INTERSTATE AND BISMARCK EXPRESSWAY CORRIDOR STUDY FINAL REPORT

November 2006

Prepared for:

Bismarck-Mandan Metropolitan Planning Organization

In Association With:

City of Mandan "Where The West Begins"

Bismarck

NDDOT North Dakota Department of Transportation

URS Transportation

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INTRODUCTION

The primary purpose of the Interstate and Bismarck Expressway Corridor Study was to identify improvements that can be implemented to improve safety and traffic flow within and through the corridors. The general study area is displayed in Figure 1, and includes:

- Bismarck Expressway (ND 810) from the Missouri River to Rosser Avenue
- I-94/I-194/ND 810 from Mandan Avenue to the Missouri River

The Bismarck Expressway on the east side of the Missouri River is a principal arterial that serves as one of the primary east-west travel corridors within Bismarck. A number of retail/commercial developments are located adjacent to this corridor.

On the Mandan side of the Missouri River, the interstate facilities included in this corridor study provide quick and efficient travel within that community, as well as providing connectivity to the Bismarck side of the river. These interstate facilities also handle a fair amount of regional and statewide travel.

This study was conducted through a collaborative effort involving the following agencies/organizations:

- Bismarck-Mandan Metropolitan Planning Organization (MPO)
- City of Bismarck
- City of Mandan
- Burleigh County
- Morton County
- Bis-Man Transit
- North Dakota Department of Transportation (NDDOT)

STUDY PROCESS

The study process employed took into account the technical traffic engineering elements focused on maintain/improving traffic flow with the need to maintain the viability of the surrounding uses. The desired product was an improved roadway corridor that does not substantially impact the sustainability of current corridor activities. The balance was struck by including the public and business interests along the corridor at each of the key study junctures, including:

- Identify current and emerging corridor issues.
- Develop goals and objectives for the corridor.

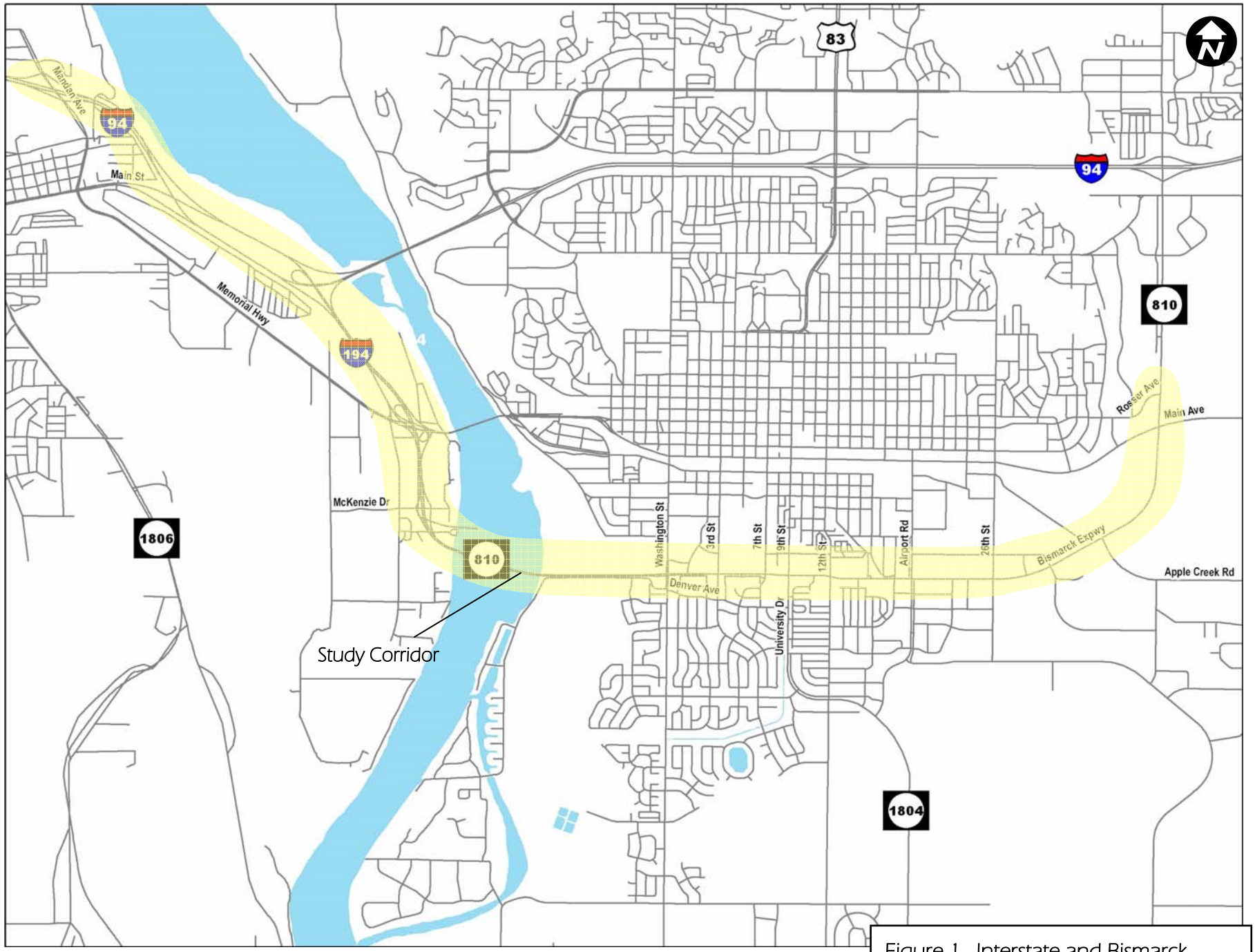

Figure 1. Interstate and Bismarck Expressway Corridor Study Area

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- Evaluation of current conditions.
- Development and evaluation of alternatives to address identified corridor issues.
- Selection of a locally preferred alternatives and development of an implementation plan.

PUBLIC INVOLVEMENT

For this study the consultant team strove for a meaningful public involvement process that supports sound transportation decision-making. This approach attempted to achieve three basic concepts:

- Provide access to information before decisions are final.
- Provide access to information in a number of ways.
- Allow for actual influence over the outcome of the decisions.

The public involvement effort for the Interstate and Bismarck Expressway Corridor Study used a number of face-to-face meetings with all of the key study participants as the principal means of exchanging information throughout the study process. A number of outreach techniques were also incorporated into the public involvement effort.

The public involvement effort for this study involved the following types of meetings:

- Public meetings.
- Staff meetings and workshops involving city, state, and MPO staff.
- Meetings with individual property owners.

The first public meeting was held on October 18, 2005 at the City of Bismarck's Public Works Department. The meeting format was an open house with a brief presentation. Approximately 20 people attended the meeting. The meeting had two primary purposes: 1) introduce the study and the members of the study team, and 2) obtain input from the public on corridor issues. Some of the key issues raised by the public at this meeting included:

- Travel speeds and weaving on I-94.
- Sight distance at the Mandan Avenue and McKenzie Drive interchanges.
- Traffic congestion on Bismarck Expressway.
- Vehicle speeds and safety on Bismarck Expressway.
- Pedestrian safety.

Additional information on these issues is provided in the next chapter.

A second public meeting was held on June 19, 2006 at the City of Bismarck's Public Works Department and on June 21, 2006 at the Mandan City Hall. The meeting format was an open house with a brief presentation. Approximately 35 people attended these meetings. The purpose of the meetings was to provide an update on the study progress, including preliminary improvement concepts for the interchange areas in Mandan and along the corridor in Bismarck.

