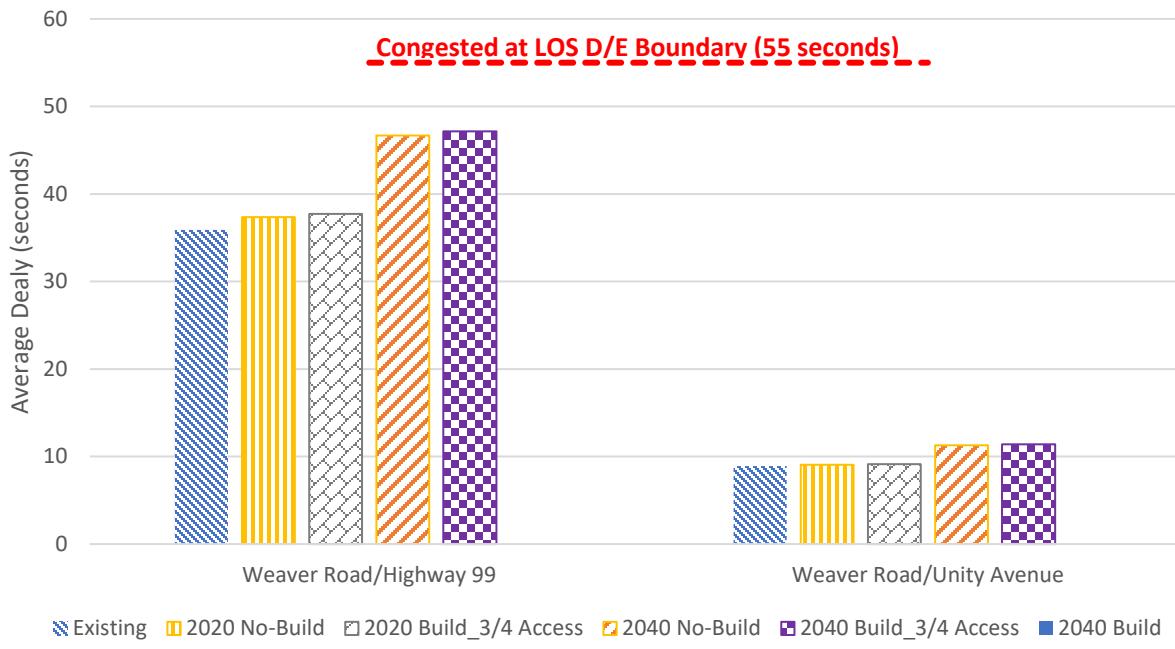


Chart 4 (a.m. peak hour) and Chart 5 (p.m. peak hour) show the 95th percentile queue lengths on the busiest stop sign controlled approach at intersections with side street stop sign control. Average delays are not calculated for intersections with side street stop sign control because the vast majority of vehicles going through the intersection are on the main roadway and have zero delay, which leads to low

overall average delays. At side street stop sign controlled approaches to busy roadways, the average delay for all the vehicles on the approach often exceeds 60 seconds. This can be the case for a few vehicles waiting at the stop sign where improvements would not be justified for the low traffic volume.

Instead of reporting average approach delays like the previous charts, Charts 4 and 5 show the 95th percentile queue as the measure of effectiveness at intersections with side street stop sign control. Based on our experience, improvements are not warranted at these types of intersections until the 95th percentile queue at a stop sign is in the five to ten vehicle range.

