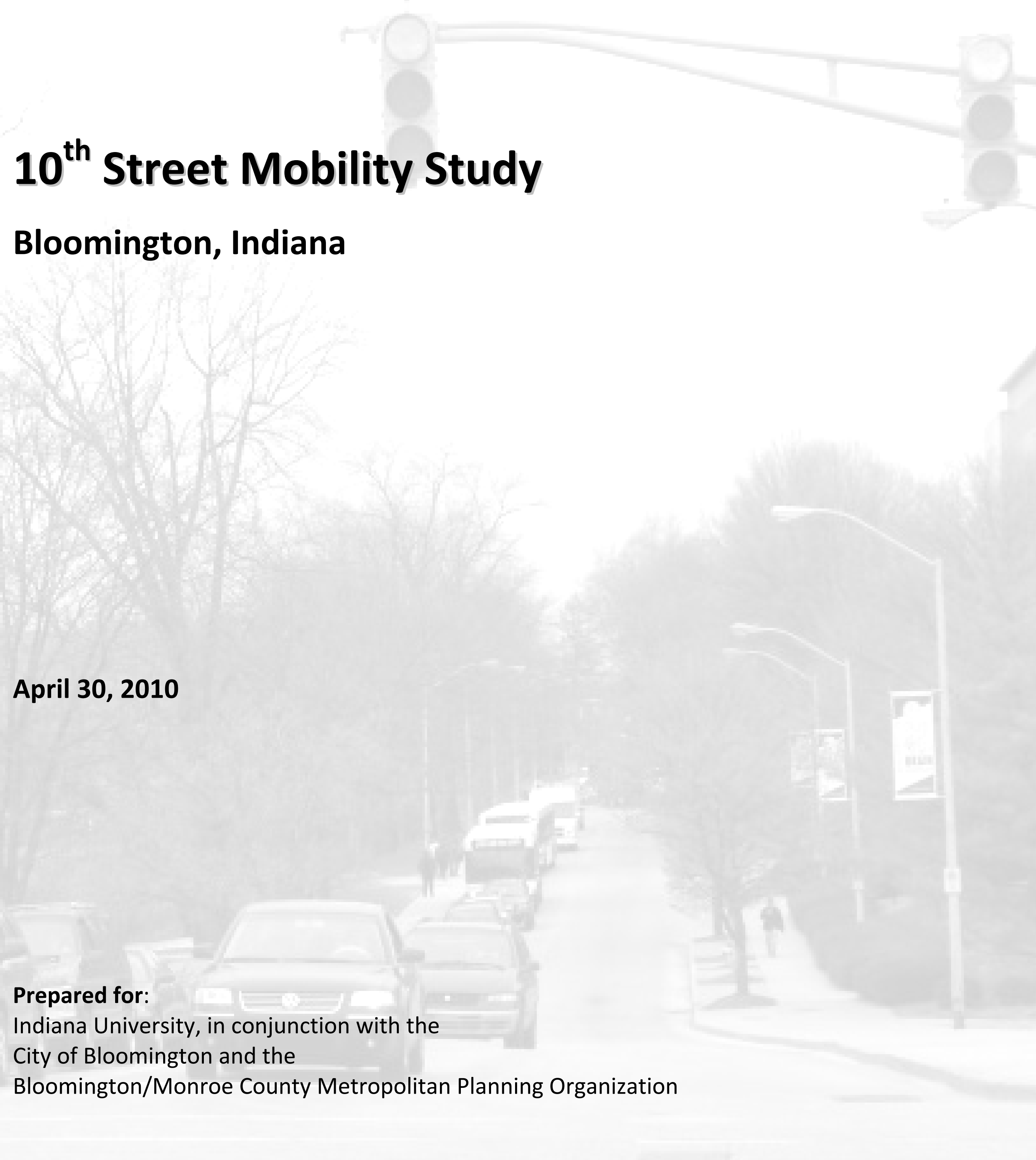
10th Street Mobility Study

Bloomington, Indiana



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Prepared for:
Indiana University, in conjunction with the
City of Bloomington and the
Bloomington/Monroe County Metropolitan Planning Organization

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Introduction

The following report presents the findings of a study evaluating current and future transportation conditions for all modes of travel within the 10th Street study area, bordered by 17th Street to the north, 10th Street to south, Dunn Street to the west, and the State Road 45/46 Bypass to the east. The Indiana University campus comprises the majority of the study area. This study was funded as a collaborative effort by Indiana University, the City of Bloomington and the Bloomington/Monroe County Metropolitan Planning Organization.

This study was developed with a context sensitive approach recognizing that the majority of the study area is comprised of a university campus. All modes of transportation operate and experience times of congestion and delay within the study area. Vehicles travelling though the study area (mostly City oriented), and vehicles travelling to and within the study area (mostly University oriented) are competing for the same roadway capacity. On 10th Street, Bloomington Transit buses, University buses, bicycles, pedestrians and private vehicles all strive to use the same limited cross-section of public space.

The existing goals and policies of the community and University were used as a guideline to develop study goals. Public and stakeholder input was used alongside the policy goals to develop alternatives for study. Given the multi-modal nature of the study area, the alternatives were evaluated using criteria assembled to address issues across all modes. The study process actively engaged stakeholders to gain broad input. Finally, an alternative was selected and refined to become the preferred alternative and the recommendation of this report.

Alternatives

An analysis of existing conditions showed a study area with several areas of concern spread across multiple modes of travel. There are numerous congestion spots along the 10th Street corridor, generated by a mix of local (University) and commuter-based traffic. In addition, the 10th Street corridor experiences a significant mixing of different modes, with heavy use by pedestrians, bicyclists, transit vehicles and automobiles on a relatively narrow right-of-way. This is created by a lack of a distinct east-west hierarchy within the study area, as there is a lack of routing options for most modes. The amount of turning vehicles at intersections also indicates a lack of options in the north-south direction, generating conflicts at intersections and undue delay for drivers.

These existing areas of concern were used as the basis to develop the set of alternatives studied in this report, along with prior concepts and analyses performed in the study area. The prior concepts of an extension of Law Lane between 10th Street to the east and 13th/14th Streets to the west has led to greater feasibility and support. Based on all stakeholder input, it was decided to focus any new roadway construction alternatives on similar concepts. In addition, based on input and existing policies (notably the Complete Streets Policy), it was decided not to include alternatives that restricted modes from roadways (ie. no new roadways without bike lanes or sidewalks, no roadways converted to transit or pedestrian only).

The three alternatives developed were:

- <u>Alternative 0</u>: A no-build alternative that represents future conditions without any action
- <u>Alternative 1:</u> A build alternative that includes a new Law Lane/14th Street extended corridor, and uses that new corridor to create a pair of one-way streets with the new corridor westbound, and 10th Street eastbound
- <u>Alternative 2:</u> A build alternative that includes a new Law Lane/14th Street extended corridor with two-way circulation

Evaluation

The alternatives developed were evaluated in three different ways. First, they were tested against the goals of the project--to increase mobility for all modes within the study area and to improve safety. Second, the alternatives were judged for their ease of implementation. Finally, a cost estimate for each alternative was assembled. The evaluation of the alternatives and stakeholder input were used to select one of the three alternatives for refinement into the preferred alternative and final recommendation. The following table summarizes the findings from the evaluation.

Evaluation Criteria	Alternative 0 No-build Alternative	Alternative 1 One-way Pair	Alternative 2 Two-Way Circulation
Study Goals			
Vehicle Mobility	Some improvement over existing conditions via signal timing changes. No significant reduction in vehicle congestion.	Traffic models show great benefit to vehicle throughput in study area.	Traffic models show benefit to vehicle throughput, although not as much as Alternative 1. More intuitive system with lower overall trip lengths, compared to Alternative 1.
Transit Mobility	No improvement over existing conditions.	Increases mobility of east-west routes through study area. One-way pair would make stop location and routing more difficult and confusing to riders.	Allows more flexibility in routing and stop placement.
Bicycle Mobility	No improvement over existing conditions.	Would add westbound bicycle lanes on new Law Lane/14th St corridor and eastbound lanes on 10th St. Increase in speeds could intimidate cyclists.	Would add bicycle lanes in both directions on new Law Lane/14th St corridor.
Pedestrian Mobility	No improvement over existing conditions.	Would add sidewalks on new Law Lane/14th St corridor. Increase in speeds is contrary to improving pedestrian safety.	Would add sidewalks on new Law Lane/14th St corridor.
Safety	No improvement over existing conditions.	Studies show one-way streets have lower vehicle accident rates than two-way streets.	Lower speeds on two-way streets reduce severity of accidents, compared to one-way streets. More flexibility in routing allows better access for emergency vehicles.
Summary	Does not meet any of the stated study goals.	Meets some of the study goals. Sacrifices multimodal goals at the expense of a significant increase to vehicular mobility. Some negative impacts may be able to be mitigated.	Meets all of the study goals. Best fits with MPO, IU and City policies.
Other Factors			
Implementation	N/A	Needs to be fully constructed prior to switching operations to one-way pair.	Can be constructed and operated in phases without major disruption.
Cost Estimate	N/A	Approximately $9.5 million, not counting right-of-way costs.	Approximately $9.2 million, not counting right-of-way costs.*
Public Input	Some support from public who did not think benefits outweighed cost.	Less public support.	Majority of public support.

** - Upon selection as preferred alternative, cost estimate was refined to $7.96 to 8.72 million, for a 65' and 80' ROW respectively*

Preferred Alternative

Based on the analysis findings, University, City, MPO and stakeholder input, Alternative 2 was selected as the preferred alternative. Alternative 0, the no-build alternative, was dismissed because it does not address any of the study goals. In addition, there is significant momentum behind a build alternative being implemented in the study area, given a variation of the build alternatives that have been discussed for decades and had been included in long-range plans.

It is important to note that the analysis shows that both the one-way and two-way alternatives demonstrate a marked improvement over existing conditions. The one-way pair (Alternative 1) improves the corridor significantly for vehicular traffic traveling *through* the corridor. The two-way alternative (Alternative 2) shows some improvement for vehicular through traffic, though not to the same extent as the one-way pair. However, the two-way alternative does outperform the one-way pair when it comes to how the corridors meet the needs of bicyclists, pedestrians, transit riders, emergency access and future growth of the University. For this reason, the two-way alternative became the preferred alternative since the study goals include enhancing all modes of transportation. Alternative 2 is a better fit with existing MPO, IU and City policies.

Two refinements to the two-way alternative are included in the preferred alternative: measures to encourage use of the new 14th Street/Law Lane Corridor, and a program to restrict access drives on the 10th Street corridor.

It should be noted that the feasibility of the preferred alternative is reliant upon many factors. Chief among these is cost. The City and IU will need to jointly seek federal funds for the design, right-of-way, and construction costs associated with the project. In the absence of adequate funding, the City and IU may explore cooperative arrangements to reduce the cost to either entity especially as it relates to right-of-way, subject to the approval of the Mayor and the Board of Trustees.

Implementation of the recommendations contained within this report will include detailed analyses and traffic modeling necessary to detail operational characteristics of the new roadway and serve as an input to design. There are numerous operational and design details to be determined in further study and they are outlined in the report. Further traffic engineering analysis also may be needed to validate the preferred alternative. In addition, several mitigation measures can be put into place prior to construction of the preferred alternative.

INTRODUCTION

East-west connectivity through the northern portion of the Indiana University campus (roughly, the 10th Street and 14th Street corridors) has long been identified as a local transportation challenge. Movement within campus, movement between points east and west of campus, and the operation of local transit routes are all made difficult due to limited east-west connectivity. This report presents the findings of a study evaluating current and future transportation conditions for all modes of travel and makes recommendations for improvements that would address mobility issues within the study area.

This study was developed with a context sensitive approach, recognizing that the majority of the study area is comprised of a college campus. All modes of transportation operate and experience times of congestion and delay within the study area. Vehicles travelling though the study area (mostly City oriented), and vehicles travelling to and within the study area (mostly University oriented) are competing for the same roadway capacity. On 10th Street, City buses, University buses, bicycles, pedestrians and private vehicles all strive to use the same limited cross-section of public space.

The existing goals and policies of the community and University were used as a guideline to develop study goals. Public and stakeholder input was used alongside the policy goals to develop alternatives for study. Given the multi-modal nature of the study area, the alternatives were evaluated using criteria assembled to address issues across modes including significant stakeholder input. Finally, an alternative was selected and refined to become the preferred alternative and the recommendation of this report.

Purpose

The purpose of the 10th Street Mobility Study was to reach a consensus on the strategic layout of the transportation system and develop a rough cost estimate. This study reached conclusions and recommendations after developing and evaluating alternatives, while incorporating public input during the entire process. The recommendations contained within will be consulted as the City moves forward to program the project into the MPO's Transportation Improvement Plan (TIP) in order to gain federal funding for design and construction.

This study is a feasibility study, performed with a level of detail of macro scale. Once project funding is secured and the design of the recommended alternative is developed, there will be many aspects of the alternative to detail.

Team

Indiana University (University or IU) undertook this project, in partnership with the Bloomington/Monroe County Metropolitan Planning Organization (MPO) and the City of Bloomington (City). The University engaged a Consultant Team to assist with this study. The Consultant Team was led by Gorove/Slade Associates, Inc. and supported by Bledsoe Riggert & Guerrettaz, Inc. The Consultant Team, together with the University, MPO and City formed the Project Team. In addition to the Project Team input was gathered during the process at two sets of public workshops where residents, students and community stakeholders were actively engaged in developing alternatives.

Study Area

Figure 1 shows the study area, bordered by 17th Street to the north, 10th Street to south, Dunn Street to the west, and the State Road 45/46 Bypass to the east. Indiana University comprises the majority of the study area. Figure 2 shows the existing land uses within the study area.

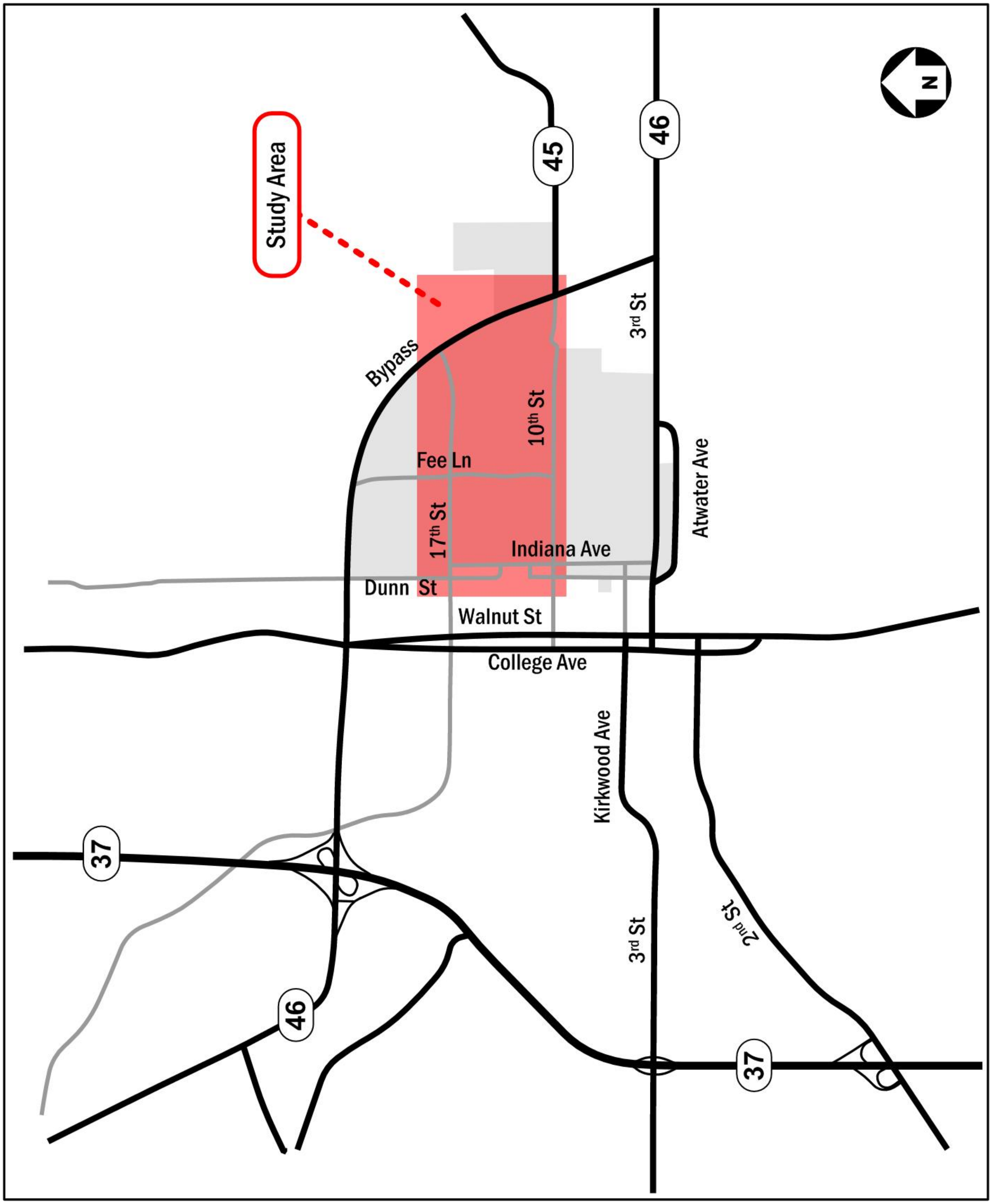

Figure 1: Site Location & Study Area

Figure 2: Land Uses in the Study Area

Study Goals

The purpose of the study was to evaluate current and future transportation conditions for all modes of travel and make recommendations for improvements that would address mobility issues. While the primary focus of the study was east-west mobility, north-south connectivity in the study area was also evaluated to ensure that a comprehensive solution was achieved.

The goals of the study were based on these objectives and included:

- Increase the mobility of persons through the study area by either
    - Increasing the mobility of private automobiles,
    - Increasing the mobility of public transit,
    - Increasing the mobility of bicyclists, or
    - Increasing the mobility of pedestrians; and
- Improve safety across all modes of transportation.

Background Documents

Over the course of this study, the study team reviewed several significant documents released by the University, the City of Bloomington and the MPO.

City of Bloomington Growth Policies Plan (2002)

The City's Growth Policies Plan (GPP) provides guidance for the development of undeveloped parcels and redevelopment sites, and establishes a structure for development based decision making. Included are policies on urban form, the environment, traffic and community character. Of relevance to this report are the following policies:

- "Limit the Spatial Extent of Community Growth". Part of this policy is discouragement of urban development to the north and east of State Road 45/46 Bypass, or to the north and east of the study area. This suggests mobility in the study area is a higher priority than mobility through the study area, such as commuter traffic;
- "Enhance and Expand Public Transit Services". This matches one of the study goals of this project;
- "Enhance Bicycle and Pedestrian Transportation Facilities". This matches one of the study goals of this project;
- "Implement Traffic Management Strategies". Included in this policy are measures to reduce the dependence on arterial corridors servicing suburban based traffic, and better connect street grids in urban communities; and
- "Mitigate Traffic". The GPP's recommendation to increase opportunities for bicycle, pedestrian and transit usage matches a goal of this study.

Included in the GPP is the Master Thoroughfare Plan, which establishes typical street cross sections and helps preserve right-of-way for future streets and establishes construction standards. Also included as part of the Master Thoroughfare Plan is the Alternative Transportation and Greenways System Plan which preserves right-of-way and defines construction standards for bicycle and pedestrian facilities.

An extended Law Lane connection is included in the Master Thoroughfare Plan. This shows Law Lane connecting to 10th Street in the east, improved and extended west to 13th or 14th Street. It is designated as a secondary arterial, which has a total right-of-way of 80 feet, including one travel lane in each direction, a center turning lane/median, and bicycle lanes.

Indiana University Master Plan (2009)

The IU Master Plan indentifies major infrastructure projects and the direction of campus growth over the next 20 twenty years. The plan includes an extended Law Lane roadway connecting 10th Street in the east to 14th Street in the west similar to prior ideas presented by the University and City. In addition, the plan includes removal of a significant amount of surface parking in the middle of campus and development of new facilities in the campus core (many on top of current parking lots). The goal is to allow for walking, bicycling, and campus transit to be the major modes of transportation within the campus, by creating a denser campus core instead of expanding outward. Included to help this goal is the improvement of Woodlawn Avenue as a north-south transit-oriented roadway connecting the campus to the remote parking lots near the athletic facilities.

Figure 3 shows a general overview of where new building construction is planned in the IU Master Plan.

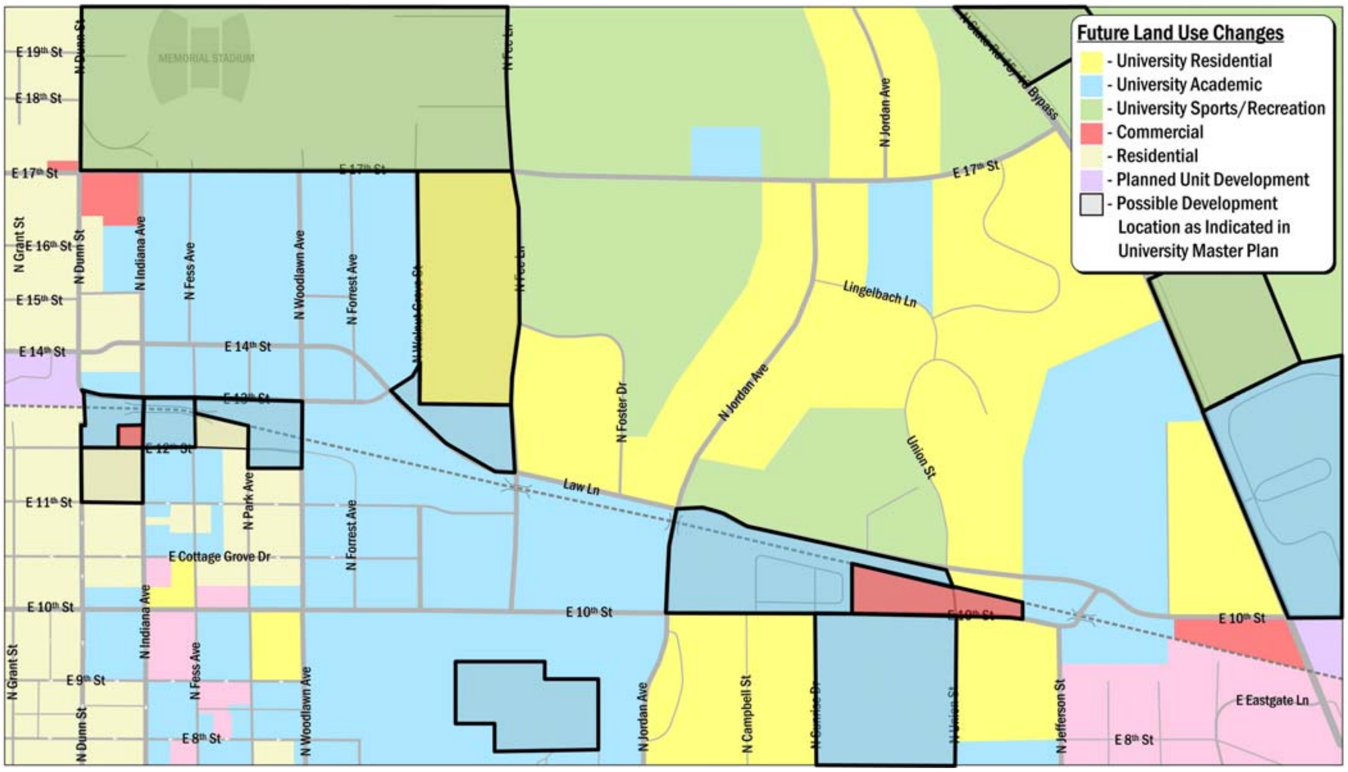

Figure 3: Future Land Use Changes due to the Indiana University Master Plan

MPO's Long Range Transportation Plan (2006)

The Long Range Transportation Plan (LRTP) is a document required by federal statutes to obtain funding for transportation projects. It includes a vision statement, a plan for future transportation needs including evaluation of several alternatives, and a cost feasibility plan for identified improvements.

Several parts of the Vision Statement are relevant to this project, including:

- Develop a truly multi-modal system;
- Create a fully developed network of alternative transportation facilities;
- Reduce the number and length of auto-trips;
- Achieve the widest possible range of alternatives to the automobile; and
- Increase the safety of all users of the transportation system.

The LRTP includes the following projects within or adjacent to the study area:

- The expansion of the State Road 45/46 Bypass from Walnut Street to 3rd Street (committed project);
- Addition of bicycle lanes and sidewalks to 17th Street within the study area (non-committed project);
- Addition of roadway connecting 14th Street at its intersections with Dunn Street and Indiana Avenue east to the Bypass, alignment to be determined (non-committed project); and
- Connecting Dunn Street across the railroad tracks at the western edge of the study area (non-committed project).

MPO's Complete Streets Policy (2009)

The Complete Streets Policy was written to empower and direct citizens, elected officials, government agencies, planners, engineers, and architects to use an interdisciplinary approach to incorporate the needs of all users into the design and construction of roadway projects funded through Bloomington/Monroe County MPO.

The goals of the Complete Streets Policy are:

- To ensure that the safety and convenience of all users of the transportation system are accommodated, including pedestrians, bicyclists, users of mass transit, people with disabilities, the elderly, motorists, freight providers, emergency responders, and adjacent land users;
- To incorporate the principles in this policy into all aspects of the transportation project development process, including project identification, scoping procedures and design approvals, as well as design manuals and performance measures;
- To create a comprehensive, integrated, and connected transportation network that supports compact, sustainable development;
- To ensure the use of the latest and best design standards, policies and guidelines;
- To recognize the need for flexibility to accommodate different types of streets and users; and
- To ensure that the Complete Streets design solutions fit within the context(s) of the community.

Summary

These documents heavily influenced this study and the evaluation of alternatives. A common theme within all of the policy documents was to focus on all modes of travel and to enhance existing neighborhoods instead of encouraging additional suburban development. The idea of complete streets aligned well with the study goals, and in particular, attention was paid to develop and evaluate alternatives that incorporated all modes of transportation instead of excluding a single mode for a greater enhancement of another. This led to the development of measures of effectiveness for a multi-modal approach. This will be discussed further in the following sections.

In addition, the idea of enhancing and extending 14th Street and Law Lane has been around for many years. A proposal of a Law Lane extension was incorporated into a University plan from the 1960s. The Law Lane extension concept has gained a lot of momentum as a solution in the study area.

Study Process

This study was structured as a planning-level study, focusing on all modes of transportation and including significant public input. Two sets of public workshops were conducted, in April and September of 2009.

The technical analyses conducted for this project for planning purposed to test overall feasibility. Traffic engineering techniques were performed to evaluate alternatives, but not to the level of specificity necessary for detailed design or operations studies. Instead, enough analyses were conducted to make decisions and compare/contrast alternatives.

The following is a general timeline of study milestones:

- May 9, 2008: The MPO passes the Unified Planning Work Program which allows federal funds to be spent on the study;

- October 2008: Indiana University selects Gorove/Slade Associates, Inc. as the consultant for the project;
- March 2009: Contracts are finalized between the University, MPO, the City, and the consultant for the project;
- March-May 2009: Data is collected for the project (traffic counts, pedestrian counts, bicycle counts, transit ridership, utility information, on-line survey etc.);
- April 16, 2009: Two public workshops are held to get public input on the study area;
- April-September: The consultant formulates alternatives for consideration;
- September 10, 2009: Two public workshops are held to get public input on the work performed by the consultant on the alternatives;
- Fall 2009: Discussions take place within the study team to determine the preferred alternative;
- January 2010: First draft of final report is issued; and
- April 2010: Final report is issued.