Attendees to each public meeting were given a comment form on which they could provide their written comments. Additional public comments were also recorded by members of the MPO or the consultant team.

Other avenues available to the public for providing their comments to the study team included the project website: www.bis-manexpressway.com, toll-free phone number for questions ad comments, and the city's website.

Goals, Objectives and Corridor Transportation Issues

Transportation Goals and Objectives

On February 22, 2005 representatives from the Bismarck Planning Department, Bismarck Public Works, Mandan Engineering, the MPO, Bis-Man Transit, Burleigh County, Morton County, and the North Dakota Department of Transportation participated in a workshop in which the following topics were addressed:

- Goals of the Interstate and Bismarck Expressway transportation corridor study.
- Current transportation issues within the corridor.

The workshop was conducted as a facilitated discussion in which each participant was asked to provide, from their particular focused perspective, input on the goals of the study. From the broad range of input, the following goals and objectives were summarized:

- Develop a corridor transportation plan that looks to the future, anticipating increased traffic volume in the corridor, and provides a prioritized action plan to address current and future needs.
  - Objective: Develop 2030 daily and peak hour traffic forecasts that account for development within and adjacent to the corridor and regional expansion.
  - Objective: Based on current and future needs, identify a broad range of concepts that address the identified needs.
  - Objective: Develop a cost constrained prioritized list of multimodal improvements for the Interstate and Bismarck Expressway corridor.
- Establish a corridor that addresses the multimodal transportation needs of the corridor, including autos, trucks, pedestrians, bicyclists and buses.
  - Objective: In developing the prioritized list of corridor improvements, ensure that the needs of vehicles, pedestrians and bicyclists are taken into account.
- Provide a corridor transportation plan that addresses traffic operations, safety for vehicles and non-motorized travelers and corridor efficiency through enhanced access management.
  - Objective: Provide an alternatives analysis/review process that addresses ideas and concepts from a broad range of perspectives.

CORRIDOR TRANSPORTATION ISSUES

Transportation issues within the study corridor were identified as part of the workshop with staff, as part of the initial public information meeting and through technical analysis conducted as part of the corridor study work scope. In general, the issues can be separated into the following categories:

- Development and traffic volume growth: In the corridor area adjacent to 26th Street through Yegen Road there is a substantial level of development programmed that was not incorporated into the regional model as part of the Long Range Transportation Plan. These developments need to be worked into the corridor study forecasts.
- Traffic operations: What is the quality of traffic flow in the corridor relative to the regional level of service C operations threshold?
- Safety: How do the current crash rates within the corridor compare to averages for the type of facility in an urban setting? What actions can be taken to address any observed areas of concern?
- Access management: Are there locations in the corridor where access drives to the adjacent development areas negatively impacts corridor safety and/or traffic operations?

In the staff workshop each of the participants were asked to provide a list of specific or general transportation related issues within the corridor that reflect their particular perspective (i.e. Bis-Man Transit staff were asked to focus on transit needs, but were also encouraged to provide input on safety or land use issues). The information provided by staff and the public is included in the corridor transportation issues summary in Figures 2 through 4.

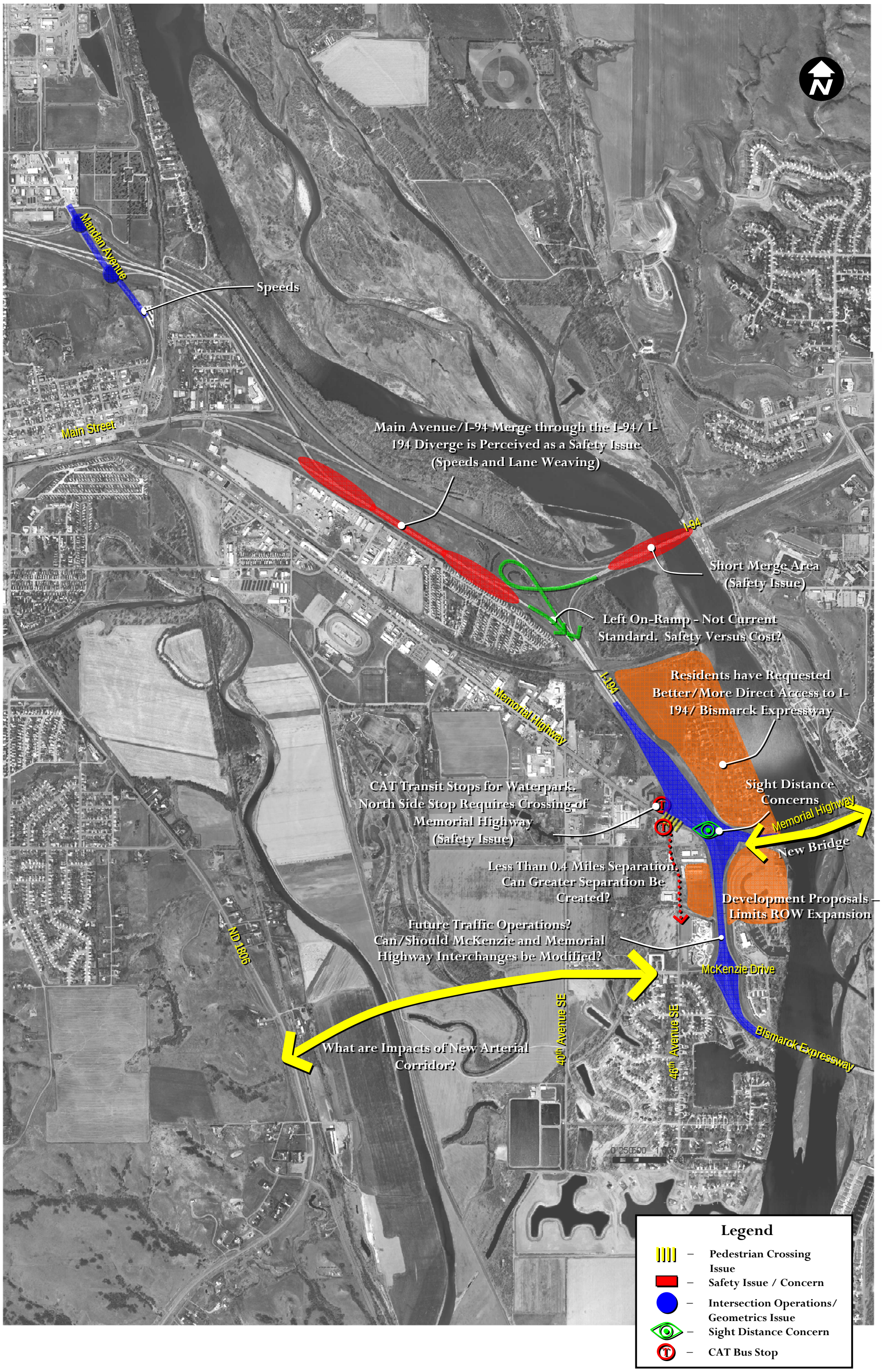

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Figure 2. Corridor Transportation Concerns / Issues - Mandan

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Figure 3. Corridor Transportation Issues and Concerns - Bismarck