Chart 4 – A.M. Peak Hour Queues: Side Street Stop Sign Controlled Intersections

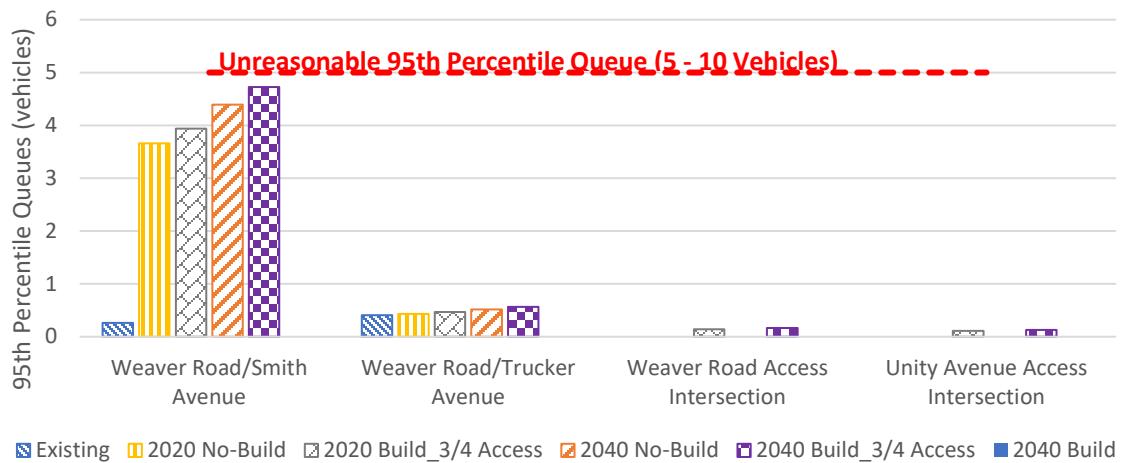
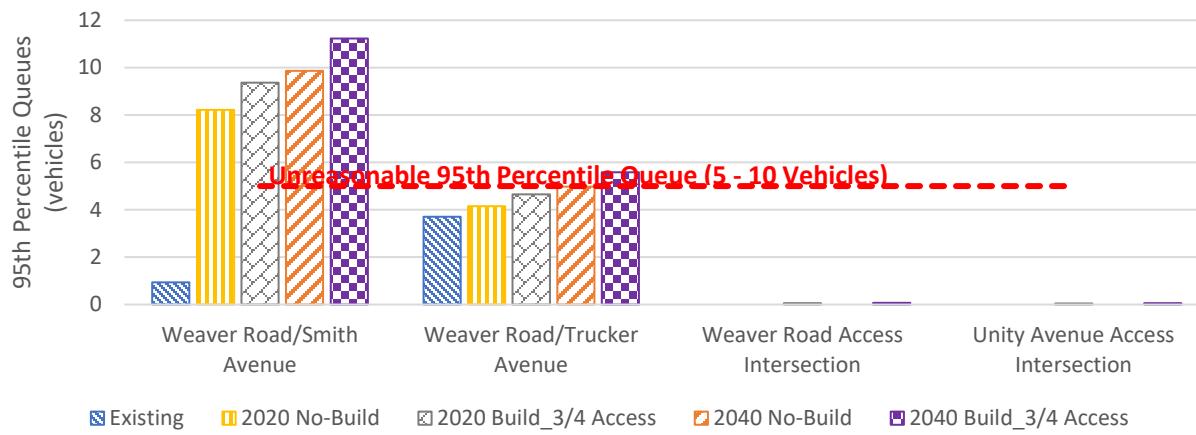