DEVELOPMENT OF ALTERNATIVES

Analysis of Existing Conditions

The existing conditions of the study area were analyzed to determine if any areas of concern or opportunity exist within the transportation network, to establish a point of reference for the analysis of future traffic conditions, and to help generate alternative concepts. The following summary of transportation facilities was compiled based on interviews with the University and City Staff, existing reports, maps and information, and observations within the study area.

Roadways

The University is served by a roadway network that includes arterials important to local traffic such as the SR 45/46 Bypass, roadways that service as important campus circulators such Fee Lane and Jordan Avenue, and streets that serve both purposes, such as 10th Street. The study area is bordered by 17th Street on the north, 10th Street on the south, Dunn Street on the west, and the SR 45/46 Bypass on the east. Figure 4 shows the street network of the study area and the existing traffic controls at the study intersections.

Figure 5 shows the classifications of the roadways located in the study area, as well as the average daily traffic (ADT), as given on the City's transportation maps. Average daily traffic (ADT) shows the average typical weekday traffic along a roadway, which is the total in both directions obtained from varying years within the study area.

These figures show that there are limited options for north-south traffic through the University campus. The Indiana Avenue/Dunn Street, Fee Lane, and Jordan Avenue connections do have high volumes and are all primarily used to collect and distribute traffic. The SR 45/46 Bypass is the only commuting or through roadway in the area that can be considered a north-south roadway. The SR 45/46 Bypass is planned to be widened from a 2-lane to a 4-lane cross-section by the Indiana Department of Transportation (INDOT).

The primary east-west routes through campus are 17th Street, 10th Street, and the 3rd Street/Atwater Avenue one-way pair; the latter is not part of the study area. 17th Street is not used as a through route, primarily because it terminates at the SR 45/46 Bypass at an intersection without a traffic signal to aid vehicles turning on and off the SR 45/46 Bypass. Encouraging more traffic to utilize 17th Street would most likely involve placing a traffic signal at the intersection with the SR 45/46 Bypass. This improvement is currently planned by INDOT as part of the SR 45/46 Bypass widening project. 10th Street also appears to act as a collector/distributor roadway instead of a through roadway during the morning and afternoon peak periods due to heavy University oriented use. During the non-peak periods, 10th Street is more conducive to serving through traffic.

Existing roadway capacity analyses were performed for the study area. Traffic volumes were assembled using counts obtained from the City and supplemented by counts conducted for the University Master Plan by Gorove/Slade. The existing count data was compiled and analyzed using the *Synchro, Version 7* software package. Capacity analyses were performed using the *SimTraffic* software to simulate the existing roadway conditions in the study area. According to the simulation results, all study intersections operate under acceptable conditions during the morning peak period, and the following intersections operate under unacceptable conditions during the afternoon peak period:

1. 17th Street and Fee Lane
2. Law Lane and Jordan Avenue
3. 10th Street and Woodlawn Avenue

4. 10th Street and Jordan Avenue
5. 10th Street and the SR 45/46 Bypass

The existing simulation results show that there is a significant amount of congestion and delay experienced by vehicles along the 10th Street corridor. This is due to the heavy amount of vehicle and bus traffic along the corridor, in addition to large volumes of pedestrians and bicycles interacting with vehicles. However, the simulation results do not show the unacceptable conditions observed by Gorove/Slade at the intersection of 10th Street and Fee Lane. The simulation shows that the intersection operates under acceptable conditions because it cannot simulate large volumes of pedestrians jaywalking across the intersection and other problems that lead to congestion and vehicular delay. Detailed capacity analysis results are shown in Appendix A.

Figure 6 shows the primary parking areas located within the study area. Approximately 9,500 University parking spaces are accessed from the roadways within the study area. The parking types consist of four categories. The grouping and coloring shown on Figure 6 are based on which of the four categories is the majority within a given group. The following categories are based on the type of traffic each type of parker generates:

1. Academic/staff/research parking, which generates traffic during the morning and afternoon peak periods;
2. Commuter student parking, which generates traffic all-day but not as concentrated during the morning peak period;
3. On-campus student parking, which generates relatively little traffic per space; and
4. Other spaces that have multiple uses, such as the parking garages and visitor parking.

As can be seen on Figure 6, 10th Street, Law Lane, and Fee Lane are very important roadways, which provide access to University parking facilities for employees and commuting students.

Figure 7 shows the concerns for the roadways located in the study area. A common concern in the study area is the existing congestion of the 10th Street corridor due to its heavy use by multiple modes of transportation. Long vehicular queues develop on a regular basis during the morning and afternoon peak periods near the center of the University campus along 10th Street. These queues primarily develop due to a lack of alternatives for vehicular traffic to travel through the study area. Roadways in the study area also develop congestion due to the amount of parking located near and within the study area and the lack of options for drivers to avoid routes with pedestrians.

There is also a lack of north-south connectivity in the eastern portion of the study area. This is shown by the lack of a direct connection between 10th Street and 17th Street east of Jordan Avenue. In addition to this, east of the Indiana Avenue/Dunn Street pair, no direct connection is provided between the 3rd Street/Atwater Avenue pair on the south side of campus and the SR 45/46 Bypass on the north side of campus.

Figure 4: Existing Study Area Roadways and Traffic Controls at Study Intersections

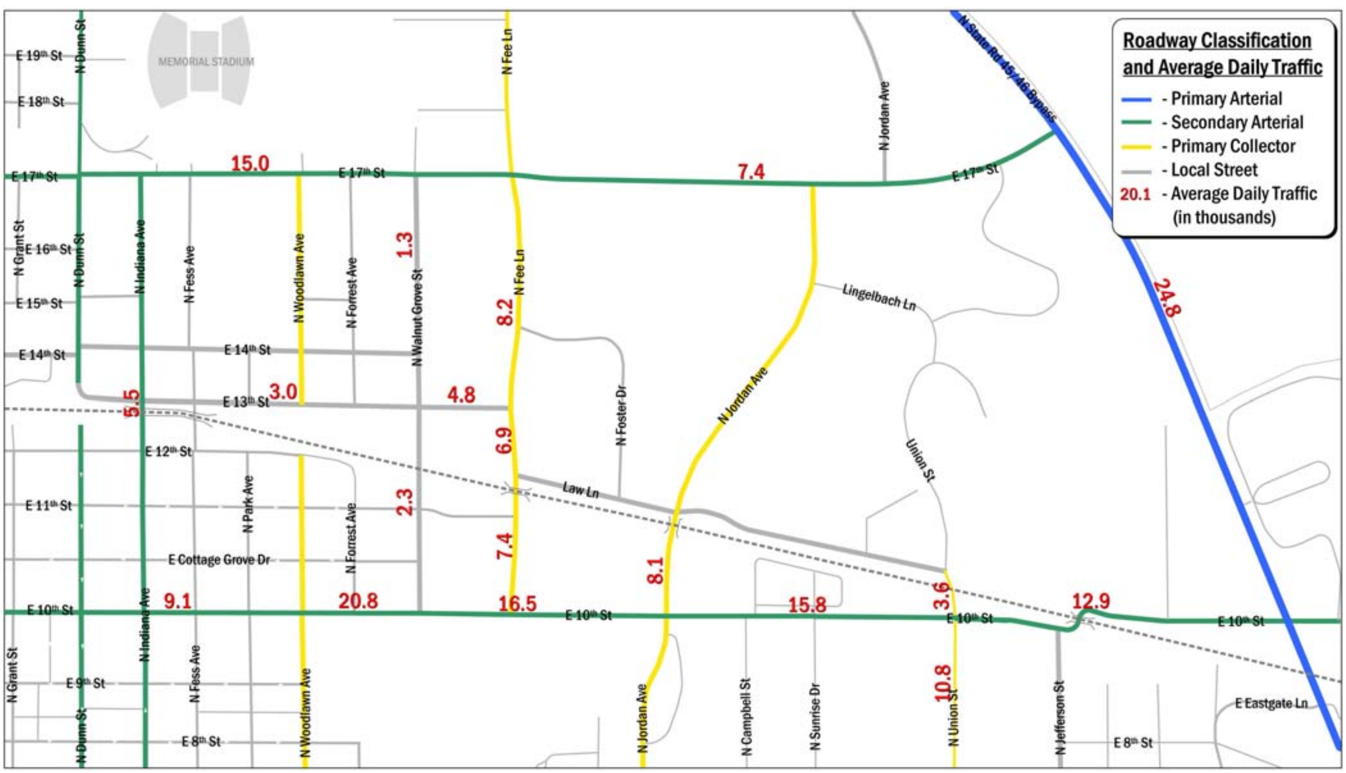

Figure 5: Existing Roadway Classifications and Average Daily Traffic (ADT)

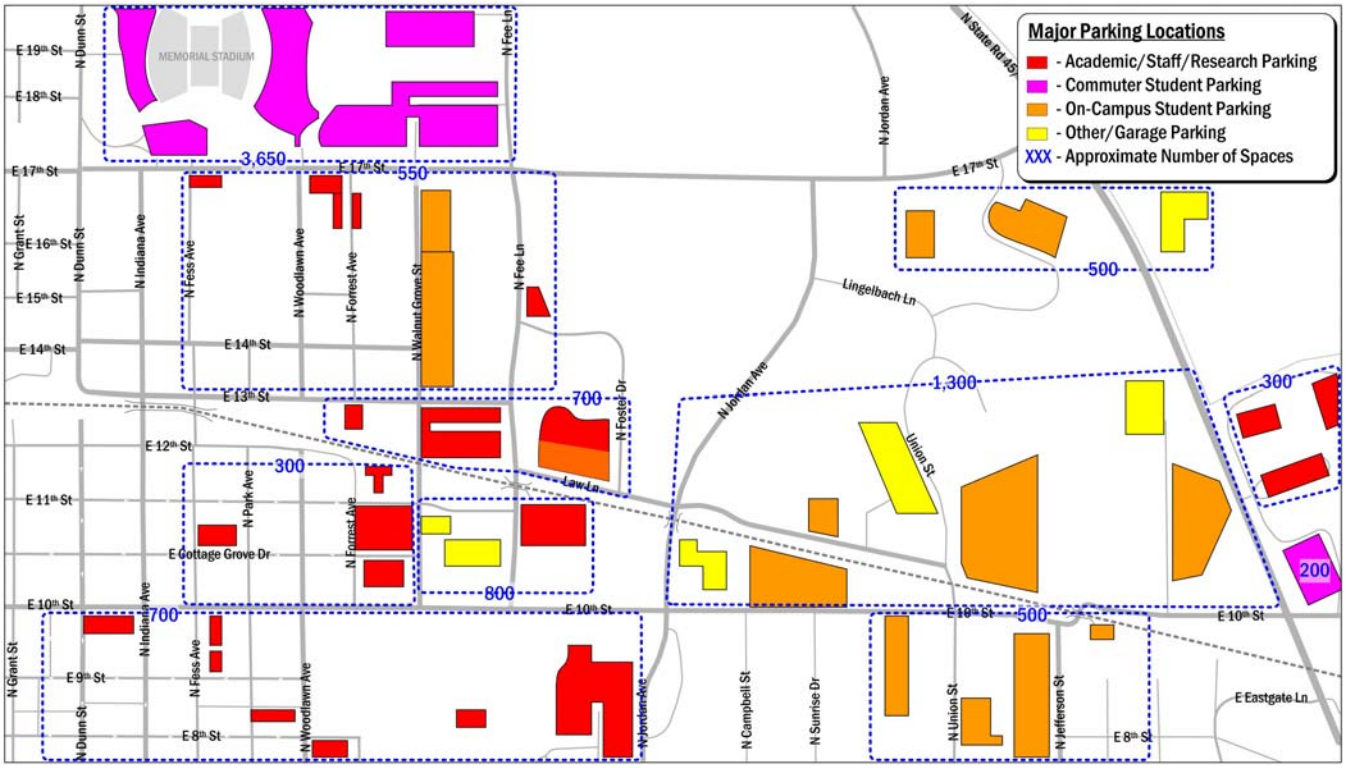

Figure 6: Major Parking Locations in the Study Area

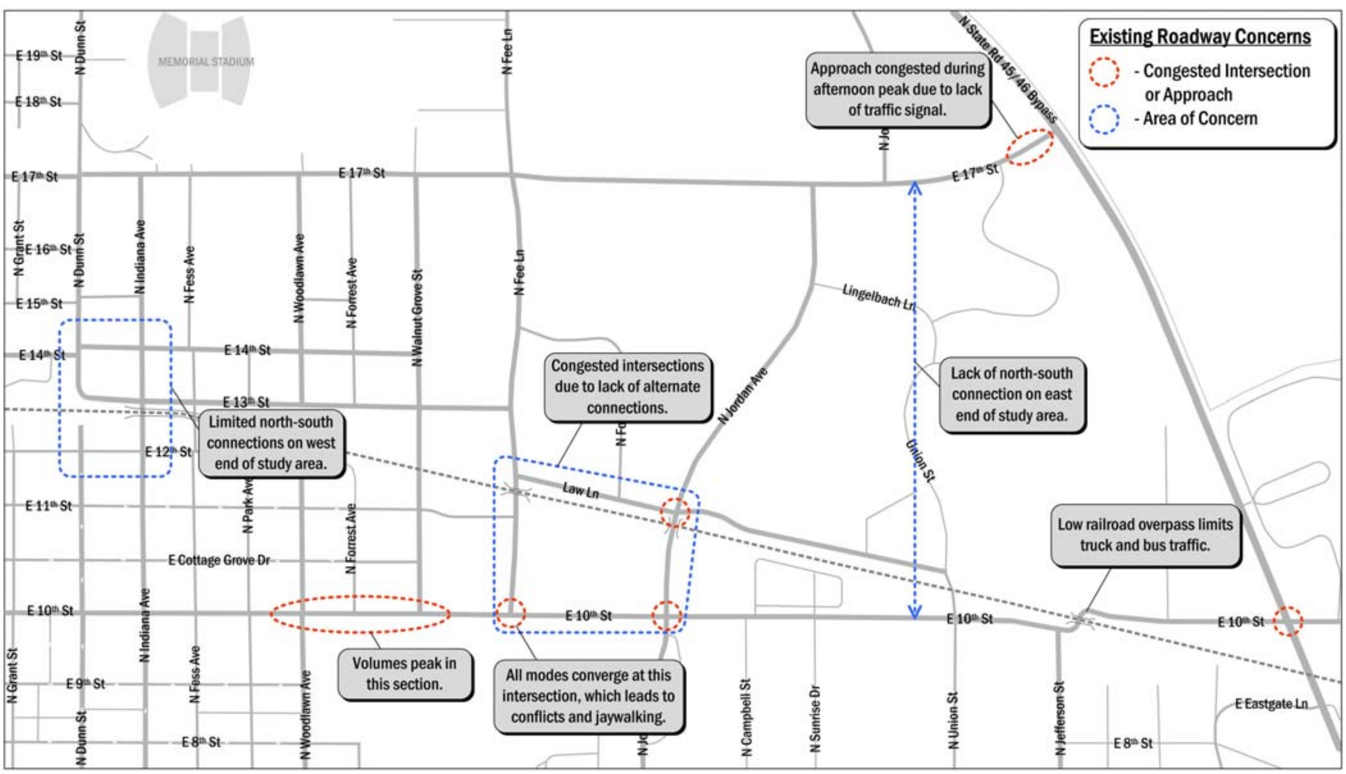

Figure 7: Existing Roadway Concerns

Transit Services

The University campus is served by seven different IU campus and Bloomington Transit bus routes, as shown on Figure 8. The primary University routes serve the campus area located between 10th Street and 3rd Street in a clockwise loop around the central academic areas. Additional routes serve the remote parking areas located near the Memorial Stadium along 17th Street and the student housing located along Jordan Avenue and Union Street. Bloomington Transit provides bus service through the study area along 10th Street, Fee Lane, 17th Street, Dunn Street, and 14th Street. Students and faculty at the University are provided free rides on both the Indiana University and Bloomington Transit systems.

According to historical monthly ridership data for the Transit systems from 1996-2008, overall transit ridership has increased significantly, as shown on Figure 9. The policy change to allow students and faculty to ride Bloomington Transit for free can be seen in the data from 1999-2000, which shows a sharp increase in ridership on Bloomington Transit, as well as a slight decrease in ridership on University Transit, which resulted in an overall increase in total ridership. Prior to this, ridership growth was rather static.

Figure 10 compares the total monthly ridership data for the University Transit system and the Bloomington system between January and April of 2008 and 2009, respectively. From these two figures, it can be seen that ridership on both the Bloomington Transit and Indiana University Transit systems are heavily impacted by the University academic calendar. Ridership data provided by the transit systems shows that ridership varies significantly through the year, with daily variations as well.

Detailed transit ridership data is provided in Technical Attachment 3: Data Collection.

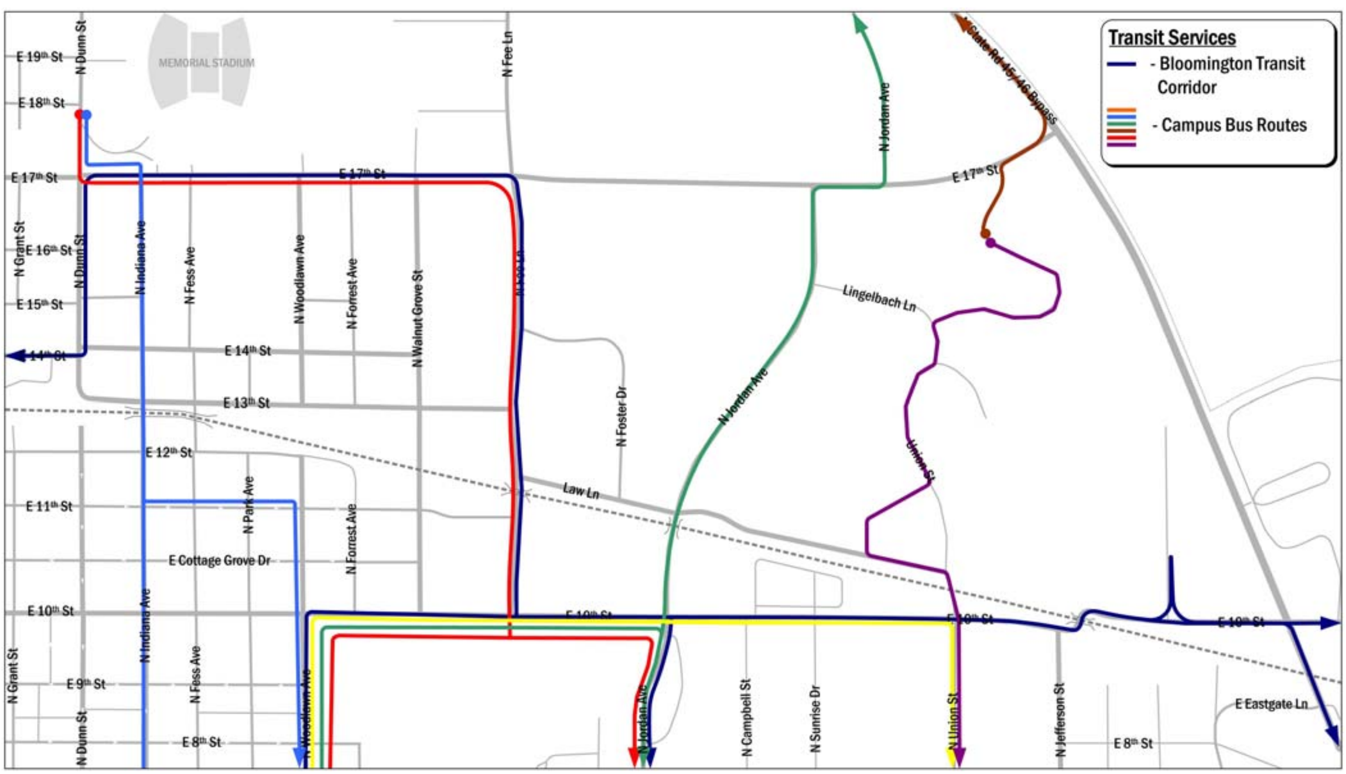

Figure 8: Transit Routes within the Study Area

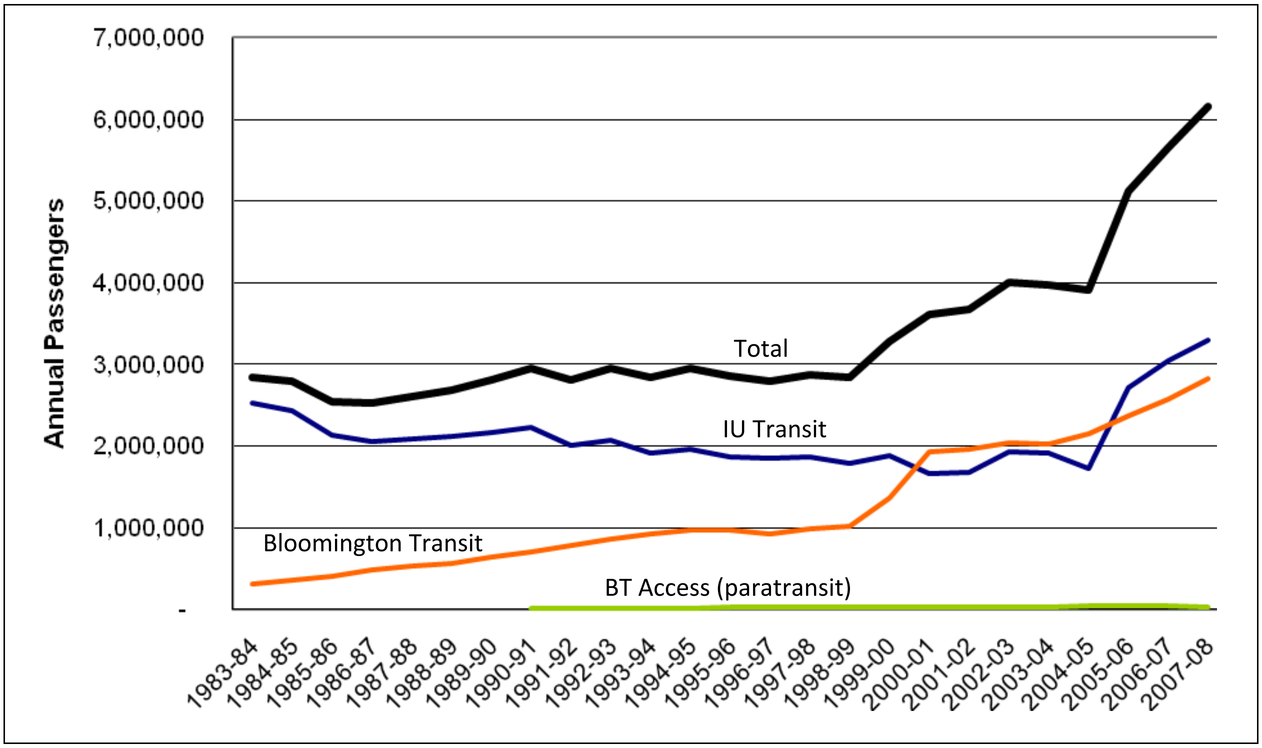

Figure 9: Historical Transit Ridership (1996-2008)

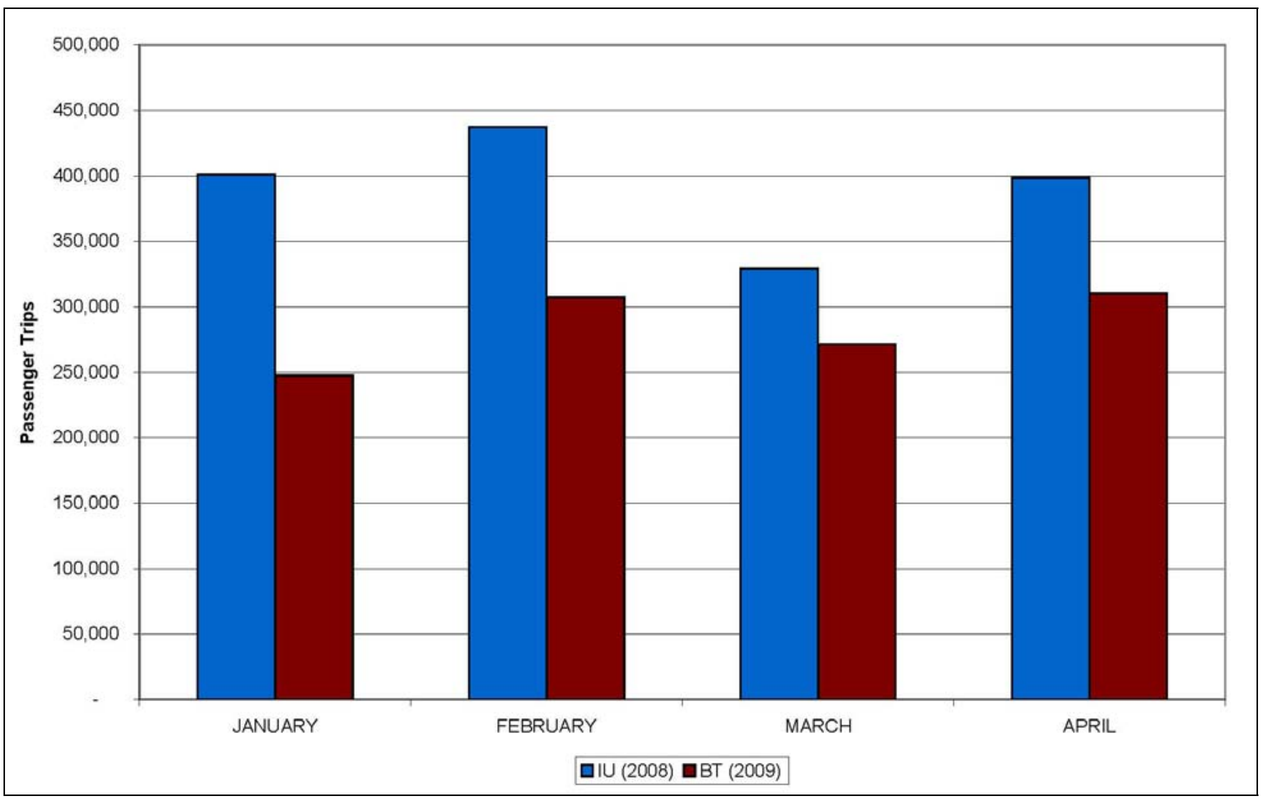

Figure 10: Monthly Total Ridership Comparison (January – April 2008/2009)

Bicycles

Bicycle use is prevalent in the study area due to the University, and many bicycle racks on campus are frequently parked over-capacity. Figure 11 shows the existing bicycle routes located in the study area. Existing bicycle facilities in the study area consist mainly of striped bicycle lanes on Fee Lane and portions of Jordan Avenue, 11th Street, and Cottage Grove Avenue. Bicyclists frequently utilize the sidewalks in favor of the roadways due to high traffic volumes and speeds on the study roadways, such as 10th Street. Bicyclists travel in the street on roadways with lower traffic volumes.

Figure 12 shows the concerns in the study area related to bicycles. As stated above, there is a concern over existing congestion on the 10th Street corridor due to its heavy use by multiple modes of transportation. Along the corridor, many bicyclists prefer to ride on the sidewalks due to a lack of bicycle facilities and heavy vehicular traffic. However, travel on the sidewalks is impeded by high pedestrian volumes and is prohibited in Bloomington per local ordinance. In the study area, the only striped bicycle lanes are provided on Fee Lane and portions of Jordan Avenue, providing limited north-south bicycle connectivity and no complete east-west connectivity. Due to a lack of bicycle routes, conflicts are created for bicyclists with pedestrians and vehicles.