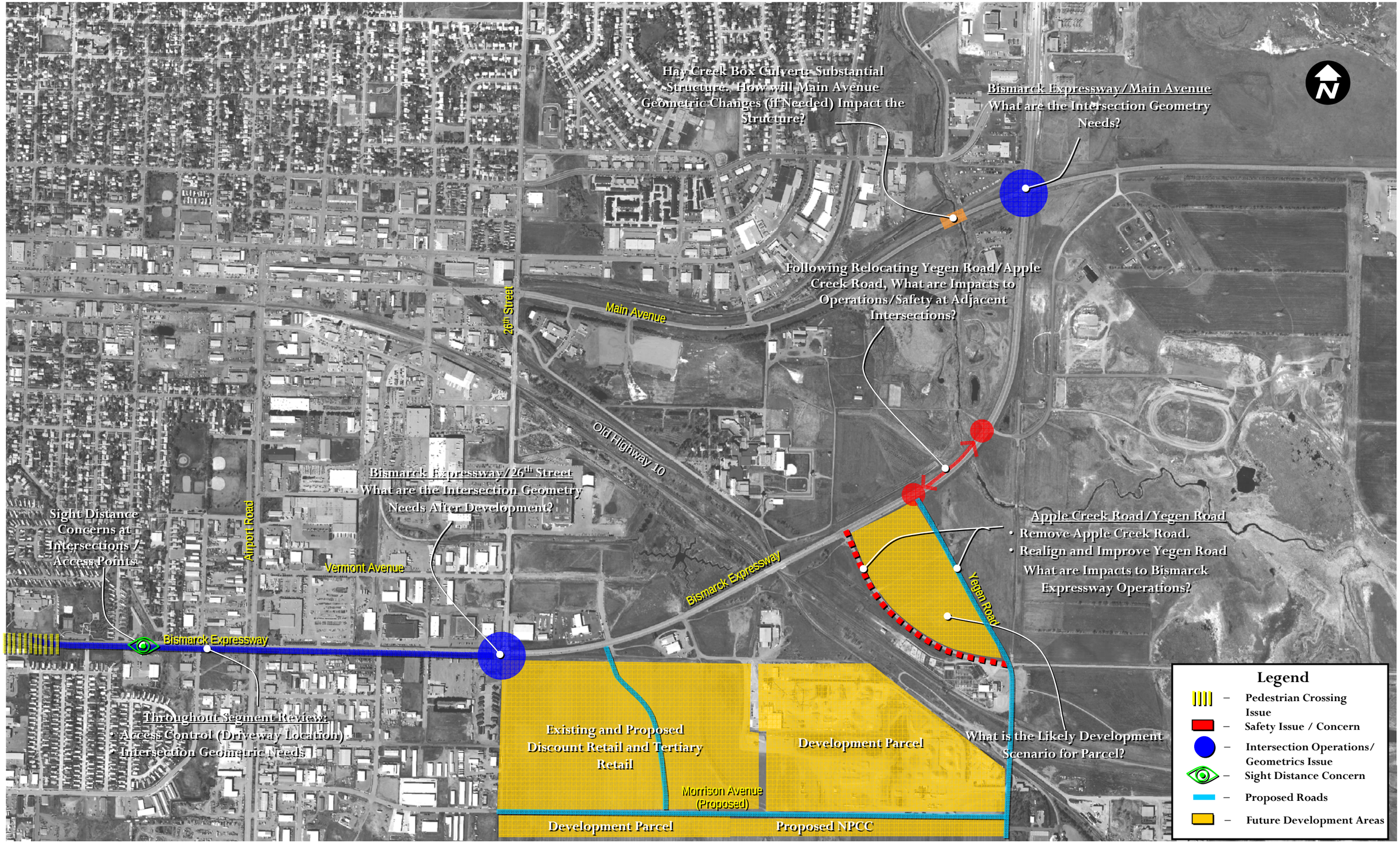

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Figure 4. Corridor Transportation Issues and Concerns - Bismarck

Existing Conditions

The purpose of the Existing Conditions chapter is to provide a summary of the various elements of the transportation system within the Interstate and Bismarck Expressway corridors. Gaining an understanding of the current system is important for the overall corridor improvement planning process in that the existing system forms the underlying foundation of the future system needs. Corridor issues that were investigated as part of this study include the following:

- Traffic volumes in the corridor.
- Roadway network and traffic control.
- Non-motorized facilities within the corridor.
- Transit routes and operations within the corridor.
- Traffic operations analyses methodology.
- Findings of the traffic operations analyses.
- Crash history for the corridor.

The data used for this analysis of existing conditions were primarily provided by the Cities of Bismarck and Mandan, the North Dakota Department of Transportation (NDDOT), and the Bismarck-Mandan MPO. Field reviews to supplement the database information were conducted by consultant team personnel.

Traffic Data

Intersection hourly turning movement volumes used for this study were provided by the City of Bismarck. Average annual daily traffic (AADT) volumes were taken from the *2001Bismarck / Burleigh County Traffic Volume Map* that is produced by the North Dakota DOT current volumes. AADT volumes are provided in Figures 5 and 6.

URS staff developed estimates of existing peak hour traffic west of the Missouri River based on available traffic data. The available traffic count information was limited to:

- Daily traffic counts on all I-94/I-194/Bismarck Expressway segments, ramps and cross-streets (North Dakota Department of Transportation Counts).
- AM peak hour counts of eastbound traffic on Main St, I-94 and I-194 segments completed during the URS/Houston license plate survey.
- AM and PM counts of the Memorial Bridge traffic (City of Bismarck Counts).
- AM and PM counts of the Bismarck Expressway Bridge (City of Bismarck Counts).