Chart 5 – P.M. Peak Hour Queues: Side Street Stop Sign Controlled Intersections



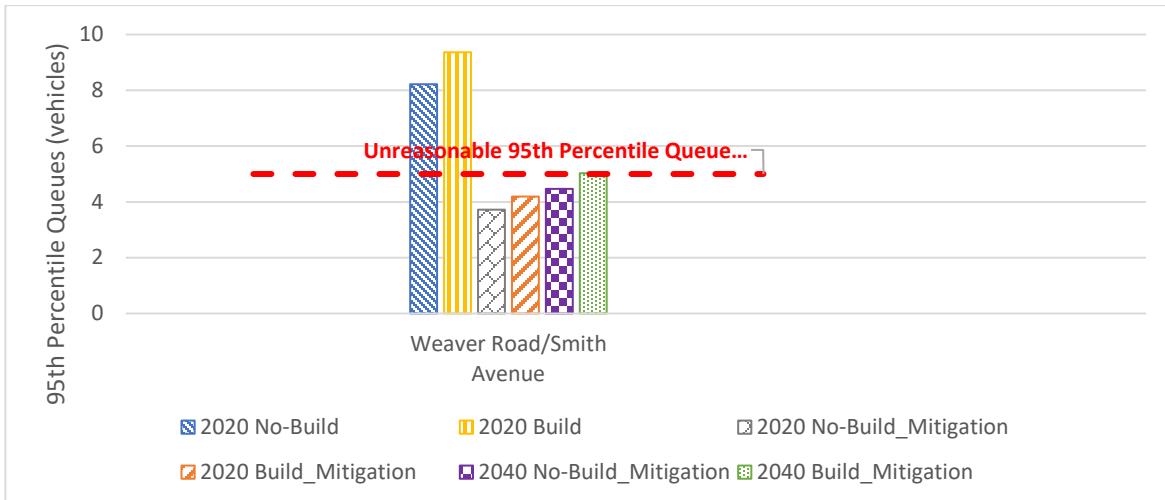
c. Vehicular Mitigation Analysis

Per the above analyses, most of the study intersections and corridors will operate acceptably throughout the study scenarios and no significant queueing is anticipated at the site access intersections. The one exception to this is Weaver Road/Smith Avenue intersection, which begins to see excessive queueing in the 20XX PM No-Build Scenario with a northbound queue of more than eight vehicles. This result is primarily due to the increase of northbound traffic departing the proposed C-store and coffee shop development and turning onto Weaver Road.

To help mitigate this queue, the intersection was re-analyzed assuming an exclusive northbound right turn lane, allowing the northbound approach to operate with a shared left/thru lane and a dedicated right turn lane. Chart 6, below, presents the resulting queues with the additional lane.



Chart 6 – P.M. Peak Hour Queues: Side Street Stop Sign Controlled Intersections



As Chart 6 shows, the additional lane improves operations and reduces the expected queuing for the northbound approach into an acceptable range. The queue approaches a five vehicle queue in the 20XX+20 scenario, but the additional lane is still viewed as an acceptable mitigation action for this intersection. As previously mentioned, although the proposed apartments are a part of the increased traffic on Weaver Road, the operational results of this intersection are primarily due to the proposed C-store and coffee shop development. This geometric improvement will be necessary with or without the proposed apartments.

The site access to Weaver Road was initially reviewed as a 3/4-access, where all entering traffic is allowed but the left turn exiting movement is prohibited. A second analysis was completed to determine the impacts if this intersection was further restricted to a right in/right out access only. The results for both site accesses as well as the signalized Weaver Road/Unity Avenue intersection are shown in the following charts.