Figure 11: Existing Bicycle Facilities in the Study Area

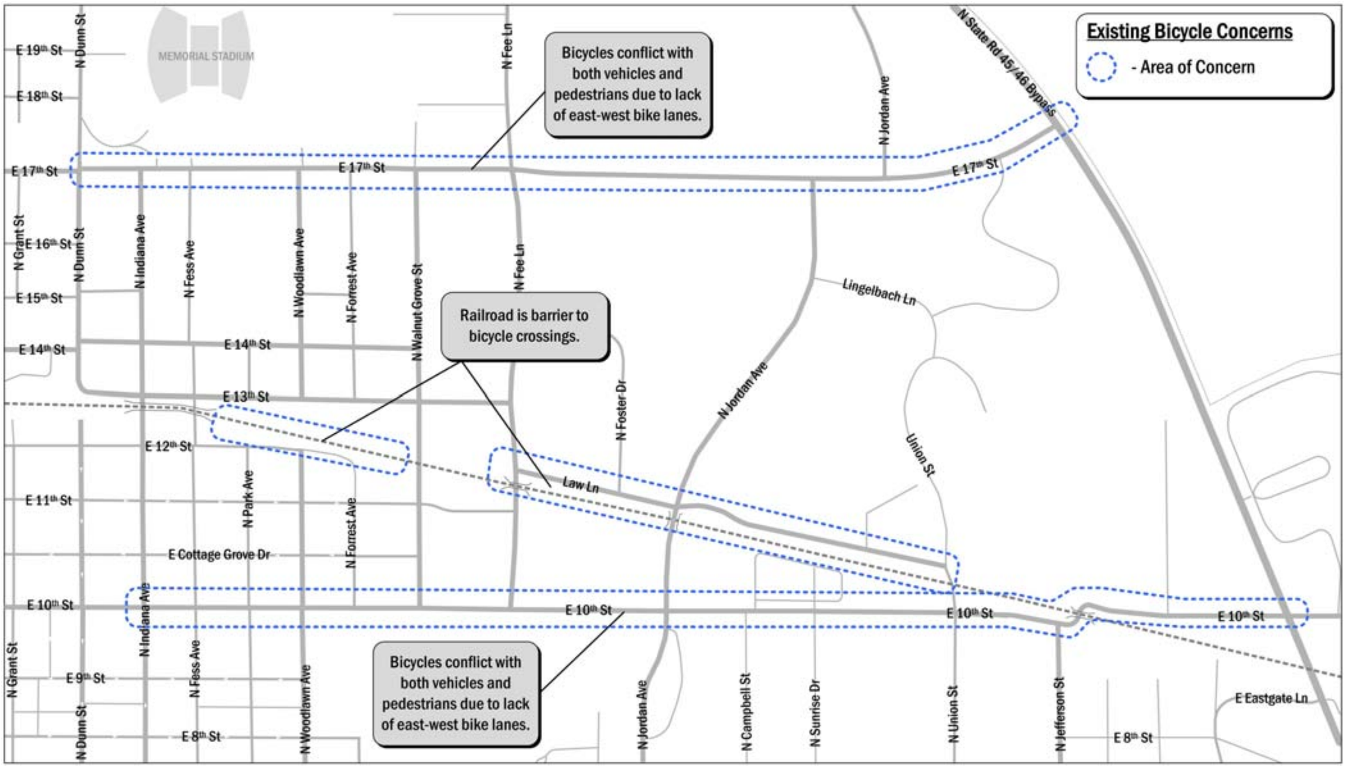

Figure 12: Existing Bicycle Concerns

Pedestrian

Pedestrian volumes within the campus are very high. Existing pedestrian facilities in the study area consist of sidewalks and crosswalks. Figure 13 shows the existing pedestrian facilities located in the study area. Sidewalks are provided along the major roadways in the study area, including 10th Street, Law Lane, Jordan Avenue, and Fee Lane. Crosswalks are provided at major intersections in the study area, though several are located at intersections without a traffic signal

Figure 14 shows the concerns in the study area related to pedestrians. As stated above, there is a common concern over existing congestion on the 10th Street corridor due to its heavy use by multiple modes of transportation. A lack of vehicular options for routing creates conflict points between pedestrians and vehicles. Additionally, the use of sidewalks by cyclists creates conflicts between pedestrians and bicycles on the sidewalks located within the study area. Few roadways in the study area have sidewalks on both sides of the street. In addition to a lack of sidewalks, high vehicular speeds and long distances between intersections with traffic signals makes it difficult for pedestrians to cross roadways within the study area. A large barrier in the study area is the railroad tracks, which travel east-west, just south of 13th Street and Law Lane. There are limited crossings provided for pedestrians, which has led to informal pedestrian crossings along heavily trafficked paths. In addition to the limited number of railroad crossings, the at-grade pedestrian crossings in the study area do not include signals or gates. Figure 15 shows the railroad crossings located within the study area.

Figure 13: Existing Pedestrian Facilities in the Study Area

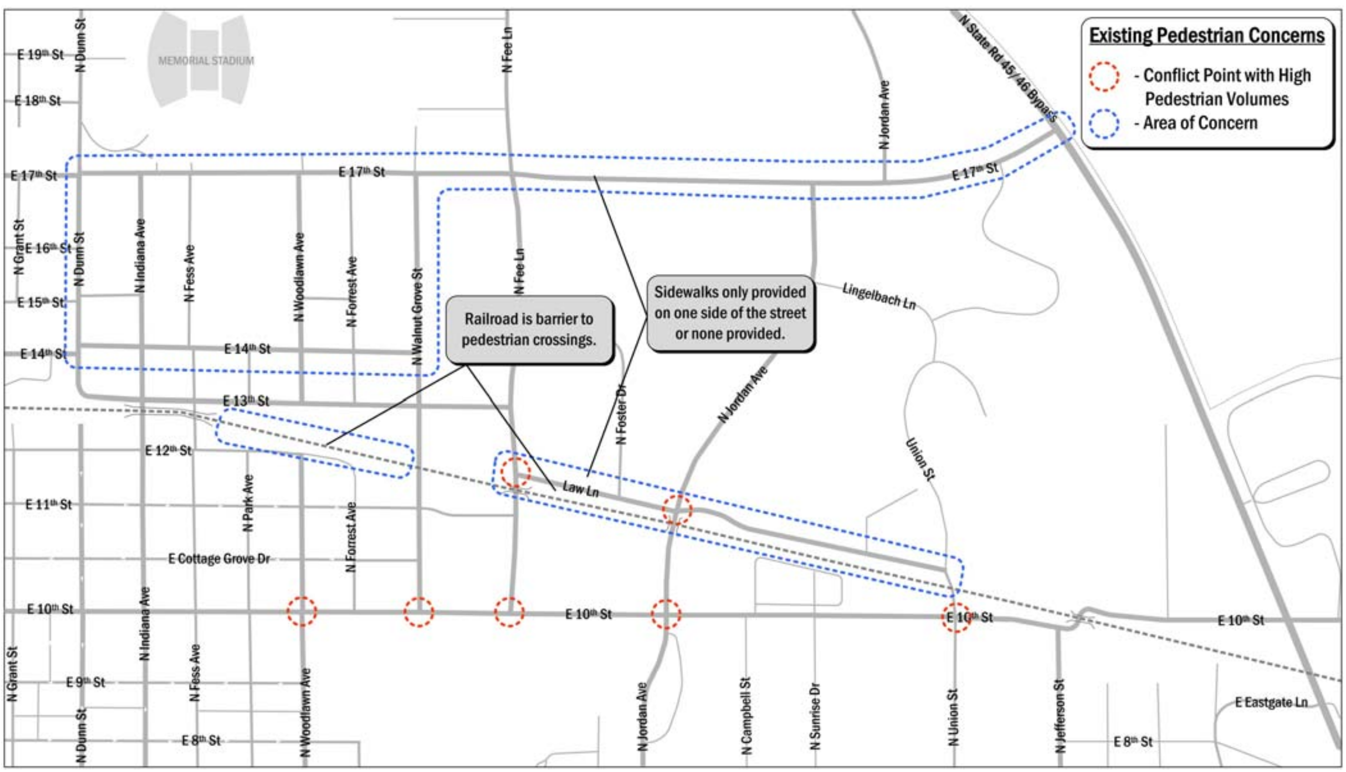

Figure 14: Existing Pedestrian Concerns

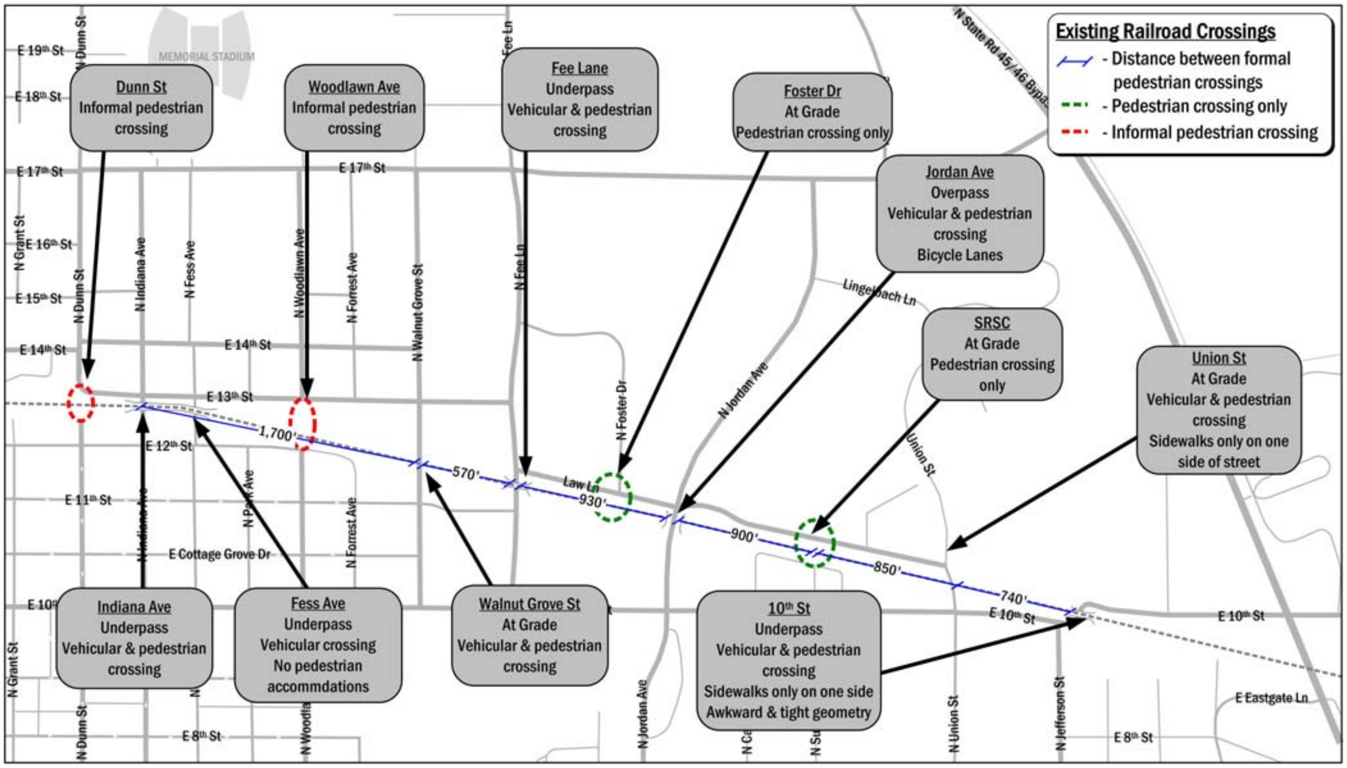

Figure 15: Existing Railroad Crossings in the Study Area

Safety

According to the latest MPO Crash Report available at the time this report was written, several of the City's high accident rate locations are within the study area. Table 1 shows the top 15 crash locations, ranked by the 4-year average of vehicular crashes per Million Entering Vehicles (MEV) from 2003 to 2006. Locations in the study area are shown in italics, which are five of the study intersections, ranked first, second, seventh, twelfth, and fifteenth in the City. The five ranked study intersections and their corresponding crash rate are shown on Figure 16.

In addition to vehicular crashes, six study intersections rank in the top 15 crash locations for bicycles and pedestrians. Table 2 shows the top 15 bicycle and pedestrian crash locations, ranked by the total number of occurrences from 2003 to 2006. Locations in the study area are shown in Italics, which are ranked fourth, fifth, sixth, seventh, tenth, and fourteenth in the City. The six ranked study intersections and their corresponding crash rate are shown on Figure 16.

During the course of this study, a pedestrian was killed and a few others were injured within the study area. This has drawn increased attention to make improvements that will ensure safe interactions between motorists and pedestrians. A special task force of City and IU interests developed a list of specific measures to be undertaken at locations throughout the IU campus.

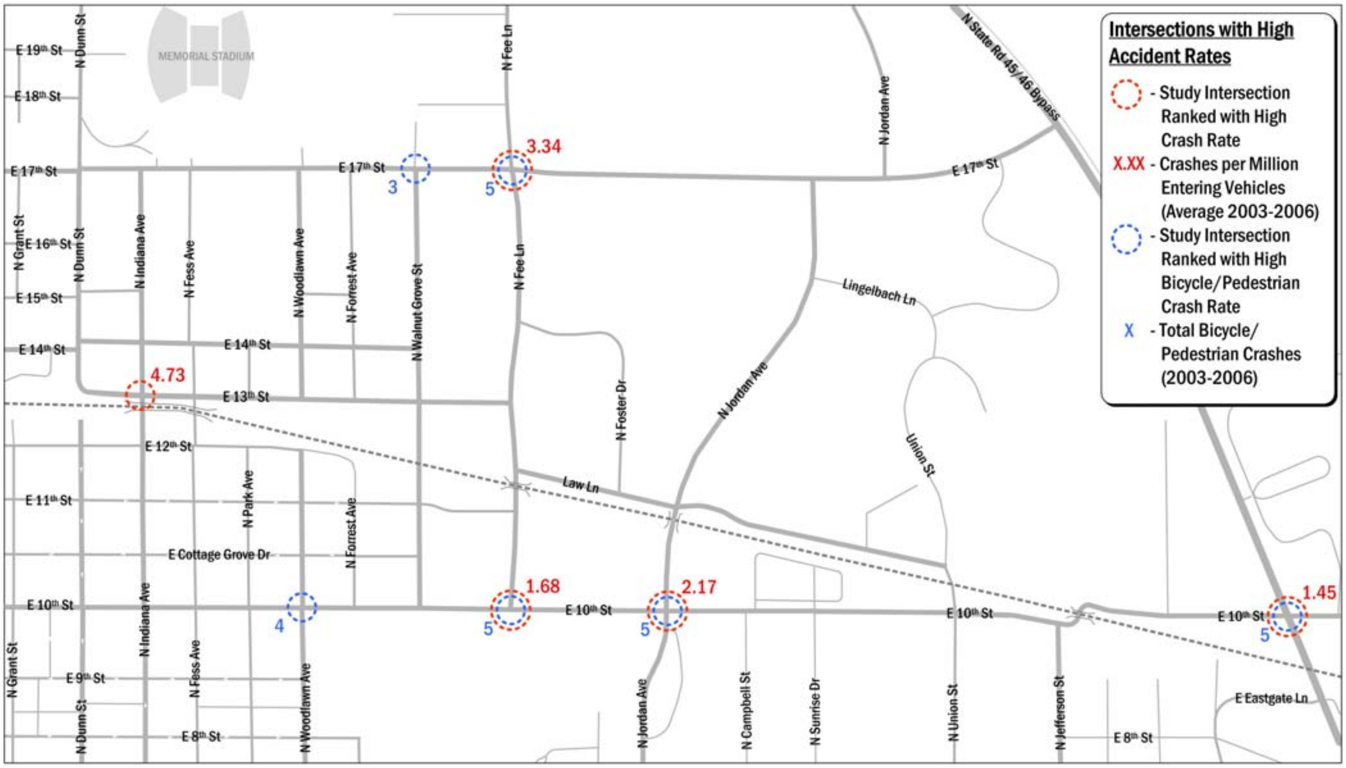

Figure 16: Intersections in the Study Area with High Accident Rates

Table 1: Crashes per Million Entering Vehicles by Location, Ranked by 4-Year Average, 2003-2006

Rank	Location	Year				4-Year Average
		2003	*2004*	*2005*	*2006*	
1	*13th Street & Indiana Avenue*	*4.76*	*5.95*	*3.96*	*4.24*	***4.73***
2	*17th Street & Fee Lane**	*4.66*	*3.44*	*2.17*	*3.08*	***3.34***
3	Bloomfield Road & State Road 37	3.28	3.47	3.46	2.86	**3.27**
4	Country Club Drive & Walnut Street	3.22	2.78	3.25	2.38	**2.91**
5	3rd Street & Jordan Avenue	2.21	2.83	3.80	2.14	**2.75**
6	State Road 37 & Vernal Pike	2.47	2.50	2.34	2.22	**2.48**
7	*10th Street & Jordan Avenue*	*1.97*	*2.15*	*2.23*	*2.31*	***2.17***
8	3rd Street & Indiana Avenue	2.68	1.55	1.03	2.19	**1.86**
9	Atwater Avenue & Henderson Street	1.72	1.85	1.74	1.96	**1.82**
10	8th Street & College Avenue	1.46	1.23	2.34	2.22	**1.81**
11	3rd Street & Smith Road	1.31	2.30	1.41	2.03	**1.76**
12	*10th Street & Fee Lane*	*1.82*	*1.95*	*0.87*	*2.06*	***1.68***
13	3rd Street & Liberty Drive	1.21	1.69	1.87	1.52	**1.57**
14	3rd Street & State Road 37	1.36	2.04	1.46	1.08	**1.49**
15	*10th Street & State Road 45/46 Bypass*	*1.32*	*1.45*	*1.45*	*1.57*	***1.45***

* - 17th Street & Fee Lane intersection has been improved

Table 2: Bicycle and Pedestrian Crashes by Location, Ranked by Total Occurrence, 2003-2006

Rank	Location	Crash Type		Annual Total
		Bicycle	*Pedestrian*	
1	3rd Street & Jordan Avenue	5	7	**12**
2	7th Street & Jordan Avenue	4	3	**7**
3	Jones Avenue & Jordan Avenue	1	6	**7**
4	*10th Street & Fee Lane*	*1*	*4*	***5***
5	*10th Street & Jordan Avenue*	*2*	*3*	***5***
6	*10th Street & State Road 45/46 Bypass*	*2*	*3*	***5***
7	*17th Street & Fee Lane**	*2*	*3*	***5***
8	3rd Street & Gates Drive	1	4	**5**
9	3rd Street & State Road 45/46 Bypass	0	5	**5**
10	*10th Street & Woodlawn Avenue*	*0*	*4*	***4***
11	3rd Street & State Road 37	0	4	**4**
12	Kirkwood Avenue & Walnut Street	2	2	**4**
13	11th Street & Fee Lane	3	0	**3**
14	*17th Street & Walnut Grove*	*0*	*3*	***3***
15	19th Street & Walnut Street	3	0	**3**

* - 17th Street & Fee Lane intersection has been improved

Public Input

Public Workshops

Two Public Workshops were held on April 16, 2009 to gain public input on the existing conditions analyses to date and on thoughts concerning alternatives to be developed. Workshop participants included a variety of approximately 25 stakeholders such as residents, business owners, students and City Council members. Input was gained through a 'dot map' exercise and break out groups. The 'dot map' exercise consisted of giving participants red and green dots and a map of the study area. Green dots were for opportunities or 'pros' of the transportation network, and red for concerns or 'cons'. The resulting maps including annotations are shown on Figure 17 and Figure 18.

Break-out groups were used to gain comments from the public in smaller groups, to maximize the amount of comments received and look for repeated concerns and ideas. The following were the six most often listed comments from the break-out groups:

- Connect Law Lane;
- Improve connectivity;
- Create/improve railroad crossings for vehicles and pedestrians;
- Provide two-way circulation;
- Improve pedestrian/transit conditions; and
- Maintain green space.

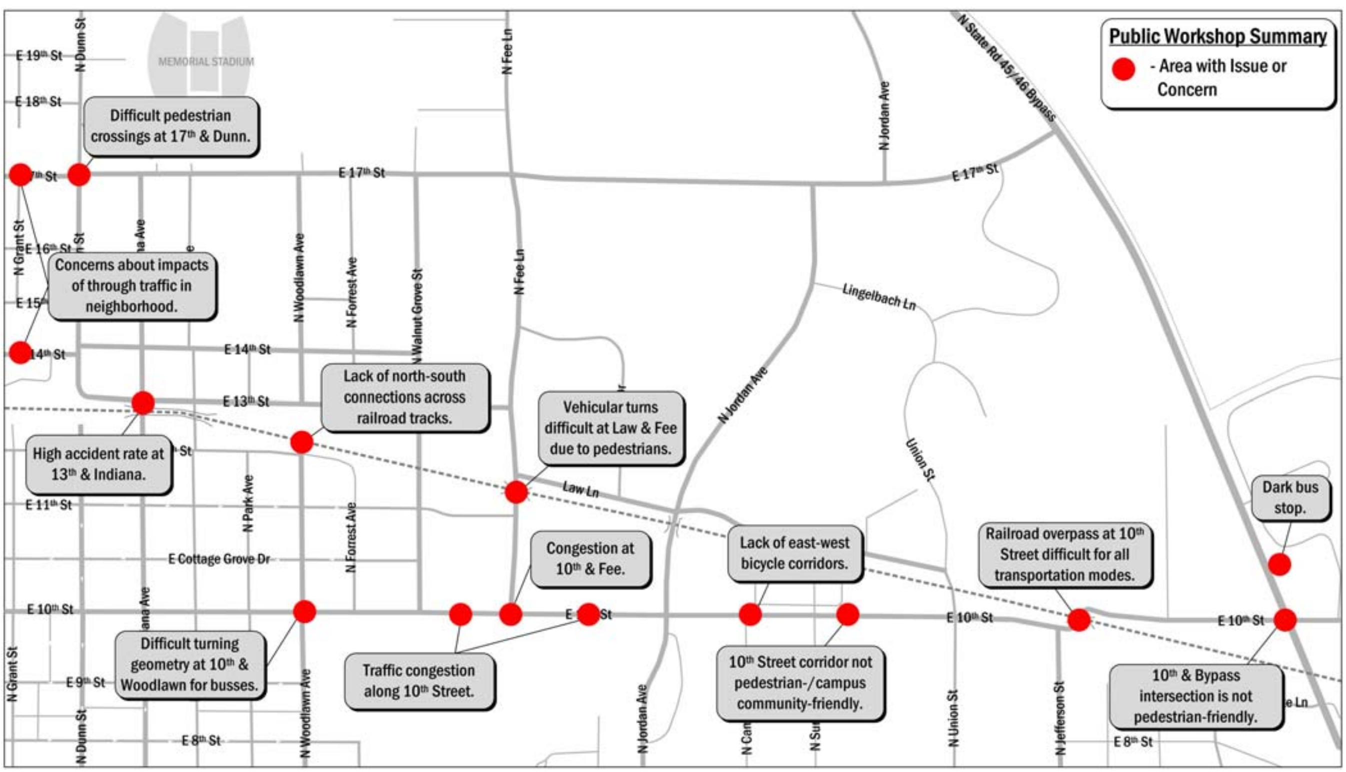

Figure 17: Summary of Public Workshop Roadway Concerns

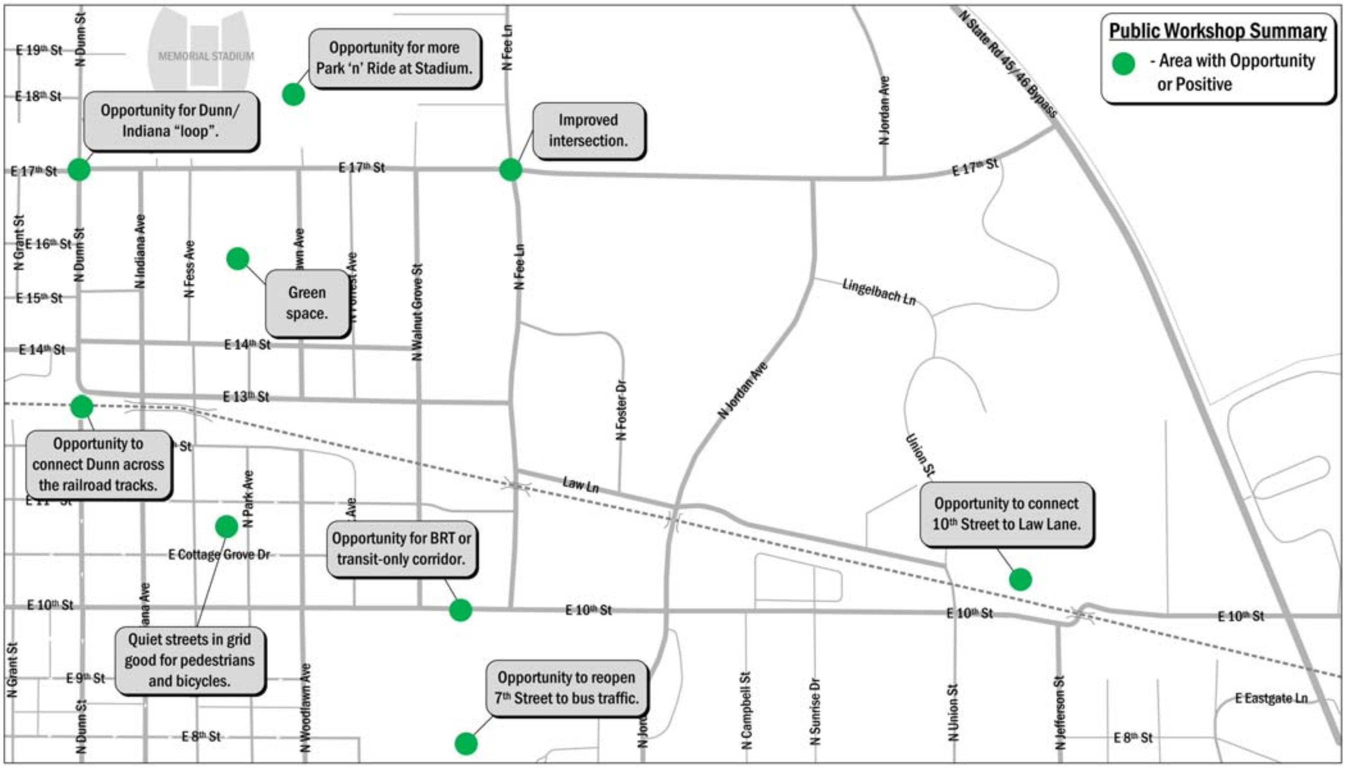

Figure 18: Summary of Public Workshop Roadway Opportunities

Online Survey

An online survey was also conducted early in the process to give direction on the framework by which the study goals would be evaluated in greater detail. It was listed on City Planning's website and Facebook site. There were 40 responses, and included the following findings:

- The majority (75%) of survey respondents were non-students working full-time jobs. More than half of those respondents were non-University employees.
- Approximately 10% of respondents were students, with approximately half of those being IU-students.
- Approximately 75% of respondents chose motorized vehicle as primary mode of transportation; 12% chose walking, 7% transit, and 5% bicycle.
- Approximately 30% of respondents utilized their primary mode several times per day. 30% of respondents chose their primary mode because it was most convenient.
- The majority (60%) of the respondents travel through the study area, utilizing 10th Street to get across town.
- Approximately 70% of the respondents travel east-west through the study area.
- Respondents ranked the following forms of transportation that should receive the most attention and funding in the future: bicycle, transit/bus, walking, motorized vehicle.
- Respondents ranked pedestrian safety and automobile mobility/accessibility/congestion as the top transportation concern for the study area.
- The top alternatives for the corridor were the following:

1) Construct additional roadway and make one-way pairs (33%)
2) Restrict access on existing 10th Street (23%)
3) Construct additional roadway and make 2-way pairs (18%)

In summary, the survey respondents were primarily non-students that drove through the study area, and not associated with the University. The majority supported the extension of Law Lane as a one-way pair with 10th Street because it would reduce travel times through the study area by increasing speeds and reducing delay. Top priorities identified were pedestrian safety and automobile mobility.