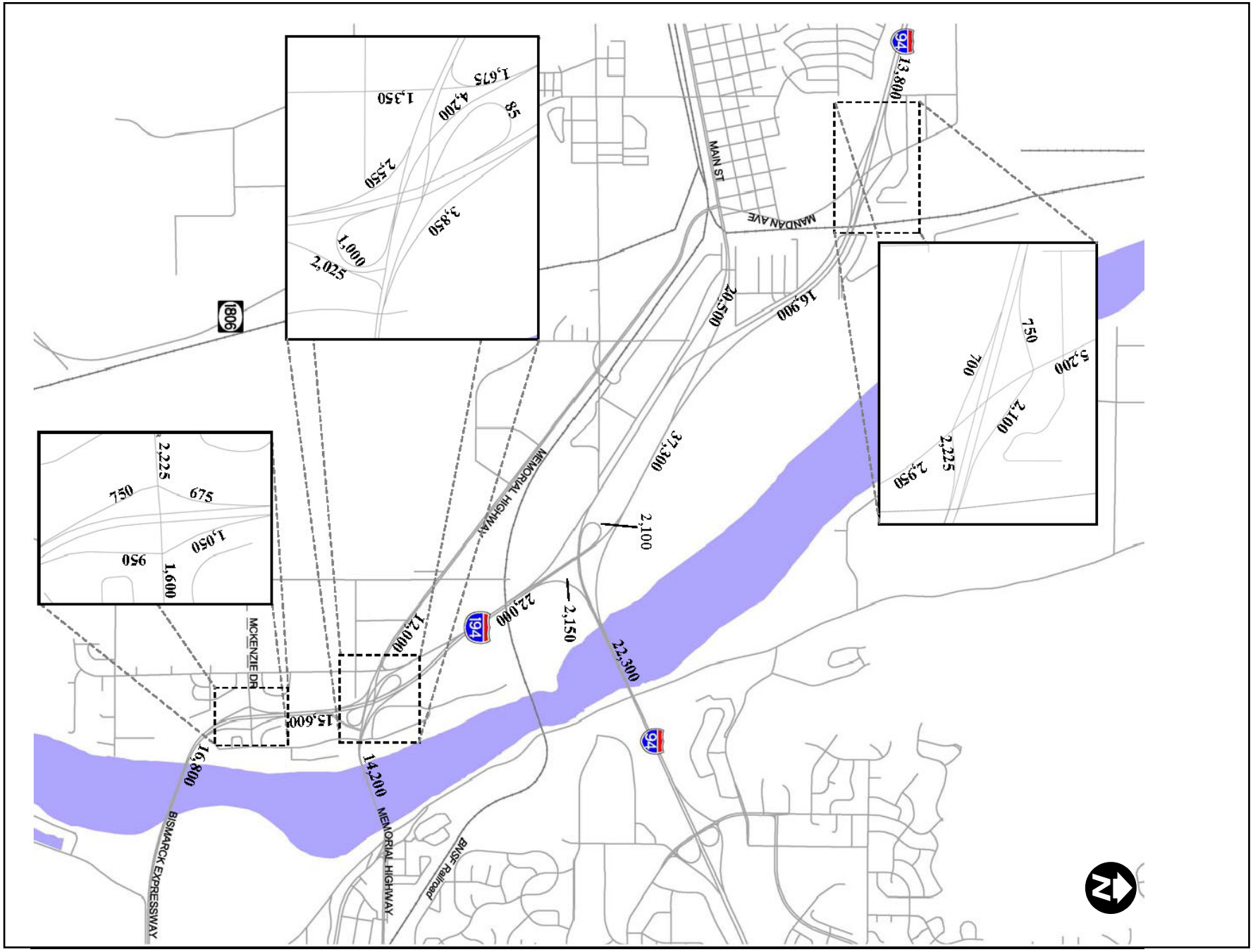

Figure 5. Existing (2001) Average Daily Traffic Volumes West of Missouri River

Source: 2001 Bismarck/Burleigh County Traffic Volume Map, NDDOT

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Figure 6. Existing (2001) Average Daily Traffic Volumes East of Missouri River

URS estimated peak hour traffic volumes using the counted segments as "anchor points". The peak hour characteristics of traffic at these locations (such as percentage of daily traffic occurring during the peak, directional split of peak hour traffic) were evaluated and applied to the remainder of the study area west of the Missouri River. Knowledge of current land uses and general traffic patterns on similar facilities within the Bismarck-Mandan area were applied while developing these estimates. Existing peak hour traffic volumes for the corridor west of the Missouri River are included in Figures 7 and 8.

Intersection turn movement counts for study area intersections on the east side of the Missouri River were conducted by the City of Bismarck between 2000 and 2002. Most of these turn movement counts were completed in either 2000 or 2001. These counts were collected throughout the year, which results in some differences in traffic volumes between adjacent intersections. These differences were adjusted during a "smoothing" process in order to develop more consistent turn movement volumes between up and downstream intersections.

A supplemental turn movement count was conducted on April 28, 2005 at the Bismarck Expressway and Kirkwood Mall/Bozeman Drive intersection. This count was undertaken to get a better understanding of the amount of traffic accessing Kirkwood Mall via this access point. Estimated turn movement volumes were developed for the intersections of Bismarck Expressway/2nd Street and Bismarck Expressway/Main Avenue. Intersection turn movement volumes for the Bismarck Expressway east of the Missouri River for the morning and afternoon peak hours are provided in Figures 9 and 10.

I-94 Travel Survey

Some members of the public viewed eastbound I-94 between the Main Street (Mandan) on-ramp and the I-194 off-ramp as congested and unsafe, particularly during the morning peak period. This segment of I-94 has three travel lanes for eastbound traffic and vehicles entering from Main Street must reach the center lane in order to continue on eastbound I-94 across the river. A license plate survey was conducted to document the traffic patterns in between these two interchanges.

This origin-destination study was conducted by collecting vehicle data from 6:30 AM to 8:30 AM on August 10, 2005. Three travel survey stations and one count station, which are displayed in Figure 11, were established so that traffic traveling between the interchanges could be matched. For each vehicle that passed a station, the following information was recorded:

- License plate number, including whether plate was in-state or out-of-state.
- Vehicle type, whether light vehicle (car, pickup, SUV, etc.) or heavy commercial truck.
- Time period, by five-minute interval.