Chart 7 – A.M. Peak Hour Delays: Signal Controlled Intersections

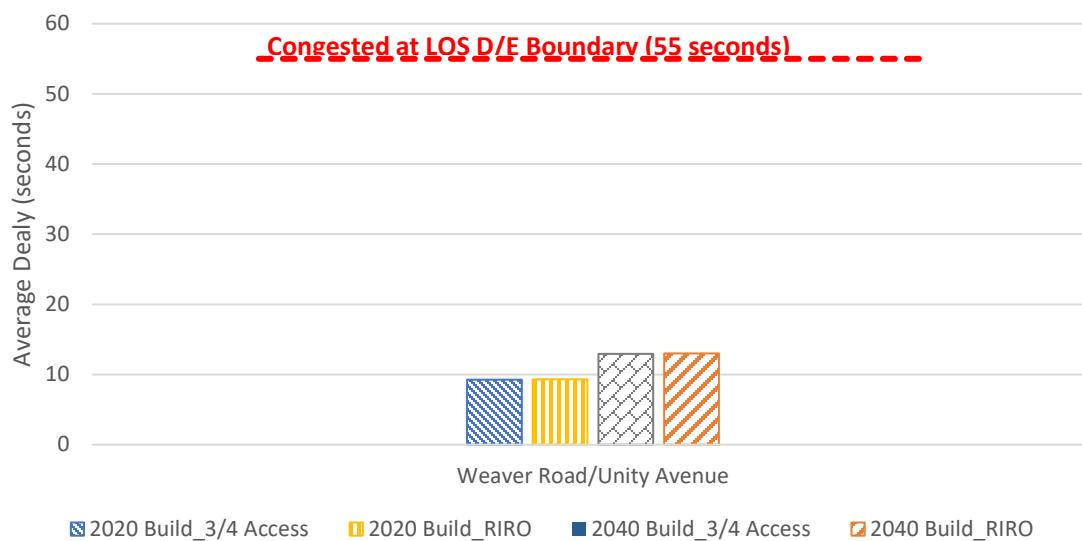


Chart 8 – P.M. Peak Hour Delays: Signal Controlled Intersections

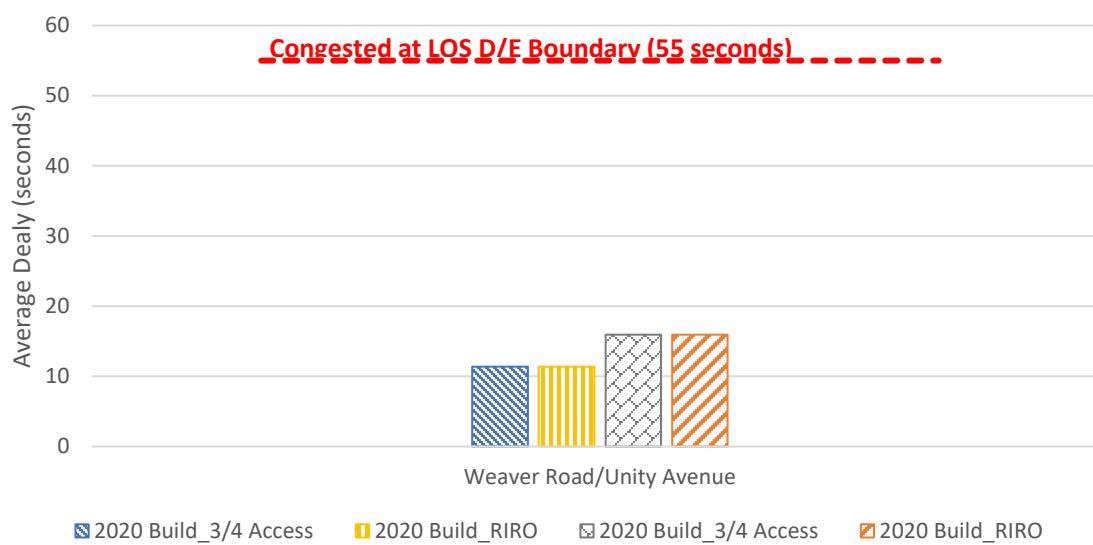
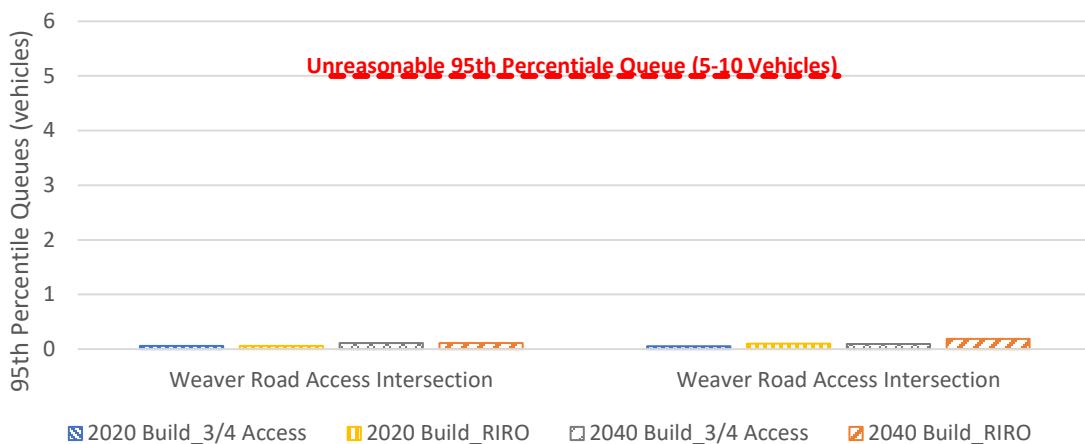