Alternatives

The existing conditions analysis shows a study area with several areas of concern spread across multiple modes of travel. There are numerous congestion spots along the 10th Street corridor, generated by a mix of local (University) and commuter-based traffic. In addition, the 10th Street corridor experiences a significant mixing of different modes, with heavy use by pedestrian, bicyclists, transit vehicles and automobiles on a relatively narrow right-of-way. This is created by a lack of a distinct east-west hierarchy within the study area, as there is a lack of routing options for most modes. The amount of turning vehicles at intersections also indicates a lack of options in the north-south direction, generating conflicts at intersections and undue delay for drivers.

These existing areas of concern were used as the basis to develop the set of alternatives studied in this report, along with prior concepts and analyses performed in the study area, and the direction provided in the GPP Master Thoroughfare Plan. The prior concepts of an extension of Law Lane between 10th Street to the east and 13th/14th Streets to the west has led to greater feasibility and support. Based on public and stakeholder input, it was decided to focus any new roadway construction alternatives on similar concepts. In addition, based on public input and existing policies, it was decided not to include alternatives that restricted modes from roadways (ie. no new roadways without bike lanes or sidewalks, no roadways converted to transit or pedestrian only).

The three alternatives, represented as Figure 19, Figure 20, and Figure 21, were developed from a list generated by public input and narrowed down by the study team. The final recommendation, the Preferred Alternative, was selected after these alternatives were evaluated.

Alternative 0: No-Build

Alternative 0, as shown on Figure 19, is representative of the future conditions of the study area under base conditions, and consists of the 'no-build' scenario in this study. The only changes included in Alternative 0 are from committed projects in the MPO's Long Range Transportation Plan, and one improvement contained in the IU Master Plan. This includes the widening of the Bypass, which is assumed to include a new traffic signal at the intersection of 17th Street, and the creation of a new transit-based north-south corridor along Woodlawn Avenue.

Alternative 1: 10th Street and Law Lane as 1-Way Streets

Alternative 1, as shown on Figure 20, is an alternative based on the concept for a new east-west road as shown in the Master Thoroughfare Plan, the Long Range Transportation Plan, and the IU Master Plan. Starting from the west it would begin at the intersection of 14th Street and Dunn Street, travel the 14th Street right-if-way and then curve south to meet Law Lane at its intersection with Fee Lane. Law Lane would be re-constructed between Fee Lane and Union Street, and extended east to 10th Street, meeting 10th Street north of the existing railroad underpass. As per the Master Thoroughfare Plan, the Law Lane/14th Street extension would be designated a secondary arterial, with a maximum 80 foot right-of-way.

In Alternative 1, the new roadway would be one-way westbound. It would include two travel lanes, with an additional left turn lane as needed at intersections, a bicycle lane, and sidewalks on both sides. In addition, 10th Street would be converted to one-way eastbound, and coordinated as a one-way pair with the new roadway. The creation of a one-way pair of streets through the study area would allow for a reduction in conflicts along intersections, simpler signal timings, and the ability to greatly reduce congestion and increase east-west throughput of vehicles.

Since this is a planning level effort, the exact alignment and intersection design details are not specified in this alternative, although some operational characteristics were selected for evaluation purposes. At the western end of the study area, it was decided to connect the new street to 14th Street instead of 13th Street for two reasons. First, there was concern about adding a significant amount of volumes to the intersection of 13th Street and Indiana Avenue, due to its high accident rate. Ideally, a new roadway intersection a block to the north could draw turning vehicles away from the intersection of Indiana Avenue and 13th Street. Second, unlike 13th Street, 14th Street continues to downtown Bloomington, and the north-south one-way pair of College Avenue and Walnut Street. Connecting to 14th Street, instead of 13th, was done in order to maximize east-west travel and logically fit a new secondary arterial into the City network.

Alternative 2: 10th Street and Law Lane as 2-Way Streets

Alternative 2, as shown on Figure 21, is a very similar concept to Alternative 1. It consists of the same new roadway, in the same alignment. The difference is that Alternative 2 would maintain 10th Street as two-way operations and designate the new street also as a two-way street. As per the Master Thoroughfare Plan, the Law Lane/14th Street extension would be designated a secondary arterial, with a right-of-way of 80 feet, and would include a travel lane in each direction, a center turn lane/median, bike lanes and sidewalks. As stated above, the exact alignment and intersection design details are not specified in this alternative, although some operational characteristics were selected for evaluation purposes.

The concept behind two-way streets is to add to the options given to drivers and minimize confusion and trip length within the study area itself. Although it will not add as much throughput capacity east-west as a one-way pair, a two-way system allows for greater redundancy, better accommodation of transit and bicycles and more overall options for all modes of transportation.

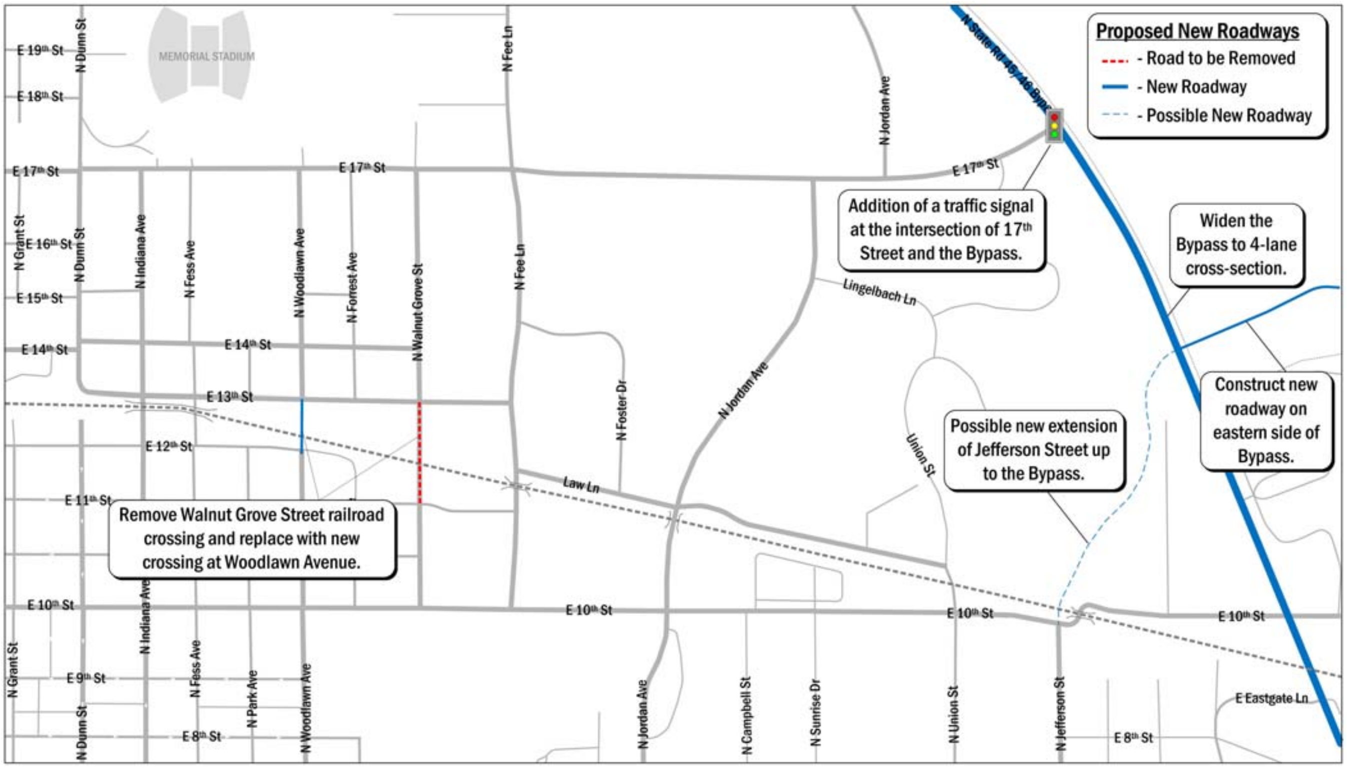

Figure 19: Alternative 0, No-Build Scenario

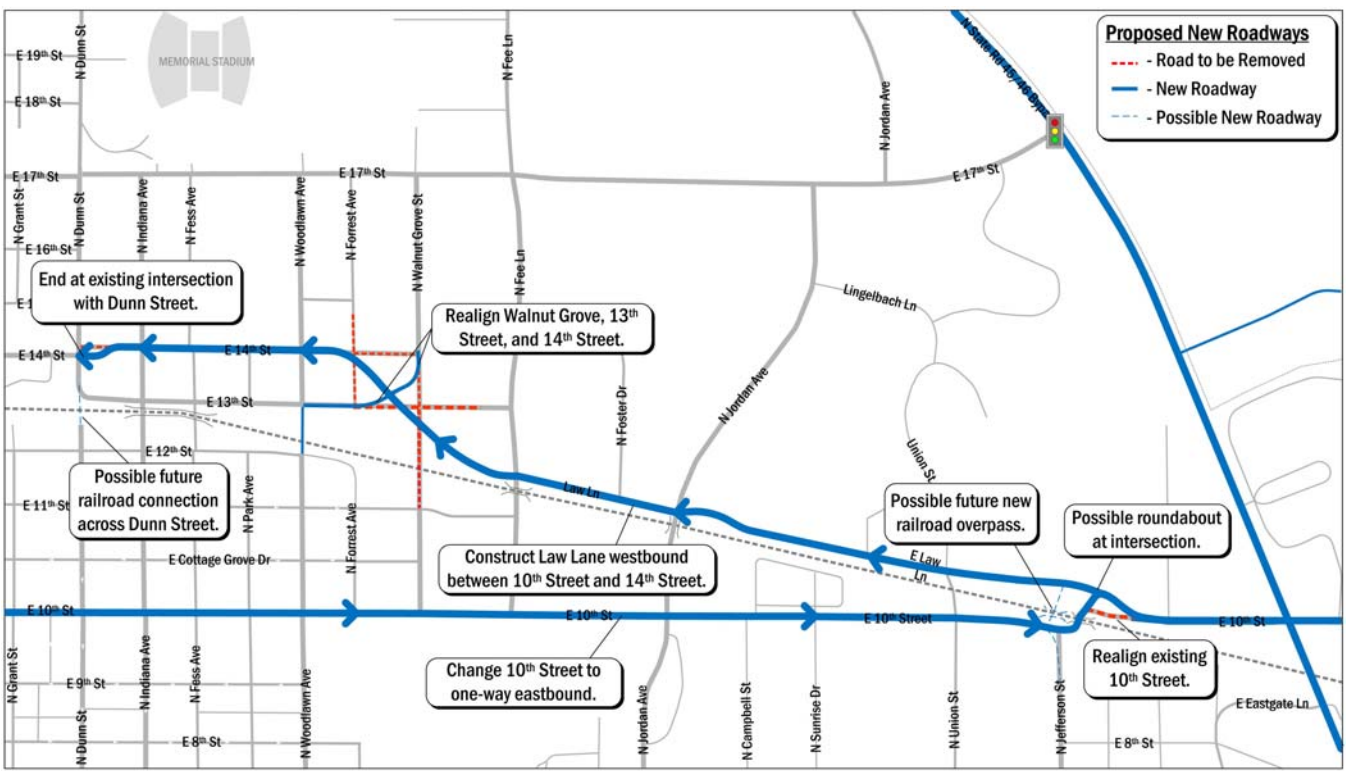

Figure 20: Alterative 1, 10th Street and Law Lane as 1-Way Streets

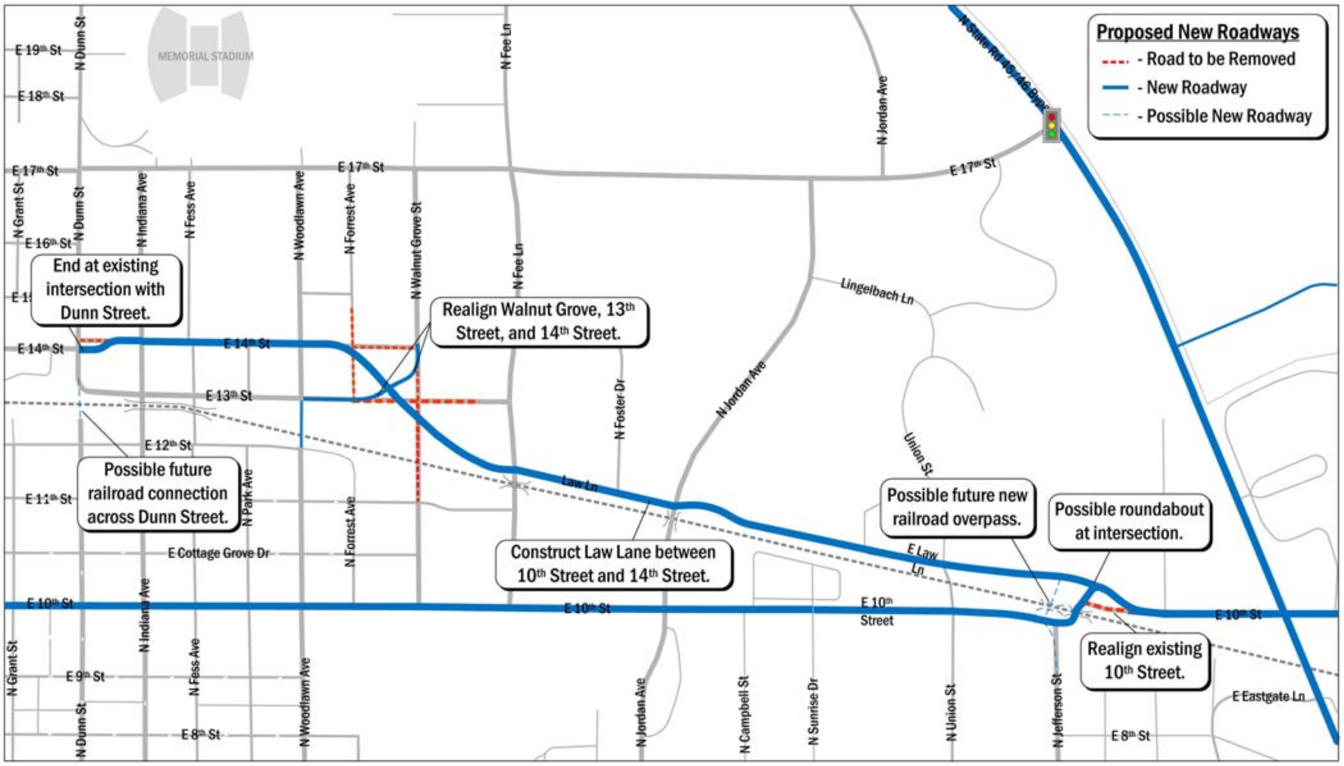

Figure 21: Alterative 2, 10th Street and Law Lane as 2-Way Streets

EVALUATION OF ALTERNATIVES

The alternatives developed were evaluated in three different ways. First, they were tested against the goals of the project--to increase mobility for all modes within the study area and to improve safety. Second, the alternatives were judged for their ease of implementation. Finally, a cost estimate for each alternative was assembled. The evaluation of the alternatives and public and stakeholder input were used to select one of the three alternatives for refinement into the preferred alternative and final recommendation.

Measures of Effectiveness (MOEs)

The study team evaluated the Alternatives by establishing a set of Measures of Effectiveness (MOEs) that were compared to the study goals stated in the first chapter of this report. The MOEs selected for the evaluation are a mix of traditional traffic-based criteria supplemented with multi-modal and sustainability-based criteria. Where possible, the MOE evaluations were performed quantitatively, although some qualitative MOEs were needed because of the difficult nature of measuring certain aspects of a transportation system. The following sections of the report summarize the goals and MOE evaluations. Technical details on the quantitative MOEs can be found in Appendices A and B.

Selection of MOEs

The transportation planning and engineering industry is evolving in response to a realization that a disconnect exists between stated policy and evaluation methodology. Traditional traffic engineering evaluation techniques focus on methodologies contained in the Highway Capacity Manual (HCM). These traffic-based measures have been incorporated into zoning laws and other land use applications, making the quality of traffic flow the main justification of infrastructure improvements or location of development.

Modern transportation planning thought incorporates concepts such as multimodalism, sustainability and context sensitive design. Many transportation plans incorporate vision statements and stated policy goals that align with these concepts, as seen in the review of local policy earlier in this report. These concepts are not well served by the traditional evaluation techniques, since traffic based MOEs focus on comparisons of traffic volumes to capacity. Often the measures needed to increase the quality of traffic work against stated policy goals, thus leading to a disconnect between selected alternatives and stated policy.

Inspired by research and new methodologies created to help solve these issues, this report uses a range of quantitative and qualitative MOEs that attempt to match the study goals and stated policies. Research into evaluation techniques include *Performance Measurement Framework for Highway Capacity Decision Making*, issued by the Transportation Research Board[1]. This report established a modern framework for selecting performance-related measures to support capacity related decision making. The Leadership in Environmental and Energy Design – Neighborhood Development (LEED-ND)[2] program, was reviewed to examine the state-of-the practice methodologies of measuring sustainability. The LEED-ND program integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design, and is used to evaluate the sustainability of a neighborhood. The LEED-ND evaluation process includes transportation measures that inspired some of the study MOEs.

Thus, this study incorporates traditional and non-traditional MOEs. Where possible, performance-related quantitative MOEs were used. In some instances there is not a quantitative measurement that relates to study goals, or is easily

[1] SHRP 2 – REPORT S2-C02-RR, *Performance Measurement Framework for Highway Capacity Decision Making, Transportation Research Board, 2009*
[2] LEED 2009 for Neighborhood Development Rating System, US Green Building Council, 2009, www.usgbc.com

measurable or calculated. Thus, several qualitative MOEs were incorporated into this report to round out the MOEs and ensure that each study goal was given weight. A drawback to this evaluation methodology is that by increasing the amount of MOEs used and incorporating qualitative discussions into the process, the selection of an alternative is a more judgment-based decision in lieu of a purely numbers based decision. The study team decided that it was best to go ahead with the comprehensive evaluation of alternatives rather than rely on the limited traditional measures.

This study explored using many different MOEs, which after being reviewed for applicability were reduced to the following list of study MOEs:

- Traditional MOEs: Intersection Level of Service (LOS) and corridor travel times (described in Appendix A).
- Non-traditional MOEs (quantitative): Intersection density, block circulation, bicycle facility coverage, pedestrian facility coverage, pedestrian LOS (described in Appendix B)
- Non-traditional MOEs (qualitative): Ease of transit routing and stop location placement, bicycle mobility barriers, pedestrian mobility barriers, review of related safety studies, perception of safety

Evaluation of Alternatives

The following section reviews each of the stated study goals from the first chapter of this report to the MOEs in order to determine how well each Alternative meets the study goals.

Vehicle Mobility

The mobility of vehicles was evaluated using measures that quantify the ability of the study area roads to circulate and distribute traffic within the study area (Block Circulation, Intersection Density), process vehicles through the study area (Corridor Travel Times), and handle problematic congestion spots (LOS).

- *Block Circulation*

  Block circulation refers to the ability of vehicles to circulate around a block. Ideally, vehicles can travel both clockwise, and counter-clockwise around a block. This aids in reducing a driver's trip length, increases the intuitiveness of the roadway network, makes signing and wayfinding easier, and allows for easier and shorter recovery routes for lost drivers. It is used as a measure of how easy it is to navigate and find your way within the study area itself. Good block circulation is also more forgiving for changing populations, as it can handle different access and development scenarios. Additionally, it is a good MOE to compare both east-west and north-south connectivity simultaneously. Block Circulation also influences transit operations and emergency vehicle operations.

  Within the study area, there are small, neighborhood size blocks, and large blocks within the University area that lack internal roadways. Under Alternative 0, most blocks would have complete circulation, as would the blocks under Alternative 2, with the only difference being the average size of the blocks (discussed under Intersection Density, below). Under Alternative 1, the block circulation would be disrupted, as the one-way pair of streets would impede complete circulation through most of the study area. Calculations for this MOE are included in Appendix B.

- *Intersection Density*

  This MOE examines the density of streets within the study area. A higher intersection density leads to a more 'porous' network with more options for drivers, and can generally support more curb cuts and access points. It is usually an indicator of mobility within a study area, instead of through a study area. Only roadways and intersections that lead to additional ones are included in the calculation (eliminating intersections that lead to dead ends and cul-de-sacs).

The addition of the new 14th Street/Law Lane roadway in Alternatives 1 and 2 slightly decreases the intersection density within the study area because several intersections are removed to allow the connection of Law Lane with 14th Street. This change in intersection density is small enough to be negligible and the results show that this MOE should not be a significant factor in selecting an alternative. Calculations for this MOE are included in Appendix B.

- *Intersection Level of Service*

  Intersection Level of Service (LOS) is a calculation of the performance of a roadway intersection in terms of overall delay to drivers that pass through it. For this MOE, LOS was projected out ten years for major study area intersections during the morning and evening commuter rush hours for each Alternative. (The 10-year projection may require additional analysis as required by state or federal regulations.) This is a traditional traffic engineering MOE, used to determine the amount of congestion before and after changes to a traffic system. Thus, this MOE allows a comparison of how each Alternative addresses congestion on an intersection by intersection basis. The LOS calculations were performed using traffic modeling, incorporating the software package *Synchro/SimTraffic*. Details on this MOE are included in Appendix A.

  The findings of the LOS analysis showed that Alternative 0 would continue to have many of the same congestion problems that the study area has today. However, signal timing changes applied to the Alternative 0 analysis led to significant improvements to the existing congested intersections. Alternative 1, with the one-way pairs, is projected to alleviate all of the unacceptable delays and congestion spots, although it should be noted that the volume of vehicles is kept constant for each Alternative. Most likely more vehicles would use the roadways in the study area, hence another way to look at these results is that Alternative 1 would be able to accommodate additional vehicles in the same time period at the same congestion levels that exist today. Alternative 2 showed a significant improvement in LOS, but not as dramatic as the results for Alternative 1. For some intersections, getting both east-west and north-south traffic to improve would not be attainable in Alternative 2.

- *Corridor Travel Times*

  Corridor travel times were also used to judge the vehicular mobility of each alternative. Travel times were calculated on 10th Street and the new 14th Street/Law Lane roadway for each alternative for the AM and PM commuter rush hours. This is a traditional traffic engineering MOE, used to determine the amount of time is needed to traverse the study area before and after changes to a traffic system. Thus, this MOE allows a comparison of how each Alternative addresses delay experience by drivers travelling through the study area. The LOS calculations were performed using traffic modeling, incorporating the software package *Synchro/SimTraffic*. Details on this MOE are included in Appendix A.

  The travel time calculations showed that both Alternatives 1 and 2 provide a dramatic improvement on east-west travel times across the corridor. It should be noted that Alternative 2 is able to achieve improvements on par with Alternative 1 only if signal timings across the corridors are biased to east-west traffic during commuter rush hours.

  Alternatives 1 and 2 both show significant improvements to vehicular mobility in the study area. The one-way pair included in Alternative 1 would allow for a great reduction in congestion in the 10th Street corridor (or the accommodation of an increase in traffic at the same congestion levels). The two-way system in Alternative 2 also shows a significant improvement over existing conditions and Alternative 0 but not the same level of improvement as Alternative 1.

Alternatives 1 and 2 add overall roadway to the study area, allowing for more access opportunities and options for drivers. Alternative 2 would also maintain the relative ease of block circulation from existing conditions and Alternative 0, where Alternative 1 would lead to a less intuitive system that would lead to longer overall vehicular trip lengths. Both build Alternatives significantly improve traffic conditions in the study area, with Alternative 1 showing a great improvement in both intersection delay and travel times across the study area.

Conversations with the City Engineering Department showed that Alternative 1 was strongly preferred due to its greater improvement to traffic conditions. Other reasons for the Engineering Department's preference include right-of-way impacts, pedestrian safety, environmental impacts, and cost.

Transit Mobility

No specific changes to transit routes are included as part of the Alternatives because it is difficult to predict the nature of the City and University shuttles at a point in the future as there are many influences to changing and altering transit service. Instead, the MOEs used to evaluate transit mobility test the ease of routing transit routes through the study area (Block Circulation), the ability to place stops in a logical manner (Stop Location), and their ability to reduce congestion to aid in travel times (Intersection Level of Service and Corridor Travel Times).

- *Block Circulation*
  Blocks with complete clockwise and counter-clockwise circulation allow for placement of transit stops on the desired side of the street, provide better options for turn-around areas, and can simplify routes. Alternative 0 and 2 provide mostly complete circulation in the study area, while Alternative 1 would require rerouting of the vast majority of existing transit routes.

- *Stop Location*
  Similarly the ability to place stops along a transit route is more difficult along a one-way pair. Thus, Alternative 1 would negatively impact stop placement. This is because on a one-way pair, stops in either direction are not located on opposite sides of the street as they are on two-way streets. In several locations within the study area, this would place corresponding stops several blocks apart if routes used the one-way pair. This would increase walk distances between stops and origin/destination points, which makes transit a less attractive travel choice.

- *Intersection Level of Service*
  As described above, Alternatives 1 and 2 showed a significant improvement to intersection LOS in the study area, with Alternative 1 having an even greater positive impact.

- *Corridor Travel Times*
  As described above, Alternatives 1 and 2 showed a significant improvement to corridor travel times in the study area. Improved travel times would have a positive impact on transit service by reducing travel times for transit routes traveling east-west through the study area.

The transit mobility evaluation shows that Alternative 1 would have the greatest improvement to congestion and delay, and would improve transit travel times greater that Alternative 2. On the other hand, Alternative 2 would allow for more flexibility in routing within the study area and better placement of stops along the major east-west corridors.

Conversations with the local transit operators, Bloomington Transit and Indiana University Transit, showed a strong preference for Alternative 2.

Bicycle Mobility

The MOEs used to evaluate bicycle mobility included the amount of bicycle facilities provided and the ability of the network to encourage and facilitate cycling.

Compared to Alternative 0, Alternatives 1 and 2 both increase the amount of bicycle facilities in the study area. The new 14th Street/Law Lane roadway would include bicycle lanes, as per the Master Thoroughfare Plan.

In Alternative 1, the new roadway as a one-way street would only include bicycle lanes on one side of the road. This could lead to bicyclists riding on the opposite sidewalk or in the wrong direction in the bike lane. This could be mitigated through a contra-flow bicycle lane or an off-street path, although this would be less intuitive to both bicyclist and drivers and would negatively impact bicycle travel times.

In addition, one-way pairs generally lead to higher speeds than two-way streets. Thus, Alternative 2 would both increase the amount of bicycle facilities and allow for the lower speeds that bicyclists prefer.

Pedestrian Mobility

The mobility of pedestrians in the study area was evaluated by examining the amount of sidewalks in each alternative, the expected wait for a 'walk' sign at traffic signals, and the ability of the network to encourage and facilitate pedestrians.

Both Alternative 1 and 2 would add a significant amount of sidewalk to the study area, compared to Alternative 0. There is no difference in the amount of sidewalk added between the proposed one-way and two-way systems. Similarly, there was no difference in the delay expected by pedestrians waiting for a "walk" sign at traffic signals. Based on the traffic signal timings developed to test vehicular mobility, the pedestrian delay at crosswalks will be kept at acceptable conditions in each Alternative. This is because the width of the roadways are not wide enough to create long crosswalks and there are few traffic control elements that will take time away from "walk" time provided for pedestrians to cross the roadway.

As discussed for bicycles, the pedestrian experience along 10th Street and the new 14th/Law Lane extension would be enhanced with lower speeds along those roadways, as would happen in a two-way system compared to a one-way system.

Safety

Safety is a difficult thing to quantify in transportation networks, but several factors that influence safety were evaluated.

First, when comparing Alternatives 1 and 2, a one-way system has fewer possible conflict points at intersections. For example, head-on collisions are not possible. Additionally, studies of roads that have been converted from two-way to one-way have shown a decrease in the vehicle accident rate, indicating that one-way streets would have a positive impact. Unfortunately, no studies have been performed in a University setting, to help determine the impact to transit vehicles, pedestrians and bicycles.