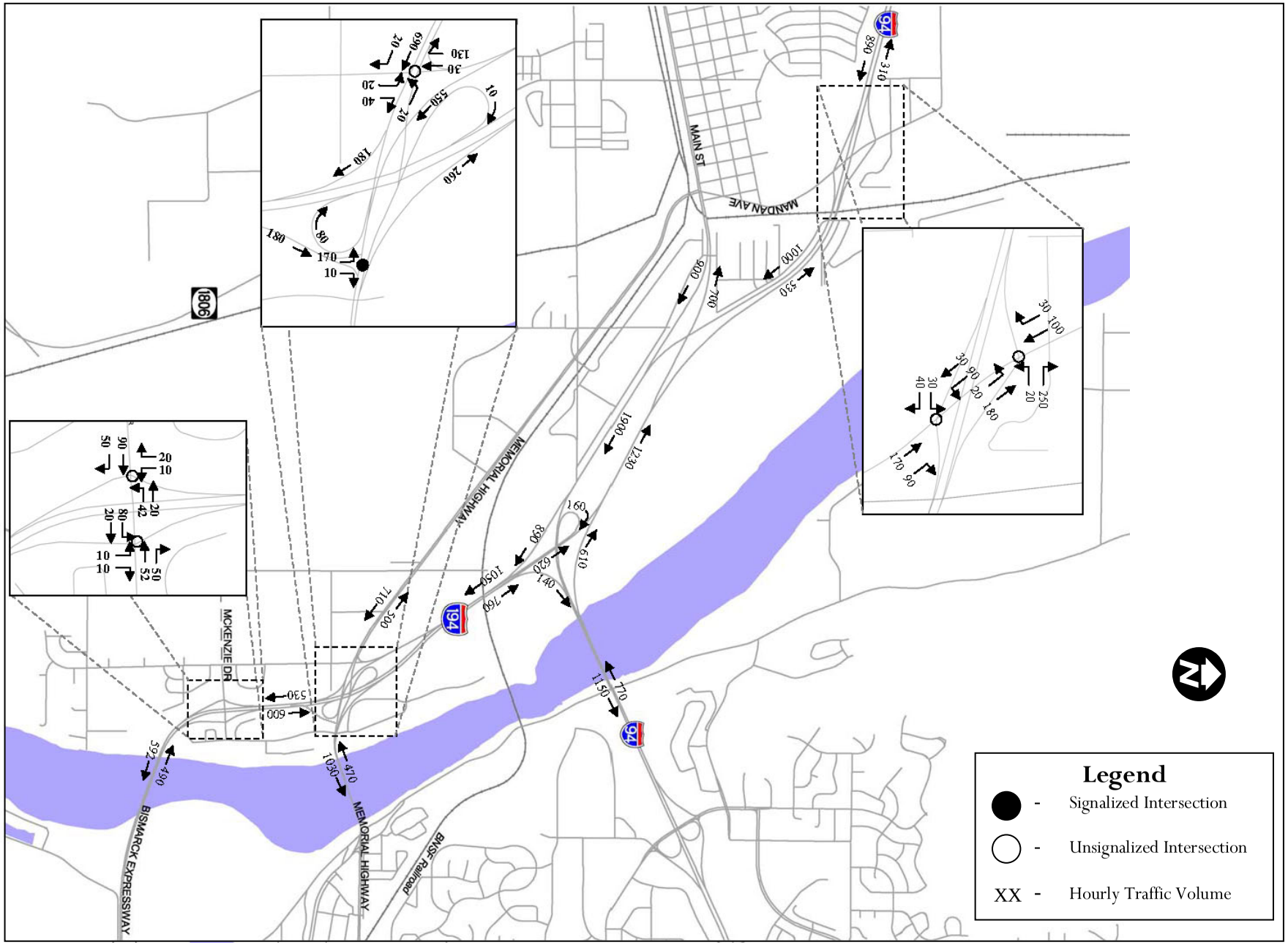

Figure 7. Existing Morning (AM) Peak Hour Volumes West of Missouri River

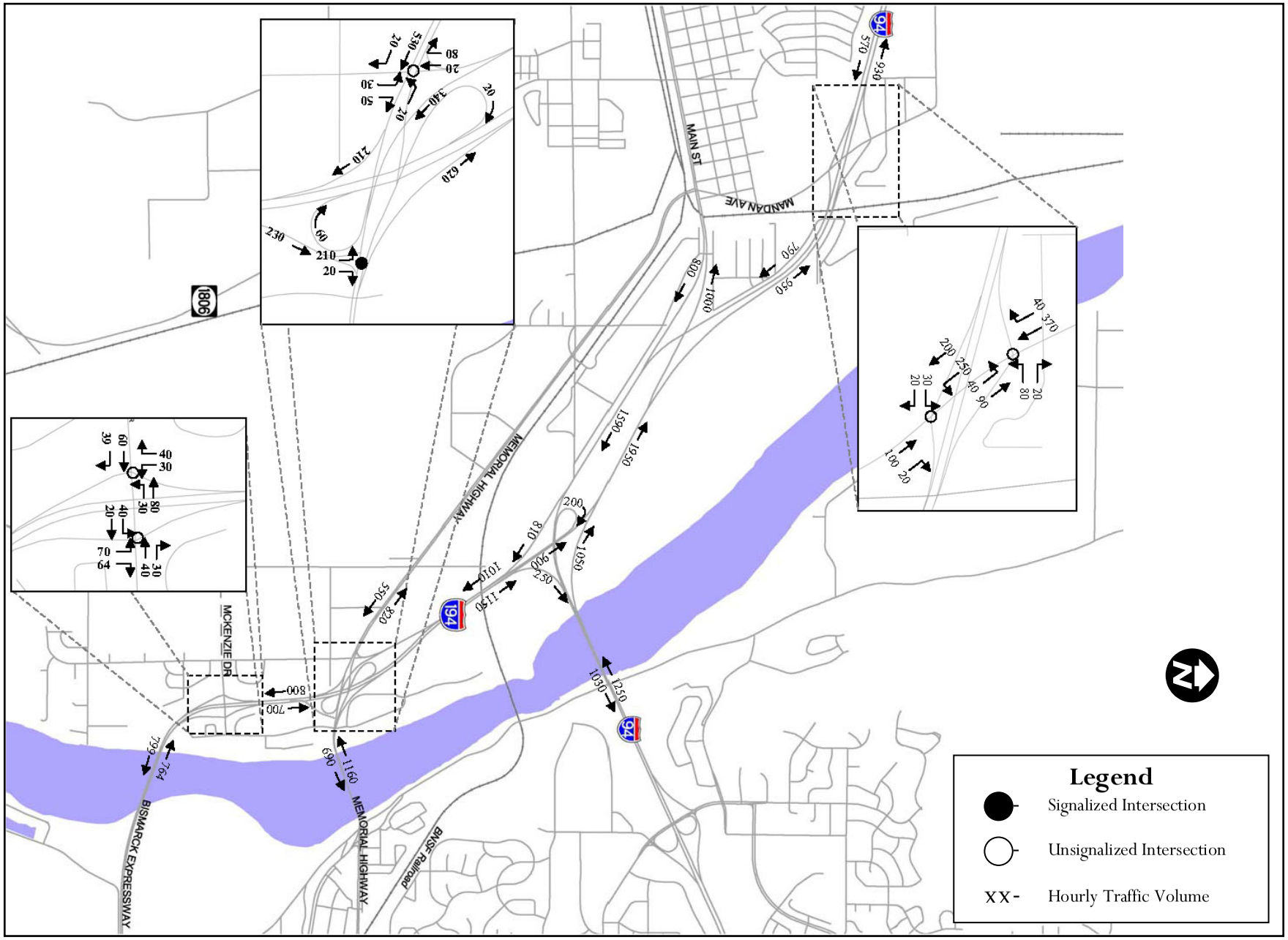

Figure 8. Existing Afternoon (PM) Peak Hour Volumes West of Missouri River

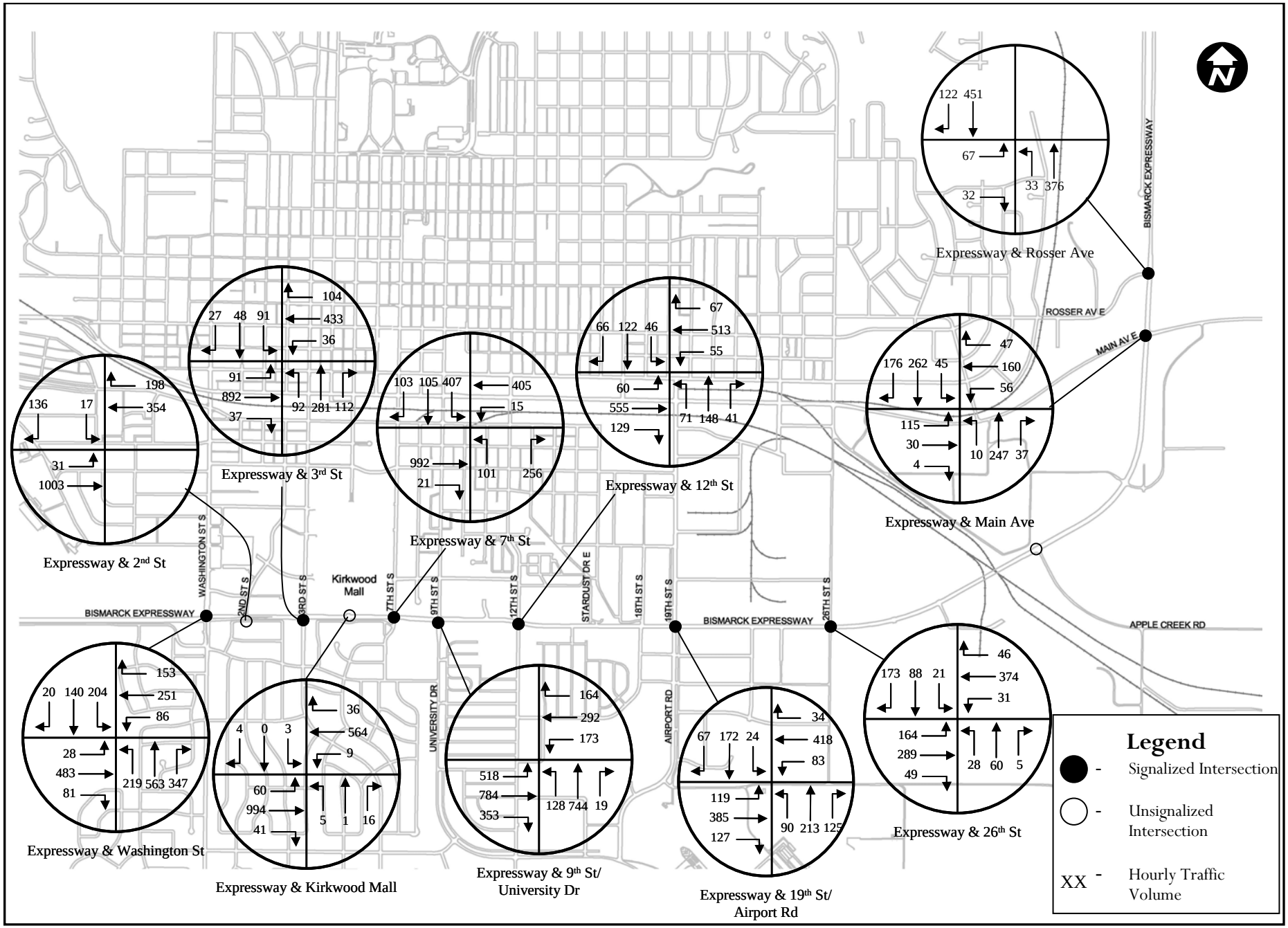

Figure 9. Existing Morning (AM) Peak Hour Volumes East of Missouri River

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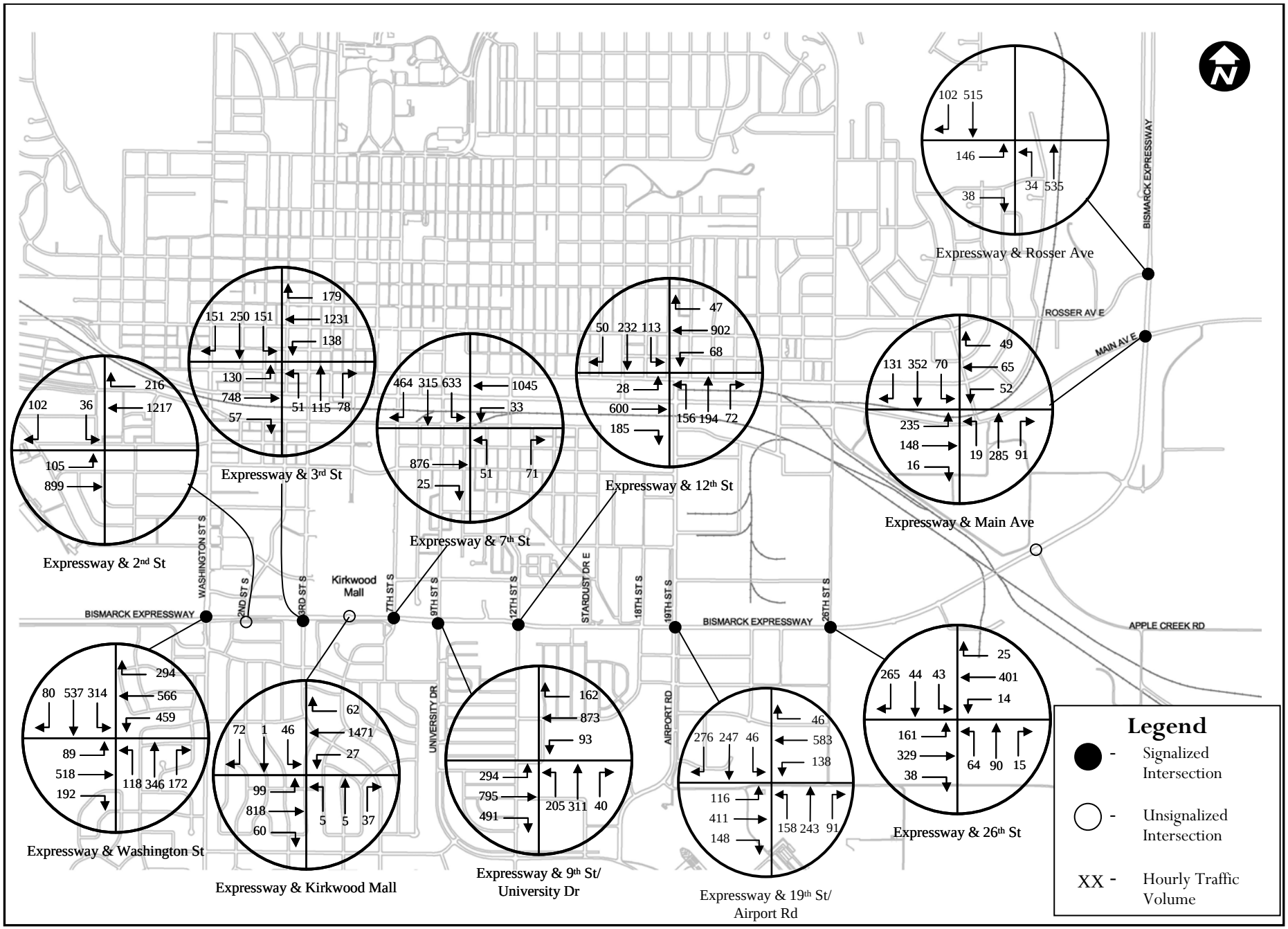

Figure 10. Existing Afternoon (PM) Peak Hour Volumes East of Missouri River

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Figure 11. I-94 Travel Survey Study Area and Survey Stations

Data on over 4,500 vehicles was collected during the survey period. Due to this large amount of data, it was necessary to create a database with the recorded license plate data to match license plates between survey stations. When the same license plate was matched at two different stations within a five minute interval of time, it was assumed that the vehicle had traveled between the two stations and the station pair would be recorded as a match. All of the matches between each origin-destination pair were then summed.

The surveyed roadway is a limited access roadway such that all traffic entering at Stations A and B must leave at Stations C and D without a stop. Thus, license plate data was collected at Stations A, B and C. There was not a safe location for a survey crew at Station D, so license plate data was not collected at this location. Instead, traffic volume was counted at Station D, but no license plate data was collected. However, the matches to Station D were effectively determined by comparing the license plate matches to Station C and the vehicle counts at all four stations; because the studied segment is limited access, observed vehicles that passed Stations A and B that were not matched to Station C most likely had to be destined for Station D.

The high levels of traffic and the presence of vehicle platoons did not allow for 100 percent data capture. Thus, the amount of traffic matched between stations was adjusted according to the proportion of vehicles that were fully recorded at each station, defined as the station capture rate. Through the method applied, the matches that were captured between each station were expanded to include the entire volume of vehicles for that station-to-station pair. This level of adjustment was equal to the percentage of vehicles captured at one station multiplied by the percentage of vehicles captured at the other station. For example, if 90 percent of all vehicles were recorded at two stations, the amount of matches recorded between the two of them is expected to be 81 percent of all actual matches (0.90 x 0.90 = 0.81)[1]. The resulting number of matches is a statistically acceptable estimation of the number of matches between each station for the two-hour collection period.

The percentage of license plates captured at each station is documented in Table 1. Vehicles were counted as "captured" when at least three digits of the license plate had been recorded. The average license plate capture percentage for all three stations was 90.7 percent. Typical reasons for a missed license plate or a partially recorded plate include:

- Large platoons of fast-moving vehicles causing one or more plates to be only partially recorded.
- Obscured plate information.
- Plates that were not displayed.
- Small letters/numbers on the license plate (e.g., motorcycle, trailer).