Chart 9 – A.M. Peak Hour Queues: Side Street Stop Sign Controlled Intersections



Chart 10 – P.M. Peak Hour Queues: Side Street Stop Sign Controlled Intersections



Charts 7 through 10 show little to no difference in queueing conditions at the proposed site accesses, and minimal changes in delay at the signalized intersection of Weaver Road/Unity Avenue regardless of the type of restriction placed on the Weaver Road access driveway. The queues remains minimal across the 20 year study window. Further discussion of the access restriction is provided in the Vehicle Circulation section of this report.

The signal timing for all signalized intersections should be re-examined at least every three to five years, with or without this proposed project. Adjusting the signal timing regularly will ensure the timing accurately reflects the most current volumes and driving habits.

7. Parking Evaluation

Parking to be Provided On Site

A total of 281 automobile parking stalls will be provided on site. These stalls are subdivided into three categories: 105 at-grade surface spaces around the building, 140 below-grade spaces under the building, and 36 spaces within the auxiliary garage.

Parking Required by Battlefield City Code

According to the City of Battlefield's Zoning Code, multi-residential developments are required to provide one parking space per bedroom and an additional one parking space per unit. The 189 units provide 252 bedrooms. These characteristics result in 441 parking spaces required for the proposed site. With a proposed 281 total spaces, City code requirements are not met by the proposed plan.

Expected Parking Demand - ITE

The Institute of Transportation Engineers (ITE) has put together a document, *ITE Parking Generation, 4th Edition*, that compiled parking demand data from different land uses. In addition to ITE, Spack Consulting has collected parking and trip generation data for land uses in the regional area. Using data from both sources, peak period parking demands were calculated for this development for a weekday and a Saturday. Those peak period parking demands are summarized in Table 4.

Table 4 – Peak Period Parking Demands

Land Use	Source	Weekday Peak Parking Demand		Saturday	
		Rate	Occupied	Rate	Occupied
Apartments	ITE	1.23	232 stalls	1.13	214 stalls
Apartments	Local	0.71	134 stalls	0.66	125 stalls

As shown, the expected parking demand is less than the requirements according to City code. The proposed supply of 281 would accommodate the expected demand.



8. Multi-Modal Evaluation & Site Plan Review

The concept site plan contained in the Appendix was reviewed to determine if the plan meets city requirements, provides appropriate circulation, and minimizes conflicts. Following are key transportation elements of the concept site plan:

a. Vehicle Circulation

The site proposed two external access driveways; one on Unity Avenue and one on Weaver Road. The Unity Avenue driveway will primarily provide access to the surface parking, the eastern below grade parking level, and the auxiliary garage. As shown in the site plan, this driveway leads to an internal intersection where potential conflicts could arise. However, per the trip generation forecast, the low volumes suggest these conflicts will be minimal. The vast majority of drivers will also be familiar with the layout and travelling at a low speed. If development occurs to the west and parking lots are connected, this design will also discourage 'cut-thru' traffic between developments or between public roads. The positive aspects of the proposed design outweigh and minimize any potential conflict issues.