Second, a major component of accident severity is speed. Since two-way streets are shown to have lower speeds than one-way streets, this may indicate that accident severity would improve in Alternative 2 compared to Alternative 1. While one-way flow could reduce vehicle accidents, the increase in speed would likely increase the severity of accidents. Given the urban, pedestrian environment within the campus, the heavy pedestrian volumes must be considered.

Finally, access of emergency vehicles may be improved most in Alternative 2. This is because it adds roadways, thus increasing the amount of access routes, and it maintains two-way circulation on the major corridors, which also increase access routes and has the most flexibility. Conversations with campus policy, City police, and the City Fire Department show a strong preference for Alternative 2 for these reasons.

Ease of Implementation

The ease of implementing the two build alternatives was also a factor in selecting a preferred alternative. Alternative 1 would require that the new roadway be fully constructed and operating before switching to the one-way pair system. It would also require traffic signal, signing and marking work along the 10th Street corridor before the switch to a one-way pair is made. By comparison, Alternative 2 could be constructed in sections and would not require any significant operational changes other than those generated by the addition of the new roadway.

Cost Estimate

The cost to build alternatives is a factor in selecting a preferred alternative. The preliminary cost estimate for the build alternatives are $9.5 million for Alternative 1 and $9.2 million for Alternative 2. The main differences between the build alternatives is that Alternative 1 would require less new pavement but would require traffic signal, signing and marking work along the 10th Street corridor to convert it to a one-way street. Both alternatives include costs for the realignment of Walnut Grove between 13th Street and 14th Street; the removal of Walnut Grove between the 13th Street and the railroad to the south; and modifications to the University's parking areas along the Law Lane corridor form Walnut Grove east to Campus View Apartments. Right-of-way acquisition costs were not included in these estimates. The City and IU will need to jointly seek federal funds for the design, right-of-way, and construction costs associated with the project. In the absence of adequate funding, the City and IU may explore cooperative arrangements to reduce the cost to either entity especially as it relates to right-of-way, subject to the approval of the Mayor and the Board of Trustees. The detailed cost estimate is included as Technical Attachment 1.

Public Input

Two Public Workshops were held on September 10, 2009 to gain public input on the evaluation of the alternatives, and gain input on which alternative was supported the most by those present. After a presentation, the participants were broken into groups and asked to form opinions on the alternatives, including a scorecard for Alternatives 1 and 2. Figure 22 shows the combined scorecard for the six groups. Each group was asked to grade each build alternative on a generic positive, neutral, or negative impact scale. Figure 22 summarizes these workshop ratings.

The consensus of the approximately 40 attendees was for Alternative 2 between the build alternatives. In addition, some participants noted their approval of Alternative 0, as they were not convinced either build alternative was worth the cost estimate.

The written and spoken comments from the public work-sessions showed a variety of concerns. The two most common were: (1) a concern that transit would not significantly improve on 10th Street, including a desire to close 10th Street to private vehicles, and (2) a concern that vehicles would not change their existing driving patterns from 10th Street to the new 14th Street/Law Lane extension, thus negating the positive impact of the new roadway. Closing 10th Street to private vehicles would be very difficult due to the amount of existing access to parking and buildings along 10th Street. One group even recommended a hybrid solution that involved a two-way new 14th Street/Law Lane and a one-way 10th Street, to 'force' drivers to the new road, but still allow for access to the parking garages and lots along 10th Street. These comments were taken into consideration during the refinement of the preferred alternative.

Goal	Alternative 1: One-way Streets	Alternative 2: Two-way Streets
Improve Mobility of Vehicles East-west connectivity, north-south connectivity, block circulation, flexibility, intuitiveness	↑↑↑↔↔↓	↑↑↑↑↑↑
Improve Mobility of Transit Corridor travel times, ease of routing, ease of stop placement, flexibility, intuitiveness for riders	↑↔↓↓↓↓	↑↑↑↑↑↑
Improve Mobility of Pedestrians Amount of sidewalks, delay at intersections, ease of crossings, reduction of mobility barriers	↑↔↔↓↓↓	↑↑↔↔↔↔
Improve Mobility of Bicycles Quantity and quality of facilities, ease of routing	↑↔↓↓↓↓	↑↑↑↑↔↓
Enhance Safety Travel speeds, conflict points, user behavior, emergency access	↑↑↔↓↓↓	↑↑↑↑↑↔

Figure 22: Scorecard for MOEs

Summary

Table 3 summarizes the factors used in evaluating the three alternatives, the comparison of study goals to MOEs, the cost estimates, the ease of implementation and public input.

Table 3: Summary of Alternatives Evaluation

Evaluation Criteria	Alternative 0 No-build Alternative	Alternative 1 One-way Pair	Alternative 2 Two-Way Circulation
Study Goals			
Vehicle Mobility	Some improvement over existing conditions via signal timing changes. No significant reduction in vehicle congestion.	Traffic models show great benefit to vehicle throughput in study area.	Traffic models show benefit to vehicle throughput, although not as much as Alternative 1. More intuitive system with lower overall trip lengths, compared to Alternative 1.
Transit Mobility	No improvement over existing conditions.	Increases mobility of east-west routes through study area. One-way pair would make stop location and routing more difficult and confusing to riders.	Allows more flexibility in routing and stop placement.
Bicycle Mobility	No improvement over existing conditions.	Would add westbound bicycle lane on new Law Lane/14th St corridor and eastbound lanes on 10th Street. Increase in speeds could intimidate cyclists.	Would add bicycle lanes in both directions on new Law Lane/14th St corridor.
Pedestrian Mobility	No improvement over existing conditions.	Would add sidewalks on new Law Lane/14th St corridor. Increase in speeds is contrary to improving pedestrian safety.	Would add sidewalks on new Law Lane/14th St corridor.
Safety	No improvement over existing conditions.	Studies show one-way streets have lower vehicle accident rates than two-way streets.	Lower speeds on two-way streets could reduce severity of accidents, compared to one-way streets. More flexibility in routing allows better access for emergency vehicles.
Summary	Does not meet any of the stated study goals.	Meets some of the study goals. Sacrifices some goals at the expense of a significant increase to vehicular mobility. Some negative impacts may be able to be mitigated.	Meets all of the study goals. Best fits with MPO and City policies.
Other Factors			
Implementation	N/A	Needs to be fully constructed prior to switching operations to one-way pair.	Can be constructed and operated in phases without major disruption.
Cost Estimate	N/A	Approximately $9.5 million, not counting right-of-way costs.	Approximately $9.2 million, not counting right-of-way costs.*
Public Input	Some support from public who did not think benefits outweighed cost.	Very little public support.	Consensus support from public workshops.

** - Upon selection as preferred alternative, cost estimate was refined to $7.96 to 8.72 million, for a 65' and 80' ROW respectively*

PREFERRED ALTERNATIVE

Selection of Alternative

Based on the analysis findings, public input and stakeholder input, the study team selected Alternative 2 for the preferred alternative.

Alternative 0, the no-build alternative, was dismissed because it does not address any of the study goals. The issues that exist today in the study area will only be exacerbated by future University growth and other developments in the area. In addition, there is significant momentum behind a build alternative being implemented in the study area, given a variation of the build alternatives has been discussed for decades and had been included in long-range plans.

It is important to note that the analysis shows that both the one-way and two-way alternatives demonstrate a marked improvement over existing conditions. The one-way pair (Alternative 1) improves the corridor significantly for vehicular traffic traveling *through* the corridor. The two-way alternative (Alternative 2) shows some improvement for vehicular through traffic, though not to the same extent as the one-way pair. However, the two-way alternative does outperform the one-way pair when it comes to how the corridors meet the needs of bicyclists, pedestrians, transit riders, and emergency access. For this reason, the two-way alternative became the preferred alternative since the study goals include enhancing all modes of transportation. Alternative 2 is a better fit with existing City, IU and MPO policies.

Other benefits of Alternative 2 include more flexibility, which better accommodates emergency vehicles, road closures, special event traffic management, project phasing, and future changes to transit routes. It also allows transit and fire trucks to avoid the 10th Street railroad overpass at the eastern edge of the study area, which has been identified as a major constraint along the corridor. The intuitive system that the two-way alternative provides is more appropriate for a campus setting with the inherent high volumes of pedestrians and bicyclists and transit usage these environments generate. This will particularly become more important in the future, as new campus development is placed along the Law Lane/14th Street corridor. Lastly, public input gathered during this study demonstrated a clear preference for two-way circulation.

It should be noted that the findings of this report are not against Alternative 1; rather it is currently seen as biased to vehicle through traffic when compared to Alternative 2. The one-way street pair is inappropriate in this setting for the following reasons:

- The grid along 10th Street & Law Lane is not dense enough. The distance between cross streets is much farther apart than the other one-way pairs in Bloomington. The result is poorer block circulation and grid density as well as higher vehicular miles traveled.
- The access needs of the University and changing populations need a forgiving roadway system.
- One-way pairs will likely result in higher vehicular travel speeds. Increased speeds are expected because the blocks through the core of campus will be long with relatively few traffic control devices, which is conducive to high speeds. Speed is one of the most serious safety concerns for the study area because of the preponderance of pedestrians and bicycles in the corridor. Although one-way pairs have fewer conflict points that could result in fewer accidents, this benefit is negated by studies that suggest crashes at higher speeds will be more severe and possibly life-threatening. Again, such potential speed increases don’t fit as well within a university transportation context.

- The distance between the one-way pairs is too great to be ideal. Bloomington's existing one-way pairs are one block apart. At the project's western limit, the one-way pairs would be five blocks removed. This adversely affects transit users, pedestrians, and bicyclists.

The actual implementation of the recommendations contained within this report will only begin after further study and design. Further traffic engineering analysis may be needed to validate the preferred alternative. If, during these processes it is determined that the one-way pair alternative can overcome these issues and perform better than the two-way street alternative in achieving study goals and existing policies, than it may be reconsidered for the preferred alternative.

Refinement of Preferred Alternative

During the alternatives evaluation process, several enhancements to Alternative 2 were discussed. Notably, during the public input process, there were concerns that the public would not drive on the new corridor, and congestion would continue on the 10th Street corridor. To account for these concerns, the following refinements to Alternative 2 are recommended:

- *Encouragement to use the 14th Street/Law Lane Corridor*

  Engineering solutions should be developed during the design phase of this project to encourage general traffic to use the new corridor. These solutions could involve the placement and operations of traffic controls, such as traffic signals, traffic signal timings, turn lanes to and from the corridor, etc. In addition, wayfinding signs for through traffic should orient traffic to the new corridor.

- *Restricting Access on the 10th Street Corridor*

  Some of the current congestion issues along the 10th Street Corridor are generated by the significant amount of access points to parking that currently exist. In order to reduce the amount of traffic that has to drive on this corridor, it is recommended that future parking and vehicular access points be located on the new 14th Street/Law Lane corridor, and that each access point on 10th Street be examined for re-location, and that new access points are only established if there are no other alternatives. This will allow policy makers the opportunity to explore promoting transit along this corridor in the future.

Design Considerations for Preferred Alternative

Following the adoption of the recommendations contained in this report, implementation will involve further analysis and design of the new roadways within the preferred alternative. Based on the analyses and input gained during the evaluation phase, the following are design considerations that should be addressed during the implementation phase of this project:

- *Secondary Arterial vs. Primary Collector*

  The Master Thoroughfare Plan designates both 10th Street and the new 14th Street/Law Lane corridor as secondary arterials. Currently 10th Street does not meet the criteria of a secondary arterial due to a lack of right-of-way width and the distance between intersections and parking access points. As envisioned, the new corridor would most likely not meet the criteria of a secondary arterial either due to the access needs along it, and right-of-way limitations in some areas (a secondary arterial is listed as having an 80' right-of-way). Thus, there were discussions regarding changing the designation of these two roadways to primary collectors, which have less stringent access standards and right-of-way requirements (only 65'). Most likely though, each roadway will have elements of both designations. This report does not recommend either keeping or changing the designation of these roadways.

- *Low impact design on streetscape*

  During the study process, there were numerous suggestions that the new 14th Street/Law Lane corridor take advantage of low impact design in its streetscape. Low impact design refers to a set of practices and controls employed to manage storm water runoff, as an alternative to conventional storm water runoff management. A roadway with low impact design implements small scale hydrological controls that treat water close to its source. This design element should be considered during the implementation phase of the project.

- *Pavement markings for pedestrian and bicycle facilities*

  The current pavement markings along 10th Street and other roadways within the study area are inconsistent, and within the campus are not differentiated from other parts of the City. The design process for the new 14th Street/Law Lane corridor can be used as a chance to develop campus specific pavement markings that are appropriate for a campus setting with an increased amount of pedestrian and bicycle activity.

- *On-street parking on 14th Street and Law Lane*

  The University currently provides some on-street parking on the existing portions of Law Lane. This report does not make recommendations on whether to permanently remove this parking or establish parking on other sections of the new roadway. In addition, no recommendations are made on the on-street parking along the existing sections of the 14th Street.

- *East end of Law Lane corridor*

  The portion of the extended Law Lane that intersects with 10th Street, just north of the existing underpass is an important element of the future roadway design. This report recommends that the eventual design help encourage drivers to use the new roadway rather than 10th Street but does not specify traffic controls or operations. There has been discussion of using a modern roundabout to handle vehicular and pedestrian movements, which should be included in future evaluations at this location.

- *10th Street Underpass*

  The underpass where 10th Street crosses beneath the railroad on the eastern side of the study area is a constraint on the transportation system: the awkward geometry limits vehicular speed and is difficult for large vehicles to pass through; the underpass is not tall enough to accommodate all of the vehicles in the Bloomington Transit fleet; and it is too narrow to allow for sidewalks on both sides of the street. This report recommends further study of the underpass, including developing alternatives and cost estimates for future solutions.

- *Union Street railroad crossing*

  The extension of Law Lane east to 10th Street will create a busier intersection at Law Lane and Union Street. Since this intersection is directly north of a railroad crossing, it will likely be necessary to upgrade the at-grade crossing controls. This may be accomplished using a coordinated set of traffic signals at Union Streets intersections with Law Lane and 10th Street, but a specific recommendation is not included in this report.

- *Alignment at western end of 14th Street/Law Lane corridor*

  The new roadway corridor was aligned with 14th Street to reduce the amount of vehicles passing through the intersection of Indiana Avenue and 13th Street, and to maximize east-west travel and logically fit a new secondary arterial into the City network. There will be difficulty in implementing this design consideration due to the narrow right-of-way of 14th Street in the western end of the corridor, the use of on-street parking on both sides of the (narrow) roadway and because 14th Street does not align across Indiana Avenue. The design of this section of the new corridor will need close attention to minimize the impact to property owners and maintain quality access for existing developments. Adjustments in the design should include minimizing the right-of-way where necessary.

In addition, the 'bend' of Dunn Street connecting to 13th Street should be examined in an effort to simplify traffic and reduce the accident rate at the intersection of Indiana Avenue and 13th Street. It may be possible to disconnect this link in the roadway system and encourage more drivers to use 14th Street, thus reducing the amount of traffic and conflicts at the intersection of Indiana Avenue and 13th Street.

- *Transit routing to take advantage of new roadways*
  With the extension of Law Lane east to 10th Street, east-west transit routes would be able to avoid the 10th Street underpass, which limits bus activity, without altering routes significantly. Although no specific recommendations are included in this report, when this section of roadway is completed, a study of transit route changes should be considered to take advantage of the new roadways.

Phasing, Implementation and Benchmarks of Preferred Alternative

The preferred alternative can be logically split into three sections, shown on Figure 23 , (1) the extension of Law Lane in the west between Dunn Street and Fee Lane, following the existing alignment of 14th Street between Indiana Avenue and Woodlawn Avenue, (2) the existing Law Lane between Fee Lane and Union Street, and (3) the extension of Law Lane in the east between Union Street and 10th Street. This section of the report details the costs, phasing implications and benchmarks for construction for these three sections.

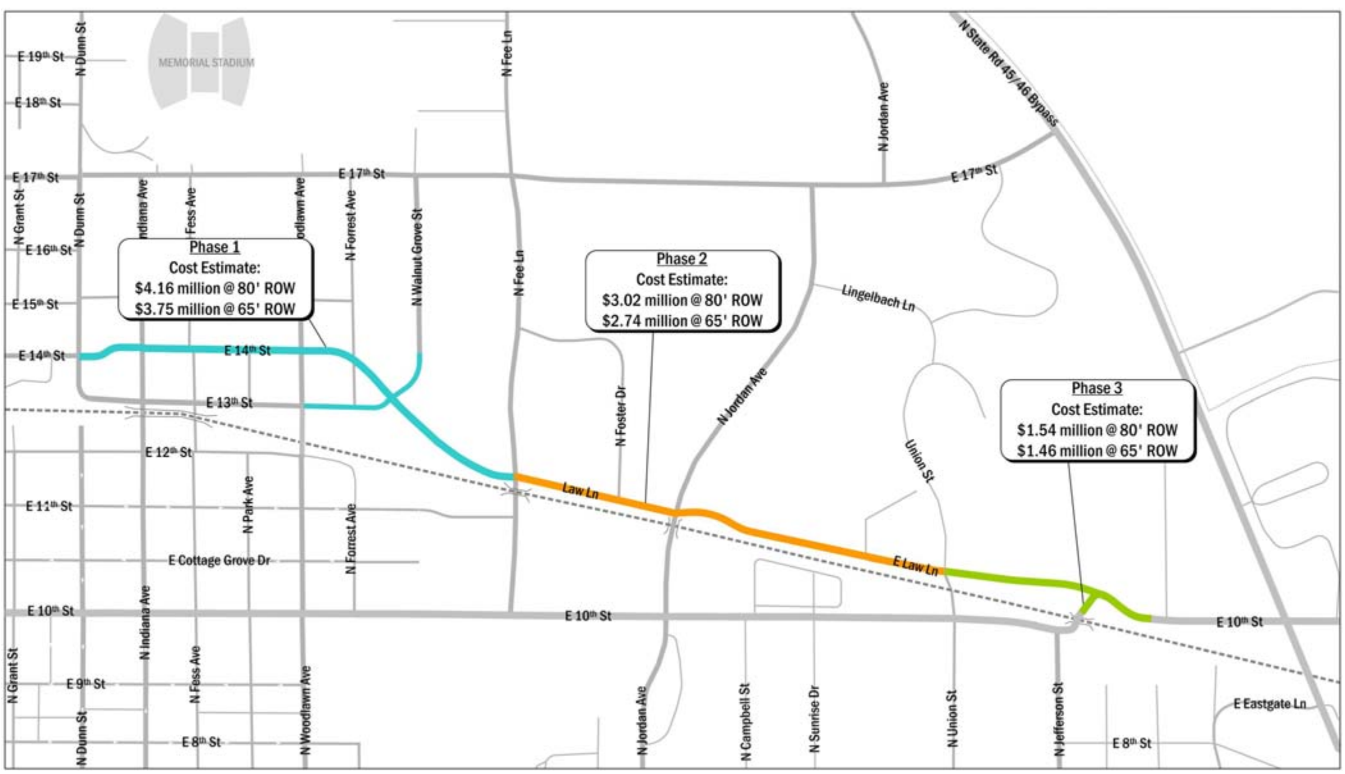

Figure 23: Phasing and Cost Estimate for Preferred Alternative

Upon selection as the preferred alternative, the cost estimates were reexamined in more detail, refined, and broken down into the three sections for possible phased construction. The difference in cost between the 80' right-of-way and the 65' right-of-way are a direct result of the reduction in the pavement from a two lane configuration with a continuous median to a two lane configuration with opposing left turn lanes at key intersections. The reduction of the cross section also results in less impact and restoration along the corridor. These estimates continue to carry the costs for the realignment of Walnut Grove between 13th Street and 14th Street; the removal of Walnut Grove between the 13th Street and the railroad to the south; and modifications to the University's parking areas along the Law Lane corridor form Walnut Grove east to Campus View Apartments. Detailed in the Technical Attachment, the cost estimates for the preferred alternative are slightly lower than those estimated for Alternative 2 during the evaluation phase of the study.

Phase 1 – Dunn Street to Fee Lane

This section of the new Law Lane corridor involves the extension of Law Lane to the west until it meets the 14^{th} Street right-of-way and connects to the existing intersection of 14^{th} Street and Dunn Street. The cost estimate for this section of roadway is $4.16 million for an 80' wide cross-section, and $3.75 million for a 65' wide cross-section.

This section could be phased in conjunction with new developments generated by the University Master Plan or private development. There are several sites slated for construction along this section of Law Lane, where reconstruction of the roadway to meet the eventual design could be incorporated. Benchmarks for implementation could be tied to adjacent improvements, or be initiated when the other phases are completed to ensure corridor continuity.

Phase 2 - Existing Law Lane

This section of the new Law Lane extended corridor would reconstruct the existing section between Fee Lane and Union Street. The cost estimate for this section of roadway is $3.02 million for an 80' wide cross-section, and $2.74 million for a 65' wide cross-section.

This section could be phased in conjunction with the University Master Plan. There are several sites slated for construction along this section of Law Lane, where reconstruction of the roadway to meet the eventual design could be incorporated. Benchmarks for implementation could be tied to adjacent improvements, or be initiated when the other phases are completed to ensure corridor continuity.

Phase 3 – Between Union Street & 10^{th} Street

This section of the new Law Lane extended corridor would extend Law Lane east from its intersection with Union Street until it intersects 10^{th} Street at the eastern edge of the study area. The cost estimate for this section of roadway is $1.54 million for an 80' wide cross-section, and $1.46 million for a 65' wide cross-section.

This section could be phased relatively early in the implementation process. A key benefit to this section is that east-west transit routes would be able to avoid the 10^{th} Street underpass, which limits bus activity, without altering routes significantly. East-West routes would be able to use Union Street as a connection between 10^{th} Street and the Law Lane corridor, using the extension of Law Lane to 10^{th} Street as a connection back to the original route. In addition to aiding transit vehicles, this new roadway connection would provide a benefit to fire department vehicle mobility.

Because of these benefits, it is recommended that this phase of the preferred alternative is implemented first.

Benchmarks for the implementation of this phase of the corridor include: (1) when triggered by transit usage and efficiency goals; (2) when the remaining phases are completed in order to achieve a complete corridor; and (3) as a maintenance of traffic plan, when reconstruction of the 10th Street underpass commences.

Interim Mitigation Concepts for 10th Street

As the preferred alternative is being implemented, some of the goals within this project could be accomplished through mitigation measures independent of any alternative. The following interim mitigation measures, developed during the evaluation and refinement process, could be implemented to the 10th Street corridor within their own timeline.

- *Pavement Markings for Bicyclists*

  The quality of the bicycling experience along the 10th Street corridor could be improved through the study and implementation of enhanced markings. These could include adding bicycle lanes and sharrows. The 10th Street corridor has a constrained right-of-way, so an innovative combination of treatments may be warranted.

- *"Polly Grimshaw" rail-with-trail through campus*

  The City's bicycle and pedestrian plan, contained within the Growth Policies Plan, contains a plan to build a multi-use trail adjacent to the existing railroad corridor within the campus. This plan could be implemented as an interim measure prior to the completion of the Law Lane corridor, and even continue to operate as a quality non-auto east-west connection once the preferred alternative is completed.

- *Increases to transit service, shelters, next bus technology*

  Enhancements to the corridor's transit service could be implemented in the interim along the 10th Street corridor. These measures could include shelters, sidewalk improvements, and technological improvements such as the ability to disseminate real-time information on bus locations and estimate arrival and wait times at specific stops.

- *Signing/striping for pedestrians*

  The current pavement markings along the 10th Street corridor are inconsistent, and within the campus are not differentiated from other parts of the City. Due to the heavy pedestrian use of this corridor, a new campus-standard for pedestrian oriented pavement marking and mid-block crossings could be used in the interim to help address pedestrian concerns.

- *Speed Limits*

  To address safety and pedestrian/bicycle concerns within the study area, a speed limit study could be conducted to determine the appropriate vehicular speeds in the campus setting where there is a significant presence of vulnerable road users.

- *Signal timing study*

  The traffic models developed to evaluate existing conditions suggested that signal timings could be studied in more detail to develop timing plans to help alleviate some traffic issues on the corridor.

Conclusions

The study team selected Alternative 2, the two-way alternative, for the preferred alternative, as it does outperform the one-way pair when it comes to how the corridors meet the needs of bicyclists, pedestrians, transit riders, and emergency access, as well as private motor vehicles. It is a better fit with existing City, IU and MPO policies, notably the Complete Streets Policy. Public input gathered during this study demonstrated a clear preference for two-way circulation.

It is important to note that the analysis shows that both the one-way and two-way alternatives demonstrate a marked improvement over existing conditions. The one-way pair (Alternative 1) improves the corridor significantly for vehicular traffic traveling *through* the corridor. The two-way alternative (Alternative 2) shows some improvement for vehicular through traffic, though not to the same extent as the one-way pair. However, the two-way alternative does outperform the one-way pair when it comes to how the corridors meet the needs of bicyclists, pedestrians, transit riders, emergency access and future growth of the University. For this reason, the two-way alternative became the preferred alternative since the study goals include enhancing all modes of transportation. Alternative 2 is a better fit with existing MPO, IU and City policies.

The preferred alternative can be constructed in three logical phases. The westernmost phase, between Union Street and 10th Street, would be the most beneficial to construct first, since it would add mobility for transit and emergency vehicles.

Two refinements to the two-way alternative are included in the preferred alternative: measures to encourage use of the new 14th Street/Law Lane Corridor, and a program to restrict access drives on the 10th Street corridor.

Implementation of the recommendations contained within this report will include detailed analyses and traffic modeling necessary to detail operational characteristics of the new roadway and serve as an input to design. There are numerous operational and design details to be determined, outlined earlier in the report. In addition, several mitigation measures can be put into place prior to construction of the preferred alternative.

APPENDICES

APPENDIX A: CAPACITY ANALYSES

This appendix details the technical traffic analyses prepared for this study. It includes descriptions of data calculated, the methodology of analysis used to calculate existing conditions, and the traffic-based measures of effectiveness (MOEs) in the report.

Existing Capacity Analysis

The existing conditions of the study are analyzed to determine if any existing areas of concern or opportunity exist within the transportation network and to establish a point of reference for the analysis of future traffic conditions.

Existing Roadway Network

The study area is bordered by 17th Street on the north, 10th Street on the south, Dunn Street on the west, and the SR 45/46 Bypass on the east. Figure 4 in the main body of the report shows the street network of the study area and the existing traffic controls at the study intersections.

The study area has several key local access roadways classified by the City of Bloomington. Average daily traffic (ADT) volumes were obtained for the heavily trafficked roadways in the study area from the City of Bloomington. The roadways in the study area include the following:

- *SR 45/46 Bypass*
  The SR 45/46 Bypass is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a primary arterial with an average daily traffic of 24,800 vehicles between 17th Street and 10th Street. Within the limits of the study area, the Bypass runs between 17th Street and 10th Street.

- *17th Street*
  17th Street is a 2-lane roadway that runs east-west through the study area. The roadway is classified as a secondary arterial with an average daily traffic of 15,000 vehicles between Dunn Street and Fee Lane and 7,400 vehicles between Fee Lane and the SR 45/46 Bypass. Within the limits of the study area, 17th Street runs between Dunn Street and the SR 45/46 Bypass.

- *14th Street*
  14th Street is a 2-lane roadway that runs east-west through the study area. The roadway is classified as a local street. Within the limits of the study area, 14th Street runs between Dunn Street and Walnut Grove Street.

- *13th Street*
  13th Street is a 2-lane roadway that runs east-west through the study area. The roadway is classified as a local street with an average daily traffic of 3,000 vehicles between Dunn Street and Walnut Grove Street and 4,800 vehicles between Walnut Grove Street and Fee Lane. Within the limits of the study area, 13th Street runs between Dunn Street and Fee Lane.

- *Law Lane*
  Law Lane is a 2-lane roadway that runs east-west through the study area. The roadway is classified as a local street. Within the limits of the study area, Law Lane runs between Fee Lane and Union Street.