[1] This method is consistent with accepted practice for origin-destination studies, as described in Traffic Engineering by McShane and Roess, 1997.

TABLE 1: LICENSE PLATE CAPTURE PERCENTAGE AT SURVEY STATIONS

Station	Direction	Percentage of Plates Captured
A	Inbound	88.4%
B	Inbound	91.6%
C	Outbound	91.9%

Persons staffing survey stations marked an "X" on the data sheets to indicate a vehicle passed their station when they could not fully record that vehicle's information. It should be noted that the portion of license plates with full information recorded represents a statistically significant sample of total traffic at all three stations. As discussed above, the final estimates of peak hour traffic patterns were calculated by applying the capture rate adjustment. The capture rate calculation is based on the equation:

$$CR_{ij} = \frac{1}{(Cap\%_i \times Cap\%_j)}$$

where:

CR_{ij} is the capture rate adjustment for the origin-destination pair,

$CAP\%_i$ is the percentage of license plates captured at the origin station, and

$CAP\%_j$ is the percentage of license plates captured at the destination station.

For instance, the capture rate adjustment for matched trips between Station A and Station C was 1.231, based on the following calculation $\frac{1}{(0.884 \times 0.919)} = 1.231$.

Table 2 documents the unadjusted vehicle matches, the station pair capture rate adjustment factor and the estimated 2-hour origin-destination volumes by station pair.

TABLE 2: SURVEY COUNT DATA AND ORIGIN-DESTINATION ESTIMATES

Station Pair	2-Hour Unadjusted Vehicle Matches	Capture Rate Adjustment	2-Hour Estimated Traffic	AM Peak Hour Estimated Traffic
A-C	535	1.231	680	400
B-C	681	1.188	810	490
A-D*	N/A	N/A	800	500
B-D*	N/A	N/A	840	510
Total			3,130	1,900

* Note: For safety reasons, license plate data were not collected at Station D. Estimates are based on license plate data recorded at the other three stations and vehicle counts taken at Station D.

INVENTORY OF THE CORRIDOR

ROADWAY FACILITIES

The corridor within the study area consists of two distinctive segments located on either side of the Missouri River. On the west side of the Missouri River, the corridor consists of freeway segments that include portions of I-94, I-194, and ND 810. On the east side of the Missouri River, the corridor is an urban arterial designated the Bismarck Expressway. The following sections describe the functional classification, roadway/interchange /intersection geometry, and the current traffic control for these two segments of the corridor.

Mandan Portion of the Corridor

This corridor serves as a key east/west transportation corridor within and through the City of Mandan and Morton County. The corridor connects to the three bridges that link the cities of Mandan and Bismarck. The roadways within this portion of the study area are classified as follows:

- I-94: Interstate
- I-194: Interstate
- ND 810: Principal Arterial
- McKenzie Drive, west of ND 810: Minor Arterial
- Memorial Highway, west of ND 810: Minor Arterial
- Memorial Highway, east of ND 810: Principal Arterial
- Main Street: Principal Arterial
- Mandan Avenue: Principal Arterial

Source: Bismarck Mandan MPO Functional Classification Network map (2004)

The freeway segments typically have four travel lanes through this corridor with the exception of two segments that have six lanes. Those segments are I-94 between the

Main Street and I-194 interchanges and ND 810 between the Memorial Highway and McKenzie Drive interchanges. The third lanes in each direction along ND 810 between the Memorial Highway and McKenzie Drive interchanges are auxiliary lanes that begin or end at the ramp junction. The Memorial Highway and McKenzie Drive interchanges are located within close proximity of one another and this results in weaving segments in between the interchanges. Another weaving segment is located along westbound I-94 between the I-194 and Main Street interchanges. There is a perception of congestion caused by weaving vehicles on eastbound I-94 between the Main Street and I-194 interchanges, however, this segment is technically not a weaving segment because the ramps are more than a ½-mile apart.

There are five interchanges within this portion of the corridor. A brief summary description of each interchange is provided below.

- McKenzie Drive
  - A diamond type interchange with ND 810 going over the top of McKenzie Drive.
  - Each ramp has a single lane and the southbound off-ramp and the northbound on-ramp are quite short (500 feet long).
  - The southbound on-ramps and the northbound off-ramp are located within close proximity to the ND 810 (Bismarck Expressway) Missouri River bridge and the merge/diverge points are located on a horizontal curve.
  - Vehicles using the on-ramps have reduced sight distance due to the upgrade on the ramps.
  - The intersections utilize stop sign control.
  - McKenzie Drive is a two-lane undivided roadway with no turn lanes provided at the ramp terminal intersections.
- Memorial Highway
  - A partial cloverleaf type interchange with a direct ramp for the southbound to eastbound movement. ND 810/I-194 goes over the top of Memorial Highway.
  - Loop ramps are used for the westbound to southbound and eastbound to northbound movements in order to eliminate the need for left-turn lanes on Memorial Highway.
  - The Memorial Highway interchange east intersection is located approximately 700 feet west of the Missouri River.
  - The east (northbound) intersection is controlled by a traffic signal, however, the heavy westbound to northbound traffic movement employs a free right-turn and is not controlled by the traffic signal.
  - The west (southbound) intersection utilizes stop sign control.
  - Memorial Highway is a five-lane roadway west of the interchange and is currently two-lanes east of the interchange. The Memorial Highway bridge over the Missouri River is scheduled to be reconstructed as a four-lane facility.

- I-94/I-194:
  - This is a three-leg, full-directional system interchange that has two levels (single structure).
  - The westbound I-94 to southbound I-194 ramp utilizes a loop ramp that creates a left-hand on-ramp at the I-194 ramp junction.
  - The northbound I-194 to eastbound I-94 ramp has a single lane while other ramps at this interchange have two lanes, although the northbound I-194 to westbound I-94 ramp tapers down to a single lane before reaching the I-94 ramp junction.
- Main Street:
  - This is a three-leg, full-directional interchange that has two levels (single structure).
  - The westbound I-94 to westbound Main Street ramp has two lanes. The eastbound Main Street to eastbound I-94 also has two lanes, which tapers down to a single lane prior to the I-94 ramp junction.
  - Main Street is the primary east-west arterial within the community of Mandan and Main Street has a five-lane cross section west of the I-94 interchange.
- Mandan Avenue:
  - A diamond type interchange with I-94 going over the top of Mandan Avenue.
  - There is a significant skew angle between the I-94 and Mandan Avenue alignments.
  - Each ramp has a single lane and the eastbound ramp is quite short (650' long) due to it's proximity to the I-94 bridge over the railroad.
  - Vehicles using the on-ramps have reduced sight distance due to the upgrade on the ramps.
  - The intersections utilize stop sign control and short left-turn lanes are provided for the off-ramp traffic.
  - Mandan Avenue is a two-lane undivided roadway with no turn lanes provided at the ramp terminal intersections.

Bismarck Portion of the Corridor

The Bismarck Expressway serves as a key east/west transportation corridor within Bismarck. In addition to serving an important transportation function, this corridor also serves as a primary commercial district with the city. The roadways within the study area are classified as follows:

- Bismarck Expressway: Principal Arterial.
- Washington Street: Minor Arterial.
- 3rd Street, north of Bismarck Expressway: Minor Arterial.
- 3rd Street, south of Bismarck Expressway: Collector.
- 7th Street, north of Bismarck Expressway: Principal Arterial (one-way pair).
- 7th Street, south of Bismarck Expressway: Local Street.