The other access driveway is proposed to connect to Weaver Road. As discussed earlier, the volumes on Weaver Road along with typical spacing guidelines and safety aspects of a minor arterial suggest limited access at this location. Full access was therefore not examined in this report.

Per the presented capacity analyses in this report, operations on Weaver Road and Unity Avenue have little to no change comparing 3/4-access to right in/right out only access. Since both are operationally acceptable, other criteria was considered to determine the appropriate level of restriction, including:

- Weaver Road currently has a center, two-way left turn lane that could be utilized for safe left turns into the proposed driveway.
- These left turn movements do not interfere with public road intersections or the private driveway intersections on the south side of the road.
- The proposed driveway could also serve a future development west of the proposed apartments.
- Allowing left turns off Weaver Road slightly reduces the proposed development's traffic on Unity Avenue.

Given these characteristics, 3/4-access is recommended for the driveway access on Weaver Road. This access will need an appropriate design to naturally enforce the access restriction, including a raised median on the driveway to guide exiting traffic west. A short right turn lane into the development is also recommended to remove those vehicles from the through lane on Weaver Road.

Per the capacity analyses, the queues for vehicles exiting the development are forecast to be low, suggesting no congestion or issues entering or exiting the proposed parking areas. Single lane entrances and exits on the access driveways, as shown in the attached site plan, are sufficient.

Drop-offs and pick-ups at the building can be accommodated in the circulation loop at the front of the building and are not expected to impact parking operations.

b. Bicycle and Pedestrian Infrastructure

As part of the effort to promote an efficient transportation system, the City of Battlefield believes in providing for alternative modes of transportation to reduce the number of vehicles on the roadway. The Ozarks Transportation Organization's Bicycle & Pedestrian Trail Investment Study shows future trails extending in the City and potentially toward this proposed site.

The site plan recognizes these investments by maintaining the existing sidewalk along Weaver Road and establishing new connections between the proposed apartment and the existing infrastructure. The pedestrian facilities could further be improved by extending the proposed sidewalk on the east side between the building and the parking area. Similarly, a sidewalk could be provided between the building and the parking area on the north side of the proposed site. These sidewalks would provide a safe area for residents or visitors to walk from the parking spaces to the development entrances.

Although pedestrians will still be able to walk through the parking lot, the proposed sidewalk design directs them to the corner of Weaver Road and Unity Avenue. This design should encourage pedestrians to use the existing signal for crossing Weaver Road rather than a mid-block unsignalized crossing farther to the west.

The sidewalk design provides for a designated crossing of the parking lot to the Weaver Road and Unity Avenue intersection. Pavement markings are recommended for this crossing in the southeast corner of the parking lot to highlight the area for drivers and encourage pedestrian use of this designated crossing area.

Bicycle facilities are not shown on the current site plan, but should be planned for and provided. A few spaces outside near the main entry would provide bicycle parking for short-term purposes, visitors or residents leaving again soon. Lighting for these spaces will increase safety at night.

A separate indoor bicycle room, potentially in the underground parking area, would provide long-term bicycle parking for residents. It is also recommended to install a bicycle maintenance station in that room or near the exterior bicycle parking to further encourage residents to use bicycles as a mode of transportation.

c. Truck Movements

Loading zones are not explicitly denoted in the attached site plan. However, loading could occur in several different locations in the surface lots, drop-off area, or underground garages.

The trash area for the site is located within the parking garage. Collection vehicles can enter this area via one access and exit through the other. Alternatively, the property manager could coordinate moving the trash containers for curbside collection.

It is recommended that all loading, trash pick-up, and deliveries occur outside of peak periods (7:00 to 9:00 a.m. and 4:00 to 6:00 p.m.) to reduce potential conflicts when possible.