- *10th Street*

  10th Street is a 2-lane roadway that runs east-west through the study area. The roadway is classified as a secondary arterial with an average daily traffic of 9,100 vehicles between Indiana Avenue and Woodlawn Avenue, 20,800 vehicles between Woodlawn Avenue and Walnut Grove Street, 16,500 vehicles between Walnut Grove Street and Jordan Avenue, 15,800 vehicles between Jordan Avenue and Union Street, and 12,900 vehicles between Union Street and the SR 45/46 Bypass. Within the limits of the study area, 10th Street runs between Dunn Street and the SR 45/46 Bypass.

- *Dunn Street*

  Dunn Street is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a secondary arterial. Within the limits of the study area, Dunn Street runs between 17th Street and 13th Street.

- *Indiana Avenue*

  Indiana Avenue is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a secondary arterial with an average daily traffic of 5,500 vehicles between 17th Street and 10th Street. Within the limits of the study area, Indiana Avenue runs between 17th Street and 10th Street.

- *Woodlawn Avenue*

  Woodlawn Avenue is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a primary collector. Within the limits of the study area, Woodlawn Avenue runs between 17th Street and 13th Street and between 12th Street and 10th Street.

- *Walnut Grove Street*

  Walnut Grove Street is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a local street with an average daily traffic of 1,300 vehicles between 17th Street and 13th Street and 2,300 vehicles between 13th Street and 10th Street. Within the limits of the study area, Walnut Grove Street runs between 17th Street and 10th Street.

- *Fee Lane*

  Fee Lane is a 2- to 3-lane roadway that runs north-south through the study area. The roadway is classified as a primary collector with an average daily traffic of 8,200 vehicles between 17th Street and 13th Street, 6,900 vehicles between 13th Street and Law Lane, and 7,400 vehicles between Law Lane and 10th Street. Within the limits of the study area, Fee Lane runs between 17th Street and 10th Street.

- *Jordan Avenue*

  Jordan Avenue is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a primary collector with an average daily traffic of 8,100 vehicles between Law Lane and 10th Street. Within the limits of the study area, Jordan Avenue runs between 17th Street and 10th Street.

- *Sunrise Drive*

  Sunrise Drive is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a local street. Within the limits of the study area, Sunrise Drive runs south from 10th Street

- *Union Street*

  Union Street is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a primary collector with an average daily traffic of 3,600 vehicles north of 10th Street and 10,800 vehicles south of 10th Street. Within the limits of the study area, Union Street runs between 10th Street and Lingelbach Lane.

- *Jefferson Street*

  Jefferson Street is a 2-lane roadway that runs north-south through the study area. The roadway is classified as a local street. Within the limits of the study area, Jefferson Street runs south from 10th Street

A map of the roadway functional hierarchy and Average Daily Traffic (ADT) is included as Figure 5 in the main body of the report.

Existing Traffic Volumes

Two sources of data provided existing peak hour turning movement traffic volumes. Turning movement counts were obtained for several of the study intersections from the City of Bloomington from 2000 and 2007. These counts were supplemented by turning movement counts performed by the City and Gorove/Slade on Tuesday through Thursday, March 17 through 19, 2009 from 7:00 am to 10:00 am and from 3:00 pm to 6:00 pm. The existing traffic volumes compiled for the intersections contained within in the study area are shown in Figure 24 and Figure 25. The morning and afternoon peak hours for the system of intersections being studied occurred between 8:45 to 9:45 AM and 5:00 to 6:00 PM, respectively. The existing turning movement counts are included in Technical Attachment 3.

It should be noted that a planning-study level of analysis was applied for this study. In accordance with that, extensive data collection was not performed. The count data obtained from the City of Bloomington was provided from previous studies performed by other firms. Several of these counts were provided as printouts from the software program *HCS*, which included only vehicular counts. Pedestrian data, bus blockages per hour, and truck data were not included in these counts. The counts performed by Gorove/Slade concentrated exclusively on vehicular turning movement and pedestrian counts. Future studies could include new, detailed turning movement counts, in order to collect all supplemental data.

Assembly of Traffic Model

In order to evaluate the roadway network, intersection capacity analyses were performed for the existing conditions at the intersections contained within the study area during the morning and afternoon peak hours. The *Synchro/SimTraffic* software package was used to compile a traffic model with the existing volumes and data obtained from the City of Bloomington and from field reconnaissance performed by Gorove/Slade. This data included existing lane configurations, traffic controls, and signal timings at the intersections shown within the study area.

The *SimTraffic* portion of the *Synchro, Version 7* software package was used to analyze the study intersections. *SimTraffic* modeling using simulation was chosen over Highway Capacity Manual (HCM) methodologies incorporated into *Synchro* because it is especially useful for analyzing complex situations that are not easily modeled macroscopically. *SimTraffic* modeling better evaluates the effect of signalized intersections on nearby unsignalized intersections and driveways, delays generated by pedestrians crossing roadways, the operation of intersections under heavy congestion, and closely spaced intersections with blocking and lane change problems. *SimTraffic* results typically match queues and observations of intersections in the field more closely than do results from the HCM methodology.

As stated previously, extensive data collection was not performed for this study. Due to this, several default values were assumed during the assembly of the traffic model. This includes the peak hour factor (PHF), which was assumed to be a default of 0.92. In order to remain consistent between all forms of data used, the default PHF was assumed for all the study intersections. As standard practice, the default PHF would have been used for all future scenarios since traffic patterns in the future do not necessarily follow existing traffic patterns. Using the default PHF also remains consistent throughout the entire analysis. However, altering the PHF would be performed for all alternatives and would not result in a significantly different result. The relative ranking of alternatives would remain unchanged. In addition to PHF, the default percentage of truck traffic (2%) was assumed for the traffic model. Truck data was also not included in the traffic counts. Future engineering studies could include more accurate PHF and truck data. Similarly, altering the percentage of truck traffic within the traffic models would not result in a significantly different result. Lastly, several variables were not included in the development of the traffic model, such as bus blockages along the corridor. This is due to the lack of data collection, as well as the limitations of the traffic model. *SimTraffic* does not explicitly model factors such as bus blockages, so the data was not included in the existing traffic model. Additionally, bus blockages for the future scenarios are unknown due to the rerouting of existing transit routes with the roadway improvements recommended. In order to remain consistent between all models, bus blockages were not included in any of the scenarios.

Existing Capacity Analysis Results

Intersection capacity analyses were performed for the existing conditions, as described above, at the intersections contained within the study area. The results of the intersections capacity analyses are shown on Figure 26 and Figure 27 for the morning and afternoon peak hours, respectively. The results are expressed in level of service (LOS) for the overall intersection. An overall LOS is shown for the signalized and all-way stop-controlled intersections. For two-way stop-controlled or T intersections, an overall delay is defined in the HCM, so the LOS shown is based on the delay of the minor approach(s) of the intersection.

As shown on Figure 26 and in Table 4, all study intersections operate at acceptable (LOS D or better) conditions during the morning peak hour. During the afternoon peak hour, as shown on Figure 27 and in Table 4, the following intersections operate at unacceptable LOS:

- 17th Street and Fee Lane
- Law Lane and Jordan Avenue
- 10th Street and Woodlawn Avenue
- 10th Street and Jordan Avenue
- 10th Street and the SR 45/46 Bypass

These results generally confirm what has been observed by Gorove/Slade during field reconnaissance. The only exception is the intersection of 10th Street and Fee Lane, which also appears to operate at unacceptable conditions during the afternoon peak hour. This was observed to be due mostly by pedestrians jaywalking across the intersection during the vehicular phases, which is not modeled in *SimTraffic*.

Future Capacity Analysis – Alternative 0, No-Build Scenario

Alternative 0 Roadway Network

The future roadway network is based on the existing configuration of the roadways in the study area. It was assumed that a few key roadway improvements would be implemented in the future, no-build scenario. These include the following roadway and intersection improvements:

- Construct a traffic signal at the intersection of 17th Street and the SR 45/46 Bypass;
- Widen the SR 45/46 Bypass to a 4-lane cross-section; and
- Remove the Walnut Grove Street railroad crossing and replace with an at-grade crossing along Woodlawn Avenue

The no-build scenario also includes some signal timing improvements along the 10th Street and Law Lane corridors in order to improve intersections that operate with unacceptable levels of delay under the existing conditions. Most notably, this includes the intersections of Jordan Avenue with 10th Street and Law Lane, which are vastly improved in the traffic model with signal timing changes. This was done to create a better comparison with the build scenarios, which also include signal timing changes.

Alternative 0 Traffic Volumes

For all alternatives, the LOS was projected out to 10 years. A 10 year time line was chosen because this is the earliest that improvements are anticipated to occur (State and federal regulations may require additional analysis beyond 10 years).In order to account for traffic generated by nearby development and inherent growth on the roadways within the study area, a one percent growth rate per year was assumed. This growth rate was assumed based on Census information gathered from the City of Bloomington. The one percent growth rate was summed to be sufficient to account for growth related to Indiana University because the Master Plan does not include significant new traffic generators, as the University intends to keep the relative amount of parking on campus the same as it develops and grows. Traffic volumes were also rerouted due to the construction of the new Woodlawn Avenue railroad crossing. The traffic volumes for the no-build scenario for the intersections contained within in the study area are shown in Figure 28 and Figure 29.

Alternative 0 Capacity Analysis Results

Intersection capacity analyses were performed for the no-build scenario using *SimTraffic* simulation at the intersections contained within the study area. The results of the intersections capacity analyses are shown on Figure 30 and Figure 31 for the morning and afternoon peak hours, respectively. The results are expressed in level of service (LOS) for the overall intersection. An overall LOS is shown for the signalized and all-way stop-controlled intersections. For two-way stop-controlled or T intersections, an overall delay is defined in the HCM, so the LOS shown is based on the delay of the minor approach(s) of the intersection.

As shown on Figure 30 and in Table 4, all study intersections operate at acceptable (LOS D or better) conditions during the morning peak hour. During the afternoon peak hour, as shown on Figure 31 and in Table 4, the following intersections operate at unacceptable LOS:

- 17th Street and Dunn Street
- 10th Street and Indiana Avenue
- 10th Street and Woodlawn Avenue

- 10th Street and Jordan Avenue

A few of the study intersections are improved in the no-build scenario due to signal timing changes including the intersections of (1) 17th Street and Fee Lane, (2) Law Lane and Jordan Avenue, and (3) 10th Street and the SR 45/46 By pass.

Travel time results for the morning and afternoon peak hours through the 10th Street corridor were also recorded for the no-build scenario, which are shown in Table 6.

Future Capacity Analysis – Alternative 1, 10th Street and Law Lane as 1-Way Streets

Alternative 1 Roadway Network

The future roadway network for the one-way pairs scenario is based on the existing lane configurations in the study area, including the improvements listed above for the no-build scenario. For the one-way pairs, it was assumed that Law Lane will travel westbound, and 10th Street will travel eastbound. The cross-section of the proposed Law Lane extension was assumed to be 2-lanes, with turn-lanes provided at intersections. Traffic controls at the study intersections were based on what was necessary for capacity along the corridor. As stated above, the one-way pairs scenario also includes some signal timing improvements along the 10th Street and Law Lane corridors in order to improve intersections that operate with unacceptable levels of delay under the existing conditions.

Alternative 1 Traffic Volumes

The traffic volumes for the one-way pairs scenario are based on the volumes from the no-build scenario, as explained above. In addition to the growth-rate assumed to account for future growth, vehicles were rerouted throughout the roadway network due to the construction of the Law Lane extension and the conversion to one-way pairs. The traffic volumes for the one-way pairs scenario for the intersections contained within in the study area are shown in Figure 32 and Figure 33.

It should be noted that the traffic volumes included in this study are of a planning level type analysis. They are not intended to be design-level volumes. In a future engineering study, the projected traffic volumes for the one-way pairs scenario could be revised to show a larger volumes of vehicles turning at intersections due to rerouting with the one-way streets. However, revising the traffic model parameters and volumes would not significantly changes the results of this study.

Alternative 1 Capacity Analysis Results

Intersection capacity analyses were performed for the one-way pairs scenario using *SimTraffic* simulation at the intersections contained within the study area. The results of the intersections capacity analyses are shown on Figure 34 and Figure 35 for the morning and afternoon peak hours, respectively. The results are expressed in level of service (LOS) for the overall intersection. An overall LOS is shown for the signalized and all-way stop-controlled intersections. For two-way stop-controlled or T intersections, an overall delay is defined in the HCM, so the LOS shown is based on the delay of the minor approach(s) of the intersection.

As shown on Figure 34 and Figure 35 and in Table 4, all study intersections operate at acceptable (LOS D or better) conditions during the morning and afternoon peak hours. All of the study intersections that operate at unacceptable conditions during the afternoon peak hour under the existing conditions are improved to acceptable conditions in the one-way pairs scenario.

Travel time results for the morning and afternoon peak hours through the 10^{th} Street and Law Lane corridors were also recorded for the one-way pairs scenario, which are shown in Table 6.

Future Capacity Analysis – Alternative 2, 10^{th} Street and Law Lane as 2-Way Streets

Alternative 2 Roadway Network

The future roadway network for the two-way pairs scenario is based on the existing lane configurations in the study area, including the improvements listed above for the no-build scenario. The cross-section of the proposed Law Lane extension was assumed to be 2-lanes, with turn-lanes provided at intersections. Traffic controls at the study intersections were based on what was necessary for capacity along the corridor. As stated above, the two-way pairs scenario also includes some signal timing improvements along the 10^{th} Street and Law Lane corridors in order to improve intersections that operate with unacceptable levels of delay under the existing conditions.

Alternative 2 Traffic Volumes

The traffic volumes for the two-way pairs scenario are based on the volumes from the no-build scenario, as explained above. In addition to the growth-rate assumed to account for future growth, vehicles were rerouted throughout the roadway network due to the construction of the Law Lane extension. It was assumed that approximately 50-60% of the existing westbound traffic and approximately 30-40% of the existing eastbound traffic would be rerouted to Law Lane. The traffic volumes for the two-way pairs scenario for the intersections contained within in the study area are shown in Figure 36 and Figure 37.

It should be noted that the traffic volumes included in this study are of a planning level type analysis. They are not intended to be design-level volumes. In a future engineering study, the projected traffic volumes for the two-way pairs scenario could be revised to show a larger volumes of traffic traveling on the 10^{th} Street versus the Law Lane corridor. However, revising the traffic model parameters and volumes would not significantly change the results of this study (the comparative performance of each alternative's MOEs).

Alternative 2 Capacity Analysis Results

Intersection capacity analyses were performed for the two-way pairs scenario using *SimTraffic* simulation at the intersections contained within the study area. The results of the intersections capacity analyses are shown on Figure 38 and Figure 39 for the morning and afternoon peak hours, respectively. The results are expressed in level of service (LOS) for the overall intersection. An overall LOS is shown for the signalized and all-way stop-controlled intersections. For two-way stop-controlled or T intersections, an overall delay is defined in the HCM, so the LOS shown is based on the delay of the minor approach(s) of the intersection.

As shown on Figure 38 and in Table 4, all study intersections operate at acceptable (LOS D or better) conditions during the morning peak hour. During the afternoon peak hour, as shown on Figure 39 and in Table 4, the following intersections operate at unacceptable LOS:

- Law Lane and Fee Lane
- Law Lane and Jordan Avenue
- 10^{th} Street and Jordan Avenue

A few of the study intersections are improved in the two-way pairs scenario due to signal timing changes and rerouted volumes including the intersections of (1) 17th Street and Fee Lane, (2) 10th Street and Woodlawn Avenue, and (3) 10th Street and the SR 45/46 By pass.

Travel time results for the morning and afternoon peak hours through the 10th Street and Law Lane corridors were also recorded for the two-way pairs scenario, which are shown in Table 6.

Comparison of Capacity Analysis Results

Table 4 shows a comparison of the capacity analysis results for all the scenarios outlined above.

Table 4: Comparison of Capacity Analysis Results

Intersection	Capacity Analysis Results (Level of Service)							
	Existing Conditions		No-Build Scenario		One-Way Alternative		Two-Way Alternative	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
17th Street & Dunn Street	C	C	C	E	B	C	B	C
17th Street & Woodlawn Ave	A	A	A	A	B	B	A	B
17th Street & Walnut Grove Street	A	A	A	B	B	B	A	B
17th Street & Fee Lane	B	F	B	D	B	C	B	C
17th Street & West Jordan Lane	A	B	A	D	A	C	A	C
17th Street & East Jordan Lane	A	A	A	A	A	A	A	A
17th Street & SR 45/46 Bypass	A	A	A	A	A	A	A	A
14th Street & Dunn Streeet	A	A	A	A	A	C	A	B
14th Street & Indiana Avenue	A	A	A	A	A	C	A	B
14th Street & Woodlawn Avenue	A	A	A	A	A	A	A	A
13th Street & Indiana Avenue	A	A	A	C	A	A	A	B
13th Street & Woodlawn Avenue	A	A	A	A	A	A	A	A
13th Street & Walnut Grove Street	A	C	A	A	A	A	A	C
13th Street & Fee Lane	A	D	A	A	--	--	--	--
Law Lane & Fee Lane	A	C	A	B	A	A	A	E
Law Lane & Jordan Avenue	B	F	B	C	B	C	B	E
Law Lane & Union Street	A	A	A	A	A	A	A	B
Law Lane & 10th Street	--	--	--	--	A	A	A	A
10th Street & Indiana Avenue	B	D	B	F	B	B	B	B
10th Street & Woodlawn Avenue	B	E	B	E	B	C	B	C
10th Street & Fee Lane	D	D	B	B	B	D	B	B
10th Street & Jordan Avenue	B	F	C	F	D	D	B	F
10th Street & Sunrise Drive	A	B	A	B	A	A	A	B
10th Street & Union Street	B	B	B	C	A	B	B	B
10th Street & Jefferson Street	A	A	A	A	A	A	A	A
10th Street & SR 45/46 Bypass	C	F	C	D	C	D	C	D

Table 5 shows a summary of the capacity analysis results, as shown in Table 4. As shown in the table, improvements included in the no-build scenario are evident in the afternoon peak hour, with the reduction of the number of intersections operating at LOS F. For the one-way alternative, all study intersections are improved to operate at acceptable conditions during the morning and afternoon peak hours. This is due to the configuration of the one-way streets moving vehicles efficiently through the corridor. For the two-way alternative, all intersections operate at acceptable conditions during the morning peak hour and three intersections operate at unacceptable conditions during the afternoon peak hour. The number of unacceptable intersections is greater in the two-way alternative than the one-way alternative. However, it should be noted that the number of unacceptable intersections in decreased from the existing conditions to the future two-way alternative.

Table 5: Summary of Capacity Analysis Results

Level of Service	Number of Intersections with Level of Service Grade							
	Existing Conditions		No-Build Scenario		One-Way Alternative		Two-Way Alternative	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
A	16	11	16	11	15	11	16	6
B	6	3	6	4	8	4	8	10
C	2	3	3	3	1	7	1	5
D	1	3	0	3	1	3	0	1
E	0	1	0	2	0	0	0	2
F	0	4	0	2	0	0	0	1

Table 6 shows a comparison of travel time results for the 10th street and Law Lane corridors for each of the future scenarios. Both the one-way and two-way alternatives show improvements in the corridor travel time due to the increase in capacity with the construction of the Law Lane extension.

Table 6: Comparison of Travel Time Results

Corridor	Travel Time Results (Minutes)					
	No-Build Scenario		One-Way Alternative		Two-Way Alternative	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
10th Street Eastbound	4.2	20.2	4.1	5.6	4.1	5.0
10th Street Westbound	5.0	6.4	--	--	4.4	5.2
Law Lane Eastbound	--	--	--	--	3.6	5.5
Law Lane Westbound	--	--	3.4	4.0	3.6	3.8

It should be noted that the two-way alternative shows better travel time than the one-way alternative although the intersections operate under more congestion. This is due to the process of calculation for intersection delay and total travel time. Travel time is calculated using origin-destination data to only count vehicles that came from the next upstream link, which is almost equivalent to taking the travel time of only those vehicles that travel the entire corridor. In contrast, intersection delay measures the travel time of all vehicles within the system. In this case, the higher levels of intersection delay simulated in the two-way alternative are most likely due to the delay experienced by turning movements, which is not reflected in the travel time. Signal timing and coordination also affect the arterial travel time.