9. Sight Distance Review

As discussed in the Preliminary Assessment, which is provided in the Appendix, a basic sight distance check was completed using the AASHTO time-based methodology for sight distance evaluation. In this case, the standard time was translated into a distance based on the posted speed limit for the roads where the access is proposed.

Weaver Road has a posted speed limit of 40 mph. Using the standard 7.5 second desired time gap, the necessary minimum sight distance is 440 feet. The graphic below shows the approximately measured distance over an aerial.

With a posted speed limit of 30 mph, the Unity Avenue intersection needs a minimum sight distance of 330 feet. The graphic below also shows these measured lines.

In both cases, the measured sight distance satisfies the minimum requirements and is acceptable. For the Unity Avenue access, tree trimming may be necessary within the right-of-way to ensure these acceptable sight lines.



10. Conclusions and Recommendations

The traffic impacts of the proposed development were thoroughly studied, and the principal findings are:

- The proposed development is expected to generate 832 new trips during an average weekday, 57 new trips during the weekday a.m. peak hour and 81 new trips during the weekday p.m. peak hour.
- While not satisfying the City Code requirements, the amount of parking proposed for the development is projected to meet peak period demand according to national and local data.
- The Weaver Road and Highway 99 corridors are “nearing congestion” range and are expected to experience traffic growth regardless of this development. However, all roadways and intersections, except one, have acceptable queues and delays through the 2020+20 build scenario based on the capacity analysis.
- The Weaver Road/Smith Avenue intersection is expected to have long queues on the northbound approach, starting with the 2020 No Build scenario. Primarily due to the proposed C-store and coffee shop development, these queues are expected with or without the proposed development.
- Little to no operational differences occur at the proposed site driveways or the Weaver Road/Unity Avenue intersection when comparing the Weaver Road access driveway restrictions as a 3/4-access or a right in/right out only access.
- The proposed site driveway to Weaver Road does have the following:
 - A two-way center left turn lane on Weaver Road for safe entering left turn movements.
 - No interference with movements on other public or private driveway intersections.
 - The potential to serve as a combined access to future development west of this site.
 - The potential to slightly reduce the proposed development’s traffic on Unity Avenue.
- No indoor or outdoor bicycle parking locations are shown within the development.
- The measured sight lines are acceptable.

The following recommendations are made based on the above findings:

- Continue monitoring future volumes on Highway 99 and Weaver Road, implementing appropriate access management to reduce conflicts and providing future intersection improvements as needed like signal retiming and turn lanes to reduce or eliminate bottlenecks.
- Provide two northbound lanes on Smith Avenue at the Weaver Road intersection. Necessary for future operations with or without the proposed development, two lanes reduce the expected queuing to acceptable levels.

- Operate the proposed access driveway to Weaver Road under 3/4-access, eliminating the exiting left turn movement. The design of this access driveway will need a raised median to direct exiting traffic to the west and a right turn lane for entering traffic from westbound Weaver Road.
- Provide pavement markings for the designated parking lot crossing in the southeast corner of the lot. This striping will highlight the area for drivers and further encourage pedestrians to cross at this location as they connect to the Weaver Road/Unity Avenue intersection.
- Provide well lit, outdoor, bicycle parking spaces and an indoor bicycle room for short-term and long-term bicycle parking, respectively. A bicycle maintenance station is also recommended at either location to further promote bicycle travel.
- Encourage all loading and truck activity to occur outside of peak periods (7:00 am to 9:00 a.m. and 4:00 to 6:00 p.m.).
- Trim the tree canopy for those trees within the right-of-way on Unity Avenue to ensure acceptable sight lines for the proposed access intersection as well as other driveways on this road.



11. Appendix

A. Preliminary Transportation Assessment

B. Site Plan

C. Traffic Counts

D. Capacity Analysis Backup

- AM Existing
- PM Existing
- AM 2020 No-Build
- PM 2020 No-Build
- AM 2020 Build
- PM 2020 Build