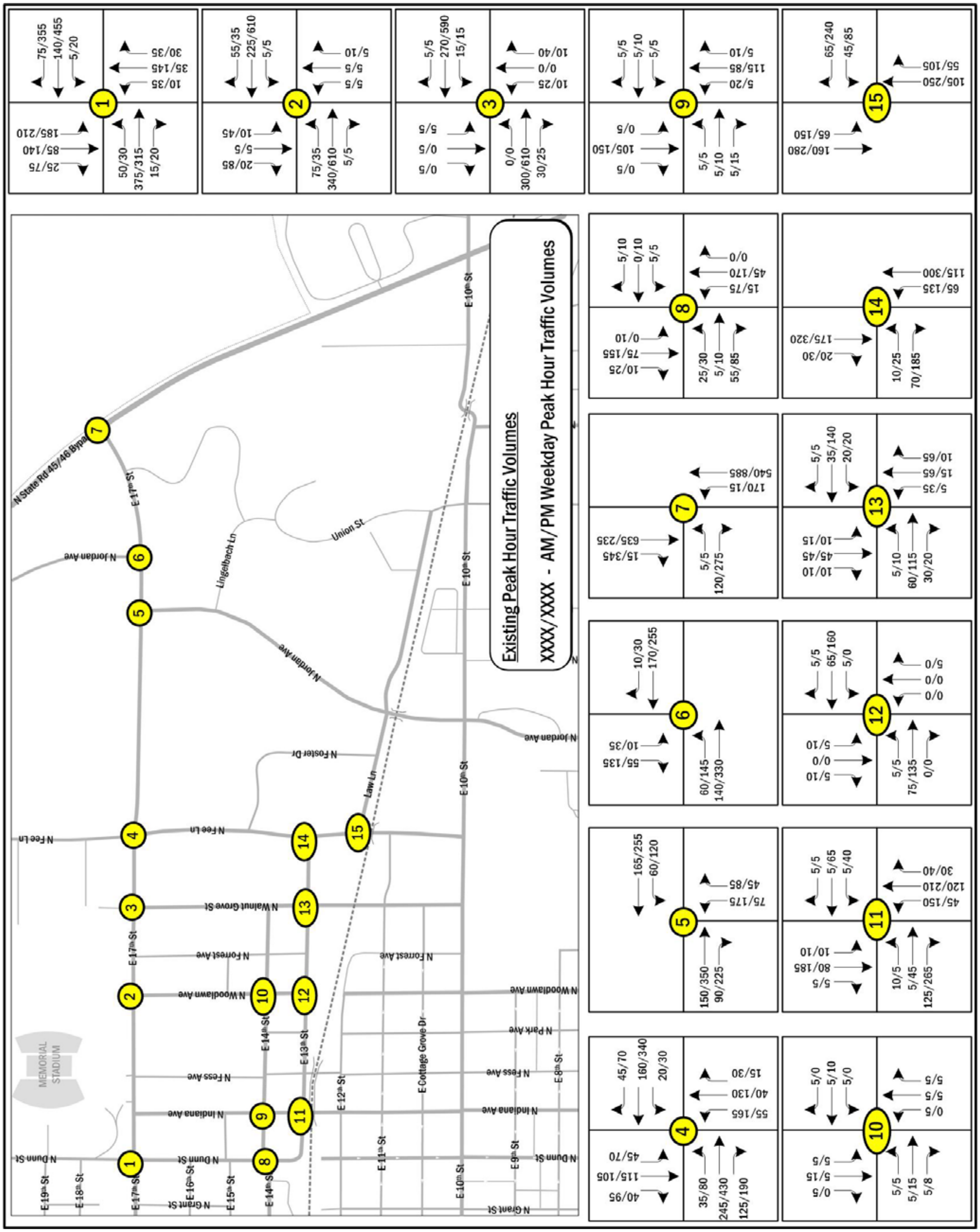

Figure 24: Existing Traffic Volumes, Page 1

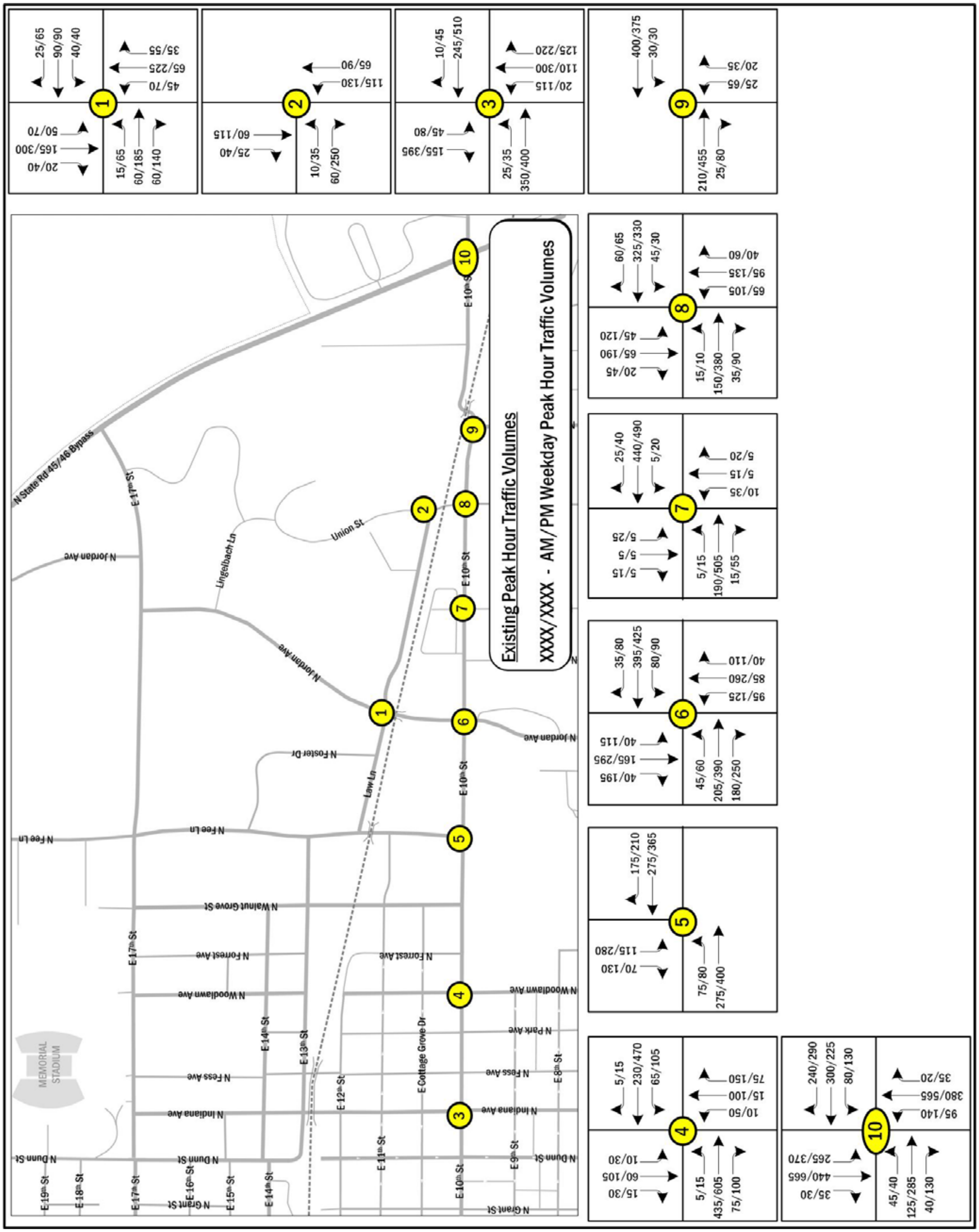

Figure 25: Existing Traffic Volumes, Page 2

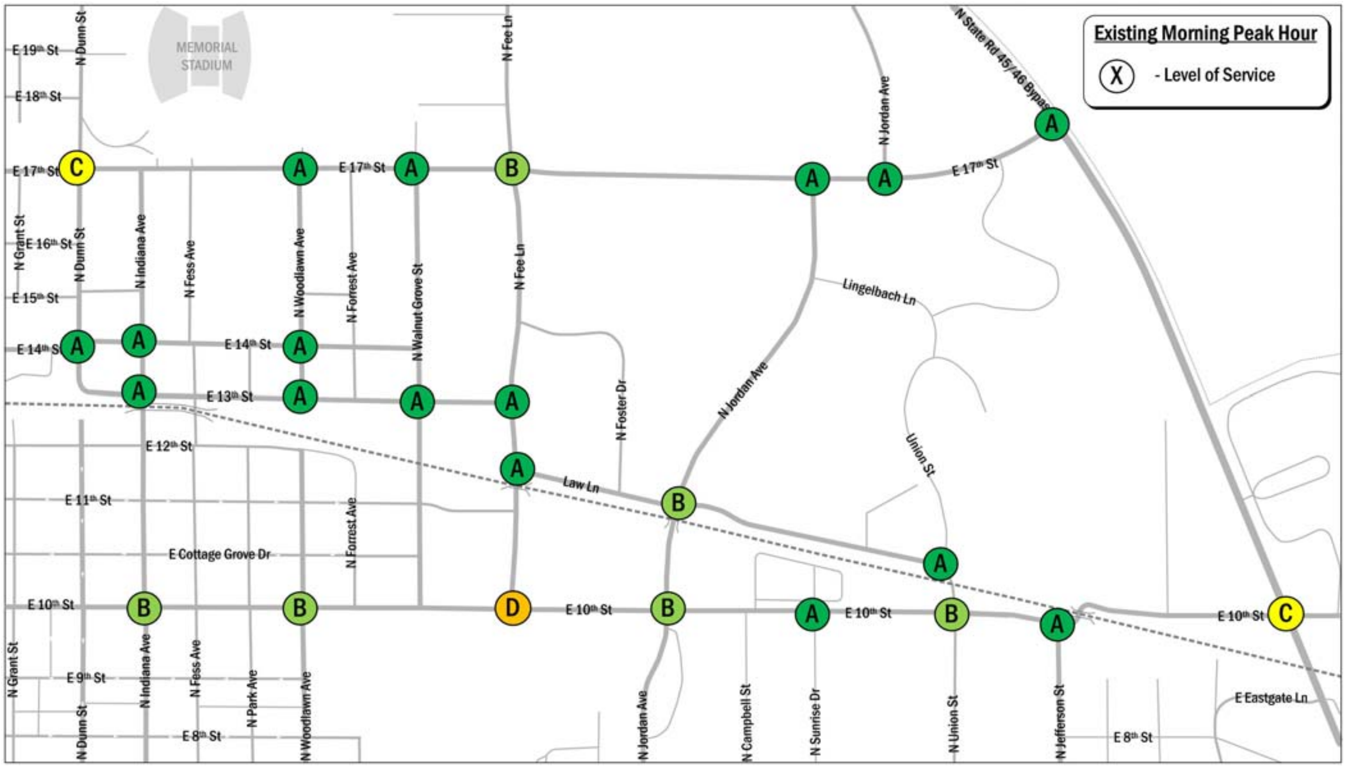

Figure 26: Existing Morning Peak Hour Levels of Service

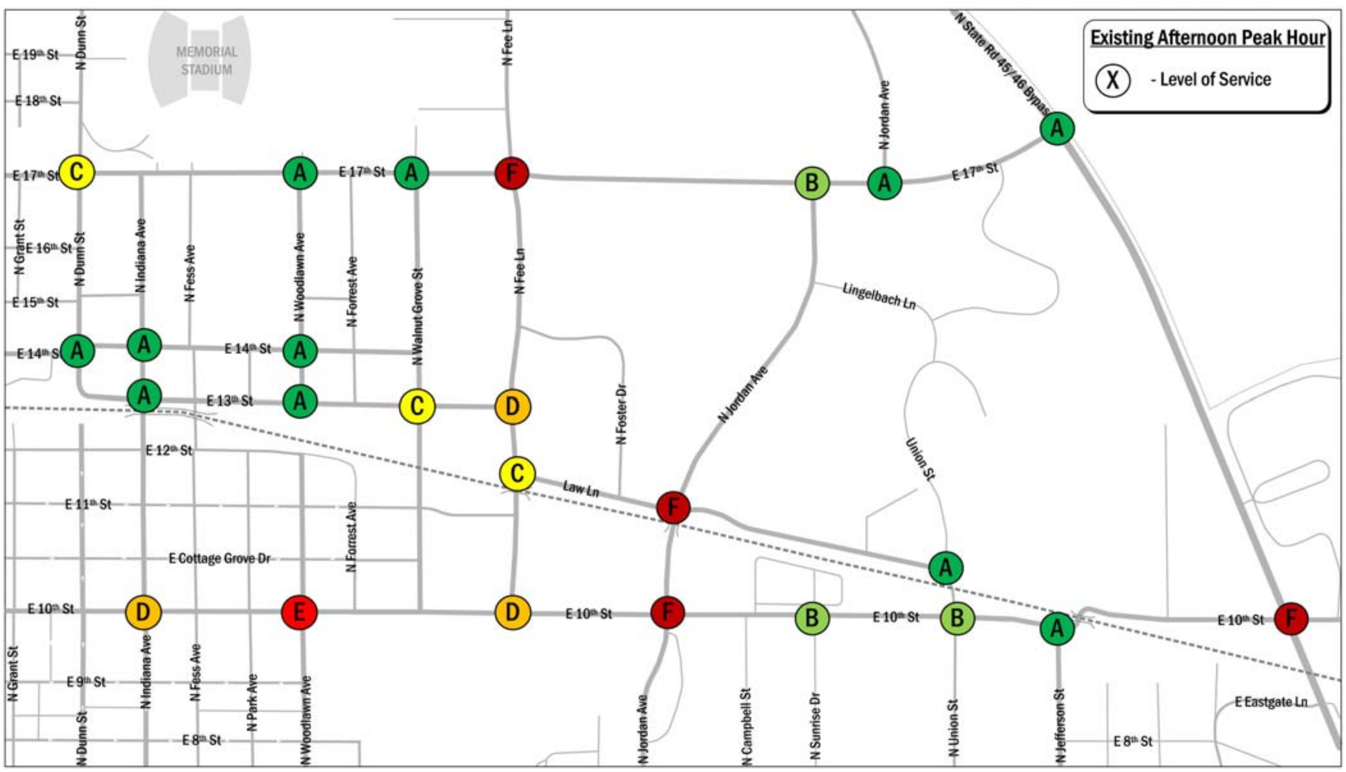

Figure 27: Existing Afternoon Peak Hour Levels of Service

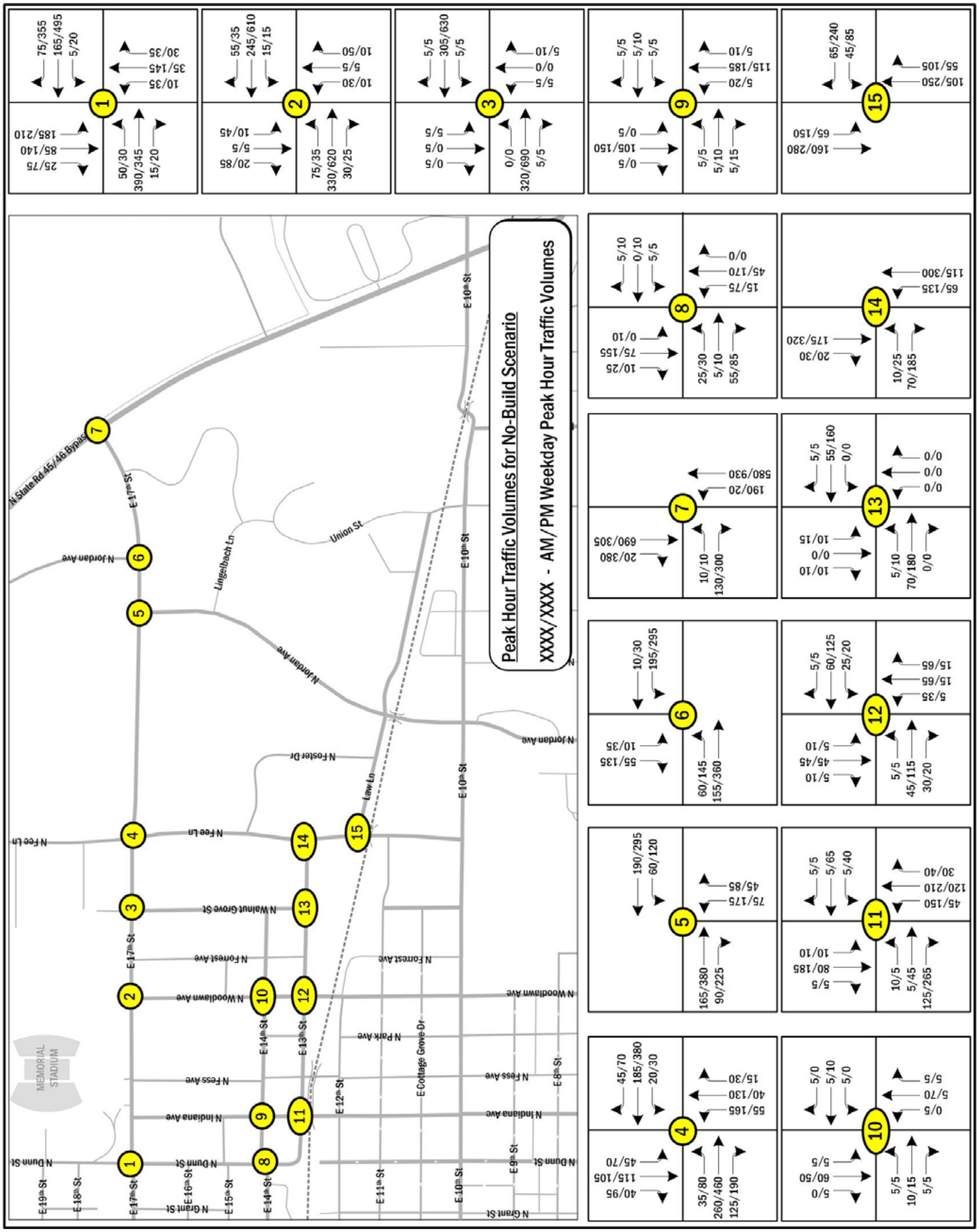

Figure 28: Alternative 0 Traffic Volumes, Page 1

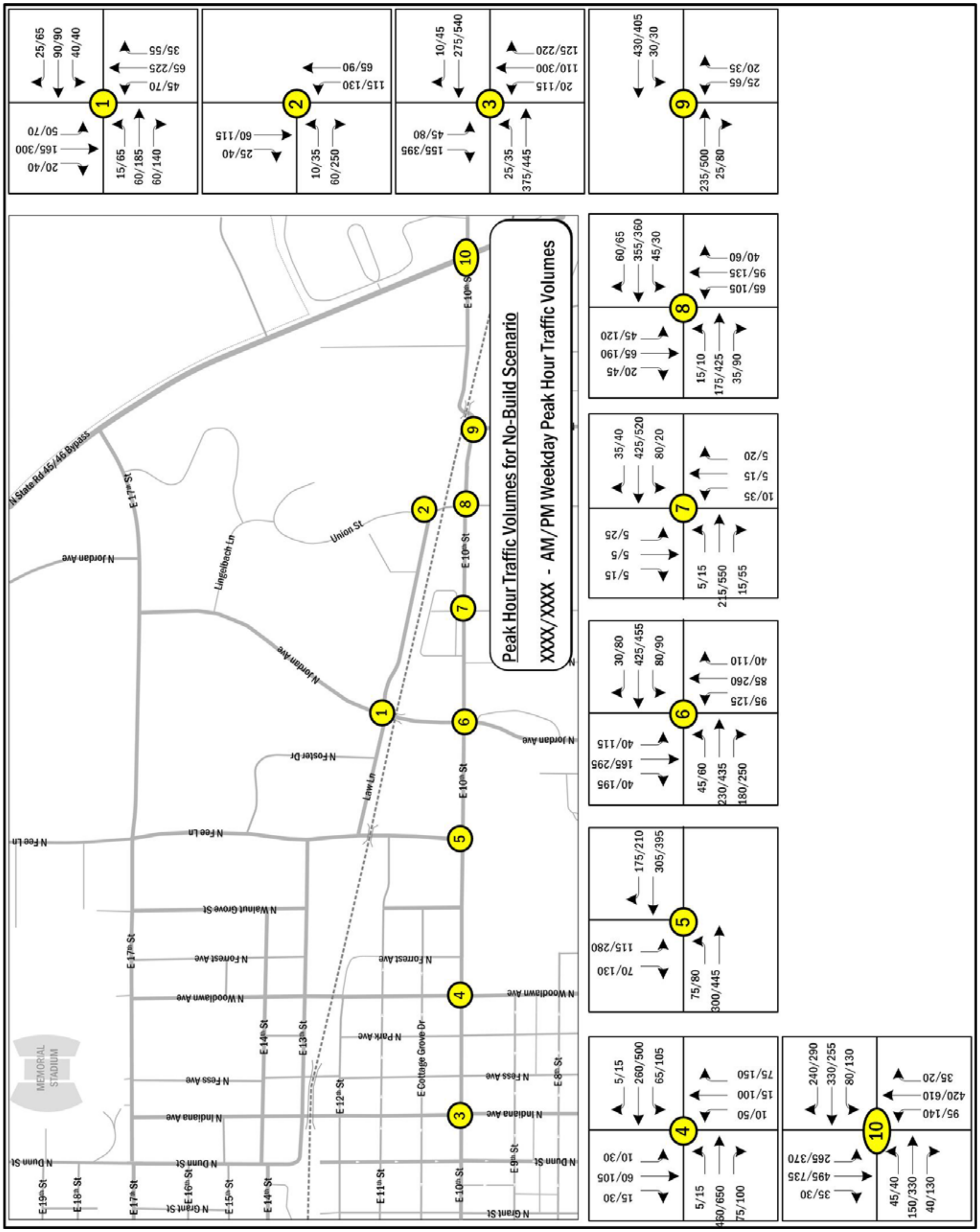

Figure 29: Alternative 0 Traffic Volumes, Page 2

Figure 30: Alternative 0 Morning Levels of Service

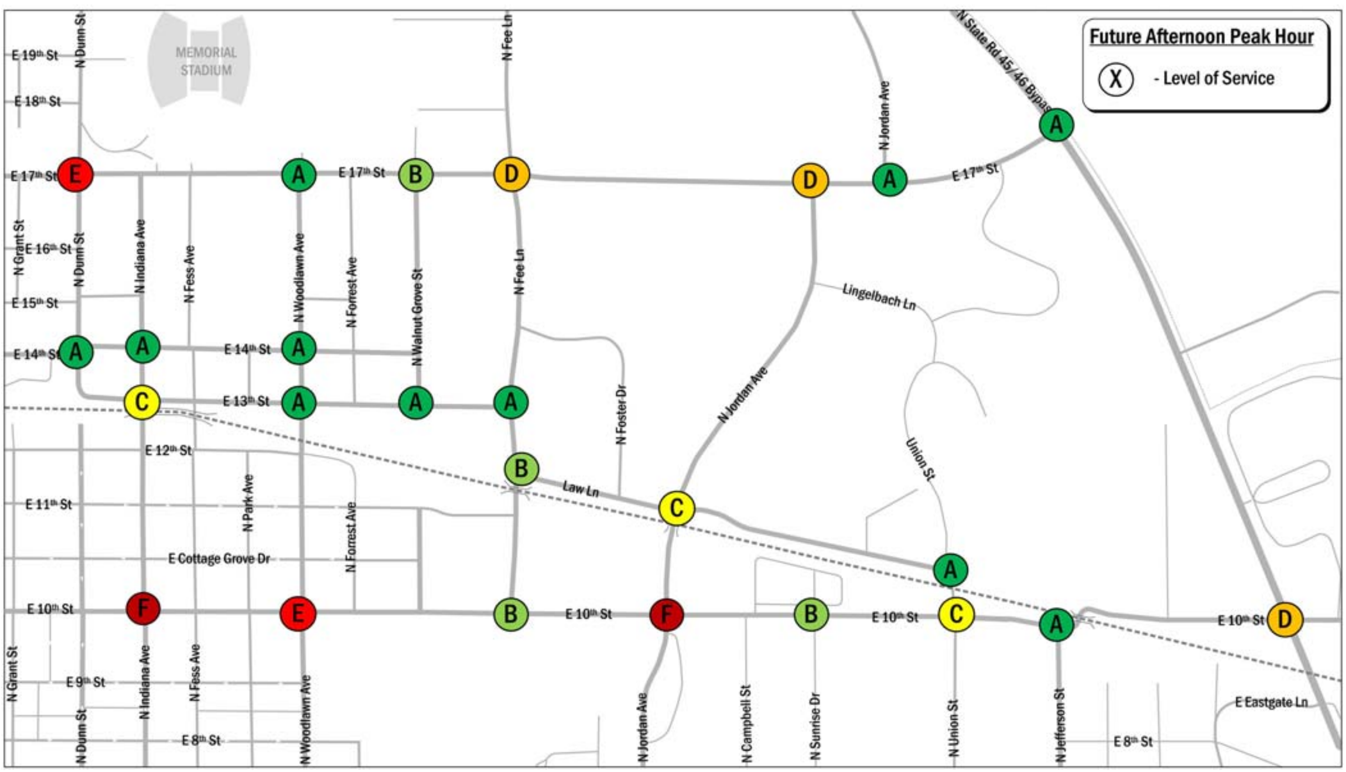

Figure 31: Alternative 0 Afternoon Levels of Service

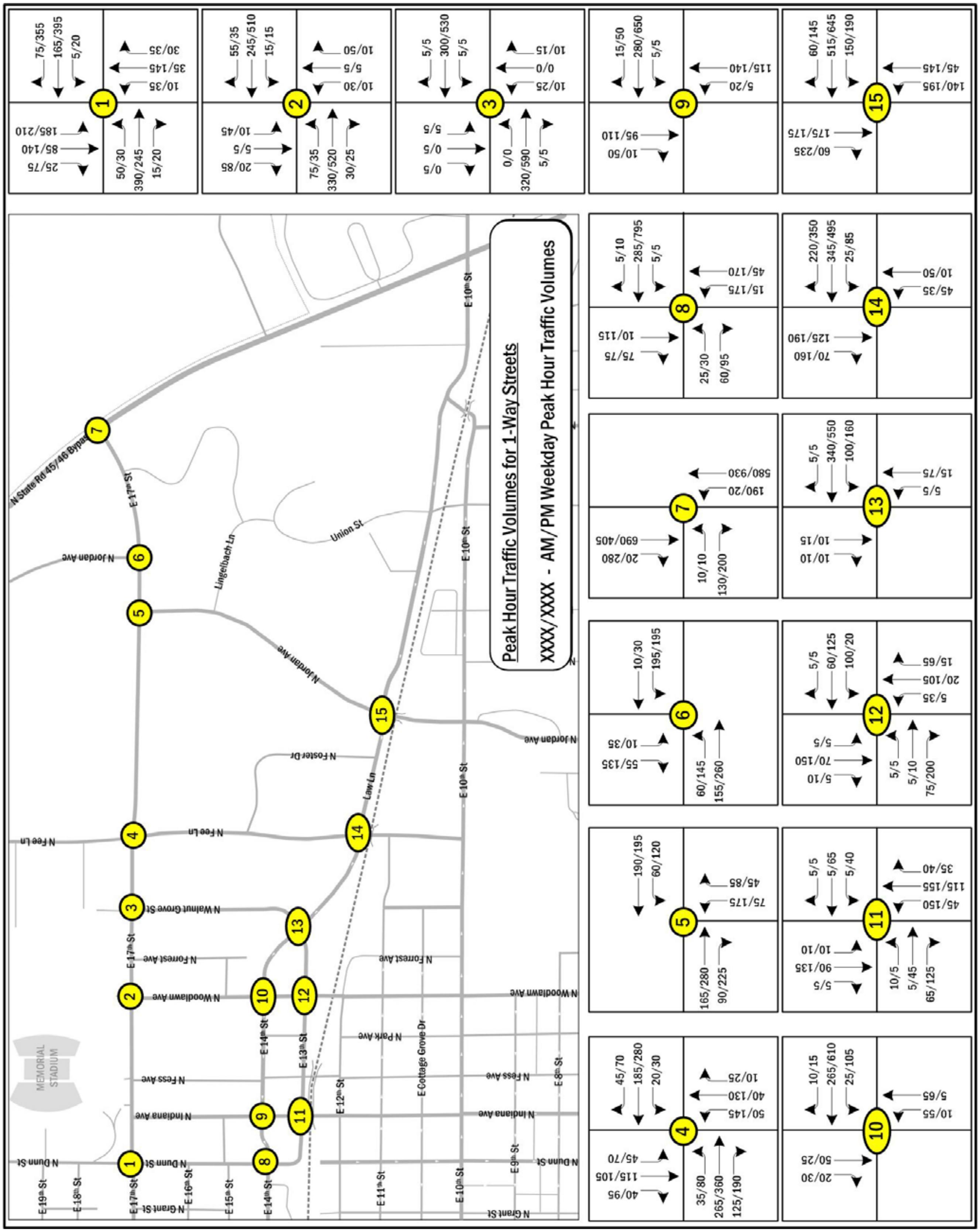

Figure 32: Alternative 1 Traffic Volumes, Page 1

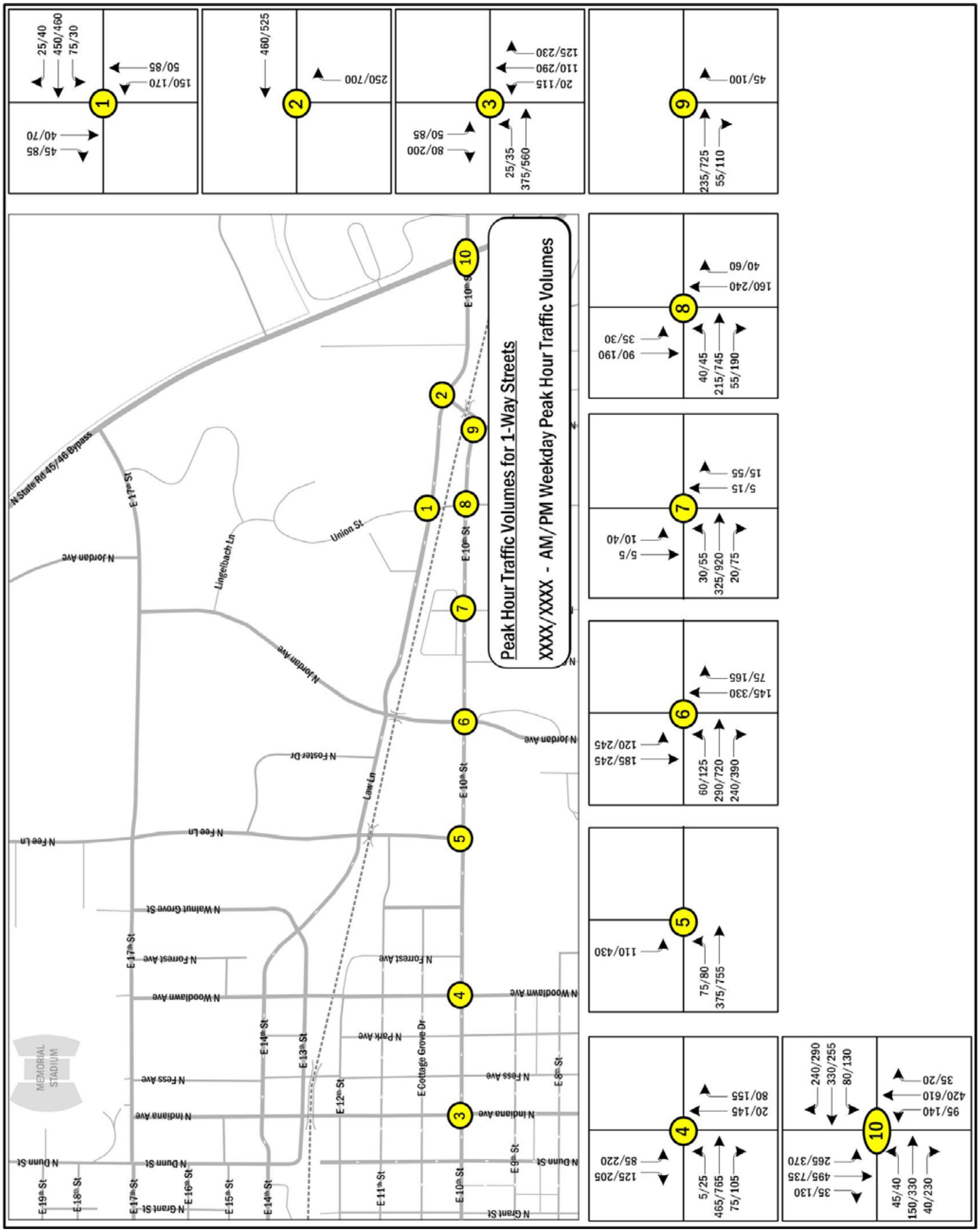

Figure 33: Alternative 1 Traffic Volumes, Page 2

Figure 34: Alternative 1 Morning Levels of Service

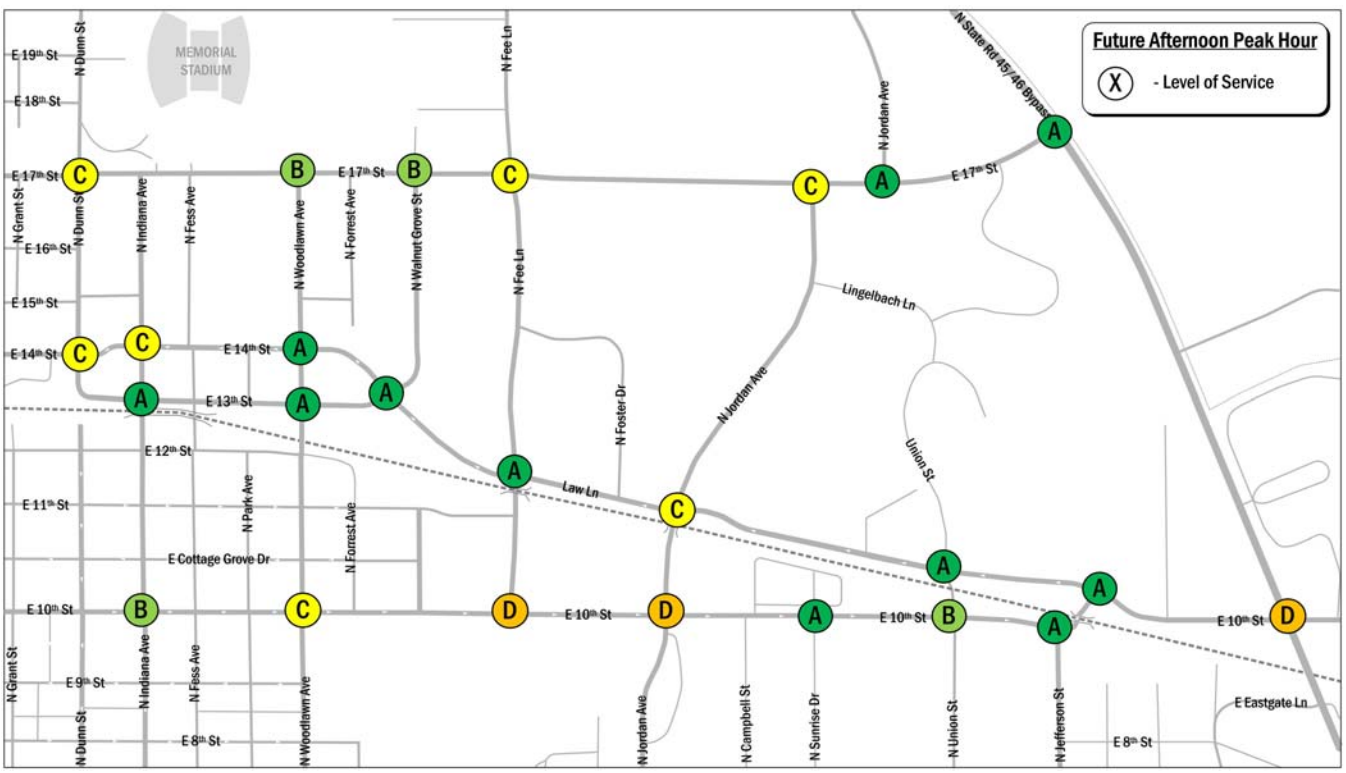

Figure 35: Alternative 1 Afternoon Levels of Service

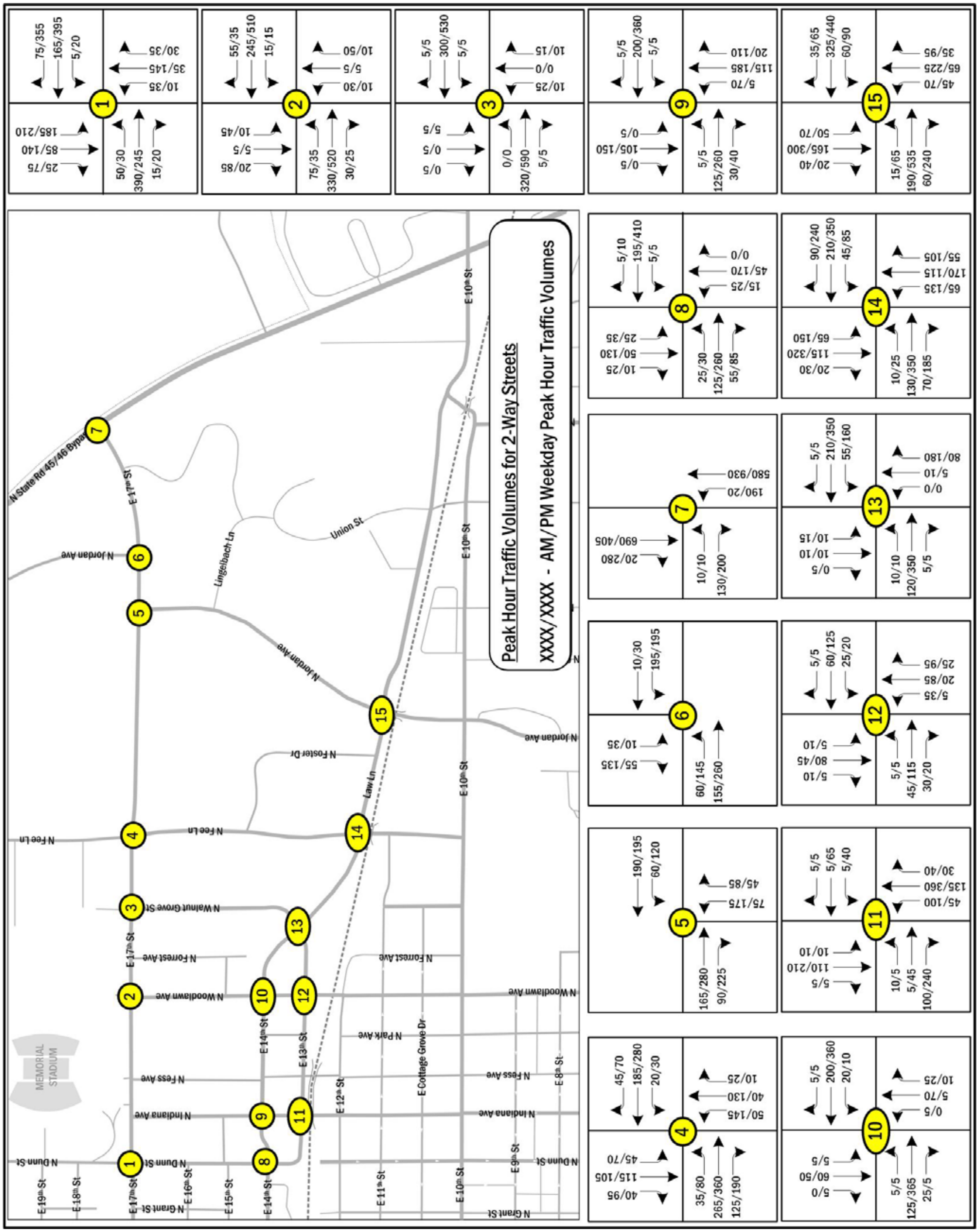

Figure 36: Alternative 2 Traffic Volumes, Page 1

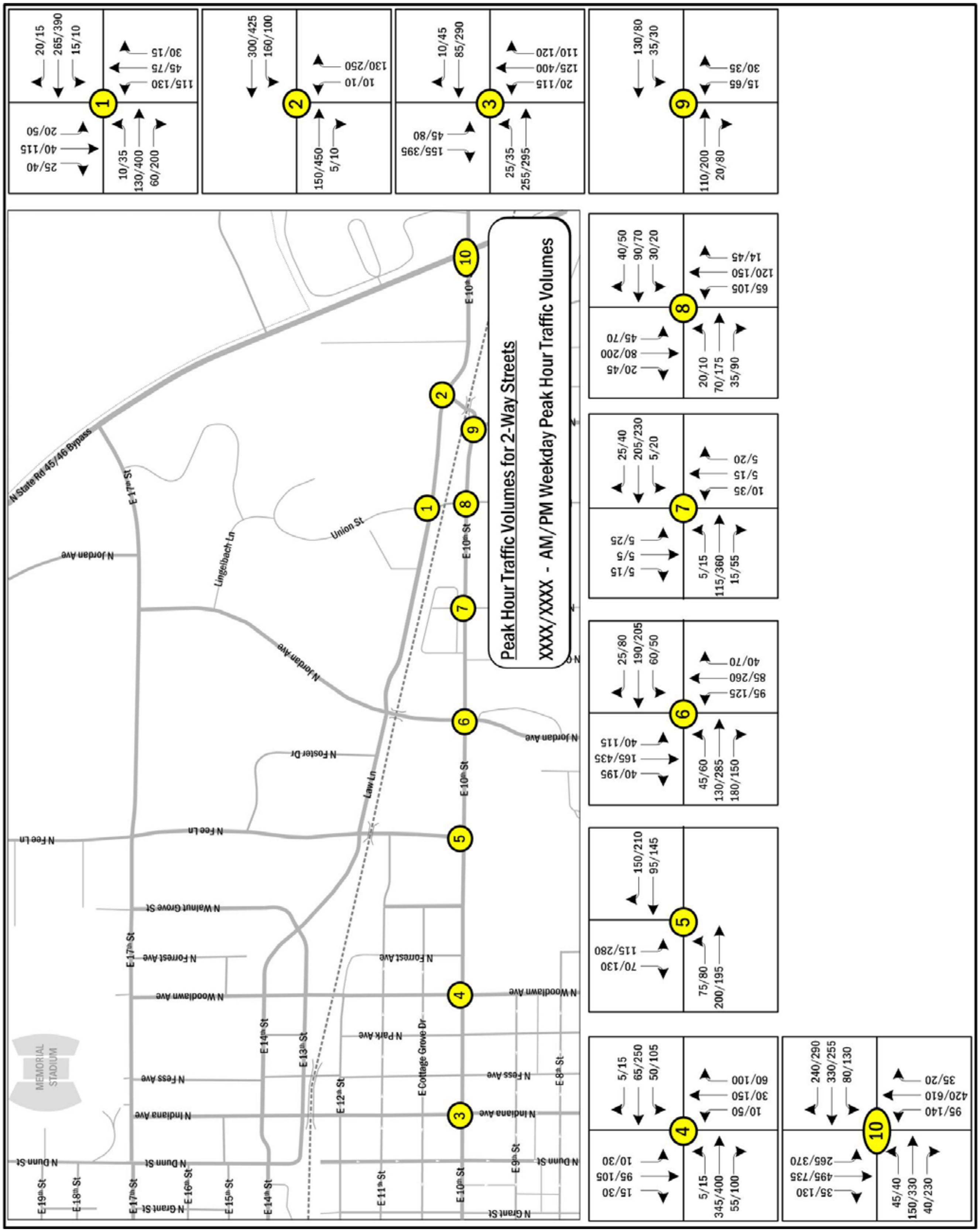

Figure 37: Alternative 2 Traffic Volumes, Page 2

Figure 38: Alternative 2 Morning Levels of Service

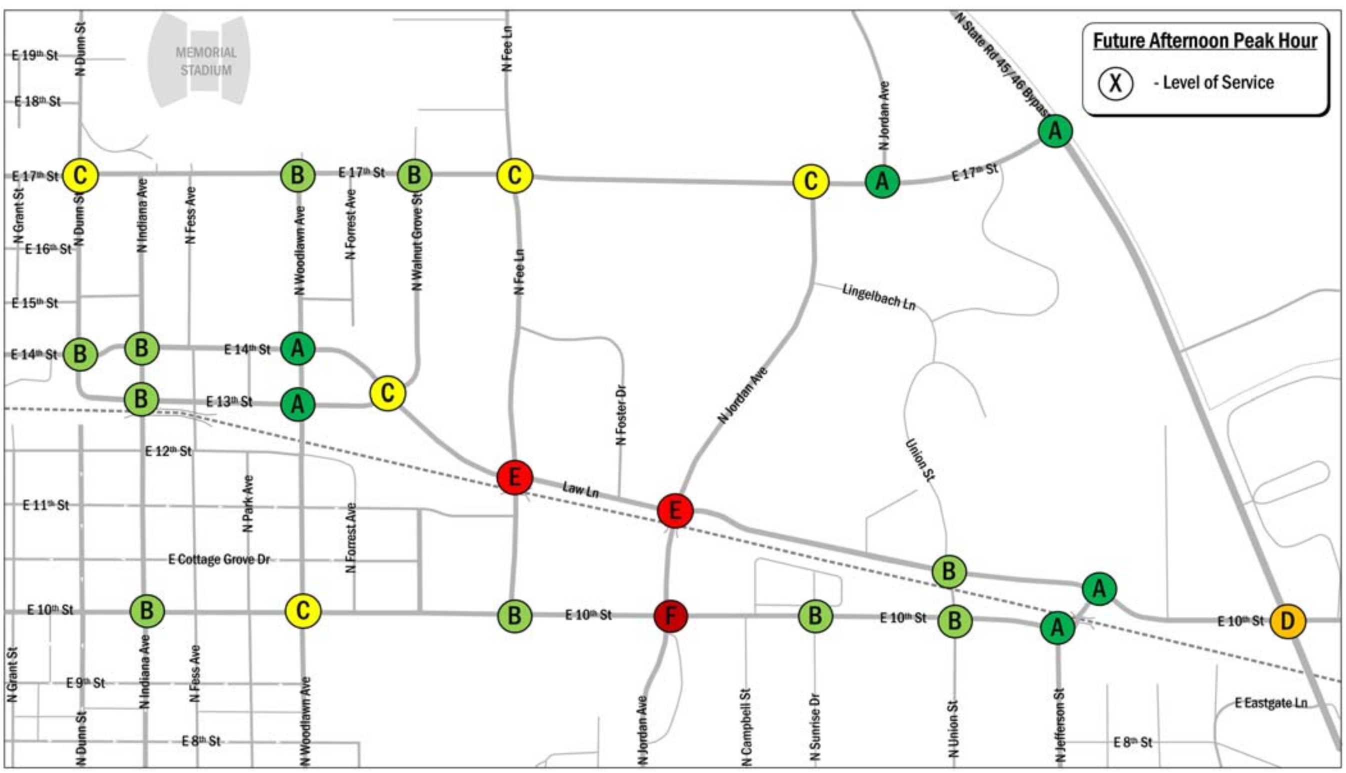

Figure 39: Alternative 2 Afternoon Levels of Service

APPENDIX B: MOE CALCULATIONS

Gorove/Slade used a wide range of quantitative measures of effectiveness (MOE) to evaluate the three alternatives. A range of MOEs were used to understand how each alternative impacted all users of the transportation network, including transit passengers, cyclists, and pedestrians. The MOEs included engineering evaluation criteria, such as intersection delay and corridor travel time, and criteria developed based on planning and sustainability principles. The remainder of this appendix describes the MOEs in greater detail and provides information on the analysis and results.

LOS and Travel Time Delay

These MOEs are described in Appendix A.

Intersection Density

Under this measure, Gorove/Slade counted the total number of intersections within the study area and calculated intersection density per square mile. Intersection density measures the internal connectivity and porosity of the network. A high number of intersections per square mile indicates that a roadway network has more options for its users, will be more flexible, and will provide a good basis for the transportation system. This MOE was developed based on a Leadership in Environmental and Energy Design – Neighborhood Develop (LEED-ND) credit. LEED is a building and development rating system developed through the creation and implementation of universally understood and accepted sustainability criteria. The LEED-ND rating system integrates the principles of smart growth, urbanism and green building into a system for evaluating neighborhood design.

Table 7: Intersection Density MOE Analysis

ALTERNATIVE 0 – NO BUILD	ALTERNATIVE 1 – ONE-WAY	ALTERNATIVE 2 – TWO WAY
Intersections: 72 Density: 111 intersections /square mile	Intersections: 69 Density: 106 intersections /square mile	Intersections: 69 Density: 106 intersections /square mile
Same as Existing Conditions	**Slightly Worse than Alternative 0**	**Slightly Worse than Alternative 0**

Table 7 lists the results of this MOE. There are no significant changes in the total number of intersections or intersections per square mile between each alternative; however, there are slightly fewer intersections under alternatives 1 and 2 than under the no build option. The difference is negligible and none of the alternatives reach the 140 intersections per square mile recommended by the LEED-ND rating system. The study area has several super blocks and a large amount of open space, which impacts the number of intersections per square mile. Since each alternative is below the 140 threshold but within a similar range, each alternative has a similar level of connectivity.

The decrease in intersections from Alternative 0 and Alternative 1 and 2 is a result of the elimination of intersections between Fee and Woodlawn along Law Lane. The reduction in the number of intersections does not result in a significant reduction in vehicle circulation or intersection density. Figure 2 shows the change in intersections between Fee and

Woodlawn along Law Lane. Note that the figure shows that Woodlawn Avenue will be connected under both Alternative 1 and 2. This will increase north south connectivity and improve circulation despite the loss of several intersections in this area.

Block Circulation

Under this measure, Gorove/Slade evaluated the clockwise/counter clockwise circulation on block by block basis. This MOE measures the intuitiveness of the roadway grid, and how forgiving the grid is for new/lost drivers. Good circulation reduces overall travel distances, helps disperse traffic better, and allows for easier transit routing.

Table 8: Block Circulation MOE Analysis

ALTERNATIVE 0 – NO BUILD		ALTERNATIVE 1 – ONE-WAY		ALTERNATIVE 2 – TWO WAY	
Circulation	No. of Blocks	Circulation	No. of Blocks	Circulation	No. of Blocks
Complete	25	Complete	6	Complete	24
Clockwise only	6	Clockwise only	15	Clockwise only	6
Counterclockwise only	10	Counterclockwise only	19	Counterclockwise only	10
None	2	None	3	None	3
Same as Existing Conditions		**Worse than Alternative 0**		**Same as Alternative 0**	

Table 8 lists the results for this MOE. The analysis found that there is good block circulation under the Alternative 0 and Alternative 2. Alternative 1 provides the least amount of block circulation of the three alternatives. The one-way pair reduces the circulation of traffic along this corridor and has a significant impact on transit routing. With the two-way pair transit routes can operate in both directions along Law Lane and 10th Street. With a two-way pair, route travel time and walk distances between eastbound and westbound stops are lowest. With a one-way pair, routes would operate eastbound along 10th Avenue and westbound along Law Lane. Transit users would have to walk between these two blocks or beyond depending on their direction of travel and departure/destination point. This may discourage some people from using transit.

Figure 40, Figure 41, and Figure 42 graphically show block circulation for each alternative. The figures also illustrate the different development patterns adjacent to the campus and within the campus. To the west there is a compact grid consistent with traditional urban development patterns, while the north campus area consists of several super blocks.

Bicycle Facility Coverage

Gorove/Slade measured the total linear feet of bicycle lanes and bicycle friendly roadways within the study area to determine the quantity of bicycle facilities for each alternative. The measurement included residential streets, bike lanes, and multi-use trails. Residential streets were included in the evaluation because they typically have low traffic volumes and low traffic speeds. They typically do not require bike lanes because traffic conditions are conducive bicycling.

Table 9 lists the results for this MOE. While there are not significant differences between the three alternatives, Alternative 2 provides the most bicycling facilities. Under Alternative 1, Law Lane would have one bike lane for eastbound bicycle traffic while 10th Street would have one bike lane for westbound bicycle traffic. Under Alternative 2, both Law Lane and 10th Street would have bike lanes on both sides of the street to accommodate two-way bicycle traffic along both corridors. Two-way operation provides more direct routing between travel points and more direct access to travel points along both roadways. Were the one-way alternative selected, bi-direction bike lanes or multi-use trails could be installed to provide two-way bicycle traffic along each one-way corridor.

Table 9: Bicycle Facility Coverage MOE Analysis

ALTERNATIVE 0 – NO BUILD		ALTERNATIVE 1 – ONE-WAY		ALTERNATIVE 2 – TWO WAY	
Type of Facility	Linear Feet	Type of Facility	Linear Feet	Type of Facility	Linear Feet
Residential Street	62,200	Residential Street	54,700	Residential Street	54,700
Bike Lanes	5,900	Bike Lanes	12,700	Bike Lanes	19,500
Multi-Use Trail	1,900	Multi-Use Trail	1,900	Multi-Use Trail	1,900
Total	70,000	Total	69,300	Total	76,100
Density: 20.4 miles/square mile		Density: 20.2 miles/square mile		Density: 22.2 miles/square mile	
Same as Existing Conditions		**Slightly Worse than Alternative 0** ↓		**Slight Improvement** ↑	

Pedestrian Facility Coverage

Gorove/Slade measured the total length of sidewalks for each alternative and developed a density for pedestrian facilities on per square mile basis. The measurement included all sidewalks and multi-use paths and/or trails. Sidewalks and other pedestrian facilities promote walking.

Table 10: Pedestrian Facility Coverage MOE Analysis

ALTERNATIVE 0 – NO BUILD		ALTERNATIVE 1 – ONE-WAY		ALTERNATIVE 2 – TWO WAY	
Type of Facility	Linear Feet	Type of Facility	Linear Feet	Type of Facility	Linear Feet
Sidewalks	52,200	Sidewalks	70,800	Sidewalks	70,800
Off-Street Path	7,600	Off-Street Path	7,600	Off-Street Path	7,600
Total	59,800	Total	78,400	Total	78,400
Density: 17.4 miles/square mile		Density: 22.9 miles/square mile		Density: 22.9 miles/square mile	
Same as Existing Conditions		**Significant Improvement** ↑		**Significant Improvement** ↑	

Table 10 lists the results for this MOE. Both Alternative 1 and 2 show significant improvement in the quantity of pedestrian facilities above the no-build alternative. The majority of the gains result from adding sidewalks along both sides Law Lane where there are existing sidewalks or pathways on one side of the street or none at all.

Pedestrian Levels of Service

Gorove/Slade calculated average wait time for a 'walk' sign at traffic signals. Long wait times decrease the quality of the pedestrian network and increases the amount of jaywalking pedestrians.

Table 11: Intersection Delay – Pedestrians MOE Analysis

ALTERNATIVE 0 – NO BUILD		ALTERNATIVE 1 – ONE-WAY		ALTERNATIVE 2 – TWO WAY	
LOS Grade	No. of crosswalks	LOS Grade	No. of crosswalks	LOS Grade	No. of crosswalks
A	57	A	64	A	61
B	19	B	48	B	55
C	8	C	8	C	8
D	0	D	0	D	0
E	0	E	0	E	0
F	0	F	0	F	0
Same as Existing Conditions		**Improvement**		**Improvement**	

Note: Summation of crosswalk LOS grades for AM and PM commuter peak hours for all crosswalks at traffic signals in study area

Table 11 lists the results for this MOE. Level of service grades were calculated using methodology contained in the Highway Capacity Manual and signal timings from the traffic model described in Appendix A. The higher the letter grade (A) the lower the delay. LOS C indicates an average delay for a 'walk' sign of 30 seconds.

Under Alternatives 1 and 2 there is a significant increase in the total number of crosswalks with LOS A and B. The change is primarily due to the creation of new signalized intersections under Alternatives 1 and 2 and not necessarily improved conditions. The addition of new signalized intersections and stop controlled crosswalks does improve overall pedestrian conditions by providing more crossings that improve walking conditions through campus and street crossing.

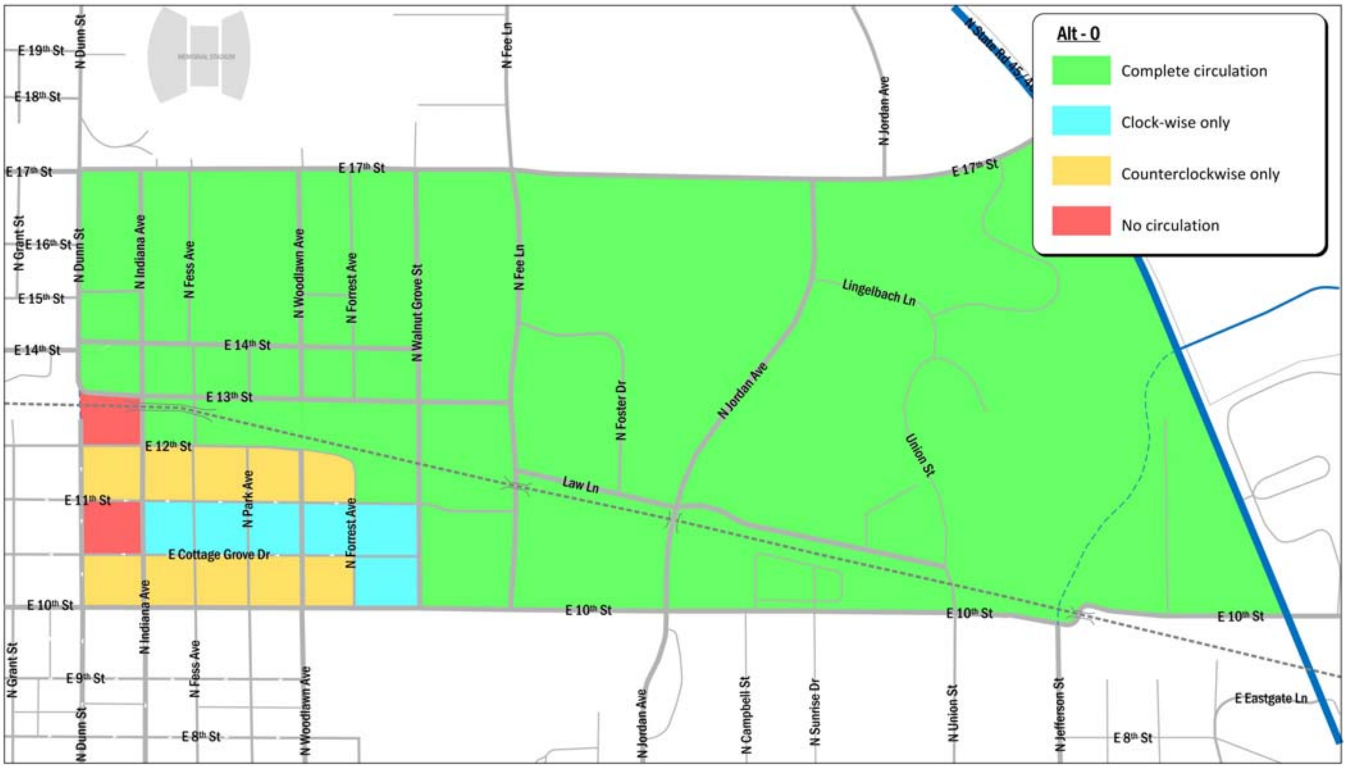

Figure 40: Block Circulation MOE Analysis – Alternative 0

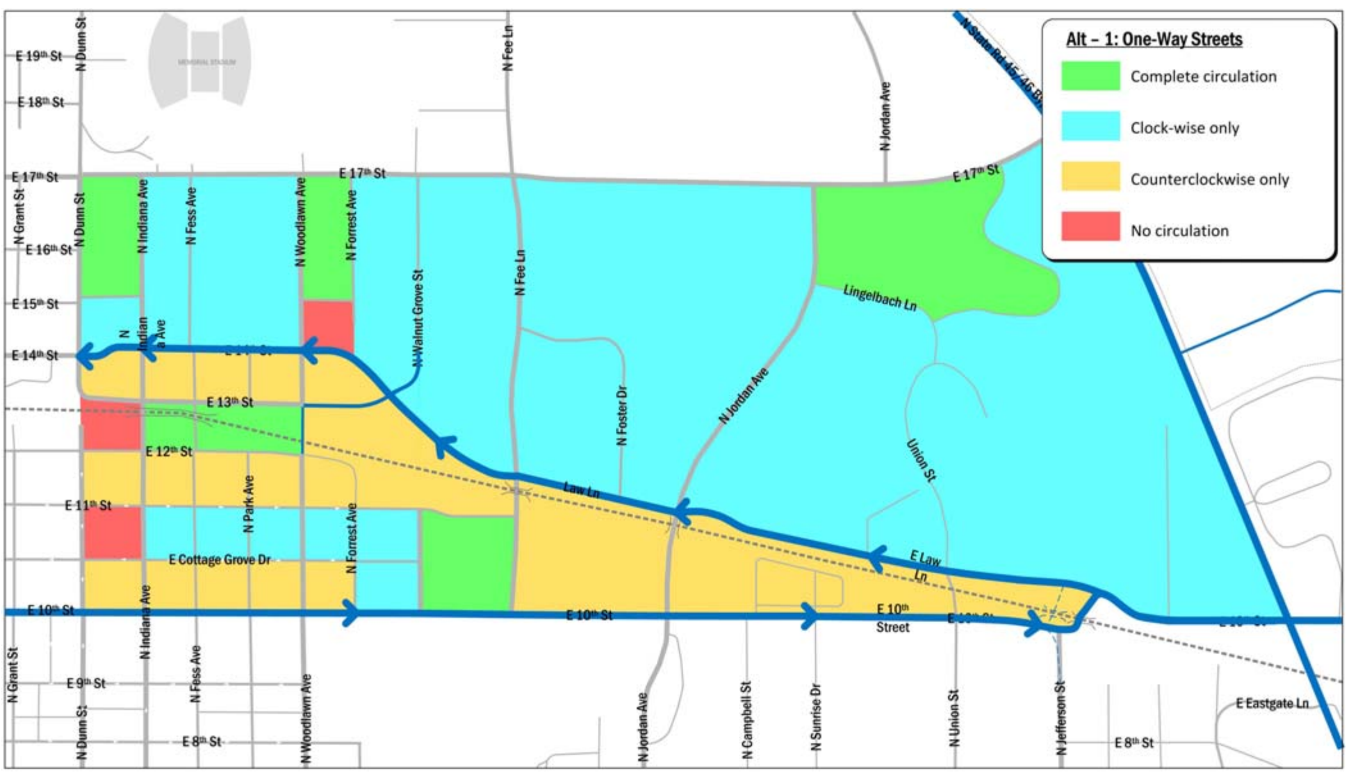

Figure 41: Block Circulation MOE Analysis – Alternative 1

Figure 42: Block Circulation MOE Analysis – Alternative 2