- 9th Street, north of Bismarck Expressway: Principal Arterial (one-way pair).
- University Drive, south of Bismarck Expressway: Principal Arterial.
- 12th Street: Collector.
- 19th Street/Airport Road: Minor Arterial.
- 26th Street: Collector.
- Apple Creek Road: Minor Arterial.
- Main Avenue, west of Bismarck Expressway: Principal Arterial.
- Main Avenue, east of Bismarck Expressway: Minor Arterial.
- Rosser Avenue: Minor Arterial.
- Denver Avenue, Washington Street to 9th Street: Collector.
- All other streets within the study area are classified as local streets.

Source: Bismarck Mandan MPO Functional Classification Network map (2004)

The posted speed limit along Bismarck Expressway is 40 mph from Washington Street to approximately Apple Creek Road and increases to 50 mph northeast of Apple Creek Road. The speed limit on most of the other major roadway segments within the study area is 35 mph with a few signed for 25 mph.

A summary of the existing lane configurations at the major study area intersections within the study area is provided in Table 3.

TABLE 3: INTERSECTION LANE CONFIGURATION

Intersection	Intersection Approach (1)			
	Eastbound	Westbound	Northbound	Southbound
Bismarck Expressway / Washington St (2)	L, T, T,T, R	L, L, T, T, R	L, L, T, T, R	L, L, T, T, R
Bismarck Expressway / 2nd St	L, T, T	T, T, R	- -	L, R
Bismarck Expressway / 3rd St	L, T, T, R	L, T, T, R	L, T, TR	L, T, TR
Bismarck Expressway / Mall	L, T, TR	L, T, T, R	LTR	LT, R
Bismarck Expressway / 7th St	T, TR	L, T, T	L, R	L, L, T, R
Bismarck Expressway / 9th St	L, T, T, R	L, T, T, R	L, T, T, R	- -
Bismarck Expressway / 12th St	L, T, TR	L, T, TR	L, TR	L, TR
Bismarck Expressway / 19th St / Airport Rd	L, T, TR	L, T, TR	L, T, TR	L, T, TR
Bismarck Expressway / 26th St	L, T, TR	L, T, TR	LTR	L, T, R
Bismarck Expressway / Apple Creek Rd	T, TR	L, T, T-	LR	- -
Bismarck Expressway / Main Ave	L, TR	L, TR	L, T, TR	L, T, TR
Bismarck Expressway / Rosser Ave	L, R	- -	L, T, T	T, T, R

Notes:
(1) L= Left-turn lane; T = Through lane; R = Right-turn lane; LT, LR, TR, LTR = Shared lanes
(2) Third eastbound through lane drops approximately 150 east of intersection and is not utilized much by through traffic.

All other intersection approaches within the study area consist of a single-lane. Most of the turn-lanes appear to have adequate storage capacity to meet demand. Inadequate storage was noted during field observations for the eastbound left-turn movements at Bismarck Expressway/xpressway/9th Street for a short period of time during the AM peak hour. In the two-block segment separating the 7th and 9th Street intersections the two left-turn lanes are placed back-to-back. This results in a relatively short left-turn lane for the 9th Street left-turn movement and spillover into the adjacent through lane is a common occurrence during peak periods.

Signalized intersections within the Bismarck portion of the corridor include:

- Bismarck Expressway/Washington Street.
- Bismarck Expressway/3rd Street.
- Bismarck Expressway/7th Street.
- Bismarck Expressway/9th Street & University Drive.
- Bismarck Expressway/12th Street.
- Bismarck Expressway/19th Street & Airport Road.
- Bismarck Expressway/26th Street.
- Bismarck Expressway /Burlington Drive (Wal-Mart).
- Bismarck Expressway/Main Avenue (Business 94).
- Bismarck Expressway/Rosser Avenue.

All other intersections and access points along Bismarck Expressway utilize two-way stop sign control. During the morning and afternoon peak periods, a 90 second signal cycle is utilized, with the exception of Washington Street, where a 100 second cycle is used. Along Bismarck Expressway a 60/40 or 55/45 timing split in favor of Bismarck Expressway traffic is used at most of the intersections. Signal timing splits are the relative amount of green time for a particular direction of travel relative to the cycle length. The 7th Street and Expressway intersection utilizes split timing for the north/south movements (i.e., the northbound and southbound traffic move during separate traffic signal phases and not at the same time).

Most of the signalized intersections listed above utilize some form of left-turn phasing. A few intersections (e.g., Washington Street) have protected only left-turn phasing, while most use protected/permitted left-turn phasing. Many of the Bismarck Expressway intersections with right-turn lanes prohibit right-turns on red.

There are two primary signal coordination systems within the study area. One system is located along Washington Street and the other is along Bismarck Expressway. The Bismarck Expressway signal system includes each of the intersections between 3rd Street and 12th Street.

PAVEMENT CONDITION

Annually the NDDOT completes an assessment of the condition of the pavement along the state system, which includes all of the Interstate and Bismarck Expressway Corridor Study area. The purpose of the review is to document the quality of the facilities and obtain information that the Department uses in setting schedules for maintenance of the entire system. Through the annual assessment the Department gathers the following information:

- Cracking: The Department has established a broad range of definitions of various types of cracks. The range of definitions is needed because cracks in different locations and directions on the pavement impact the potential for degradation in different ways and different types of cracks are more prevalent on some surface types relative to others.
- Presence of evidence of separation of the asphalt mix. Over time, the component of the asphalt mix tend to separate, which reflects conditions where the surface is becoming unstable. Evidence of this condition, referred to as bleeding, is a shiny surface.
- Patching: The percent of a segment that has been patched is recorded.
- Rutting: The presence and depth of ruts in the pavement is measured and monitored over time.
- Weathering of the pavement edge: The Department reviews the quality of the edge of the pavement to determine the level of loss in a clean edge. The level of loss of a clean edge is referred to as raveling.

Using measurement values for each of the categories listed, the Department creates a composite description of the pavement condition and has established a descriptive scale from Excellent to Poor. It is the Department's goal to minimize the mileage of facilities that fall into the Poor category and strives to maintain a minimum goal of ######

Current pavement conditions along the major facilities in the corridor are documented below:

- I-94: Mandan Avenue to I-94 –
- I-194: I-94 to Memorial Highway –
- ND 810: Memorial Highway to McKenzie Drive –
- ND 810 (Bismarck Expressway): McKenzie Drive to Washington Street – Poor
- ND 810 (Bismarck Expressway): Washington Street to 26th Street – Poor
- ND 810 (Bismarck Expressway): 26th Street to Rosser Avenue -

Non-Motorized Facilities

The Bismarck Expressway corridor includes multi-use trails and sidewalks from the Missouri River to approximately 18th Street. The sidewalk and trail system for Bismarck Expressway is shown graphically in Figure 12. A summary of the sidewalks and trail facilities in this segment of Bismarck Expressway is provided below.

- A sidewalk is provided on the north side of Bismarck Expressway and a multi-use trail is provided on the south side in this segment.
- The sidewalks and trails are typically setback from the back of curb through the use of planter strip. This planter strip creates a buffer between automobile and non-motorized users.
- The sidewalks and trails are in good condition and ADA ramps are provided at the intersections along Bismarck Expressway.
- The limited number of intersections and driveways in this section of Bismarck Expressway decreases the number of conflict points between pedestrians/bicyclists and automobiles.

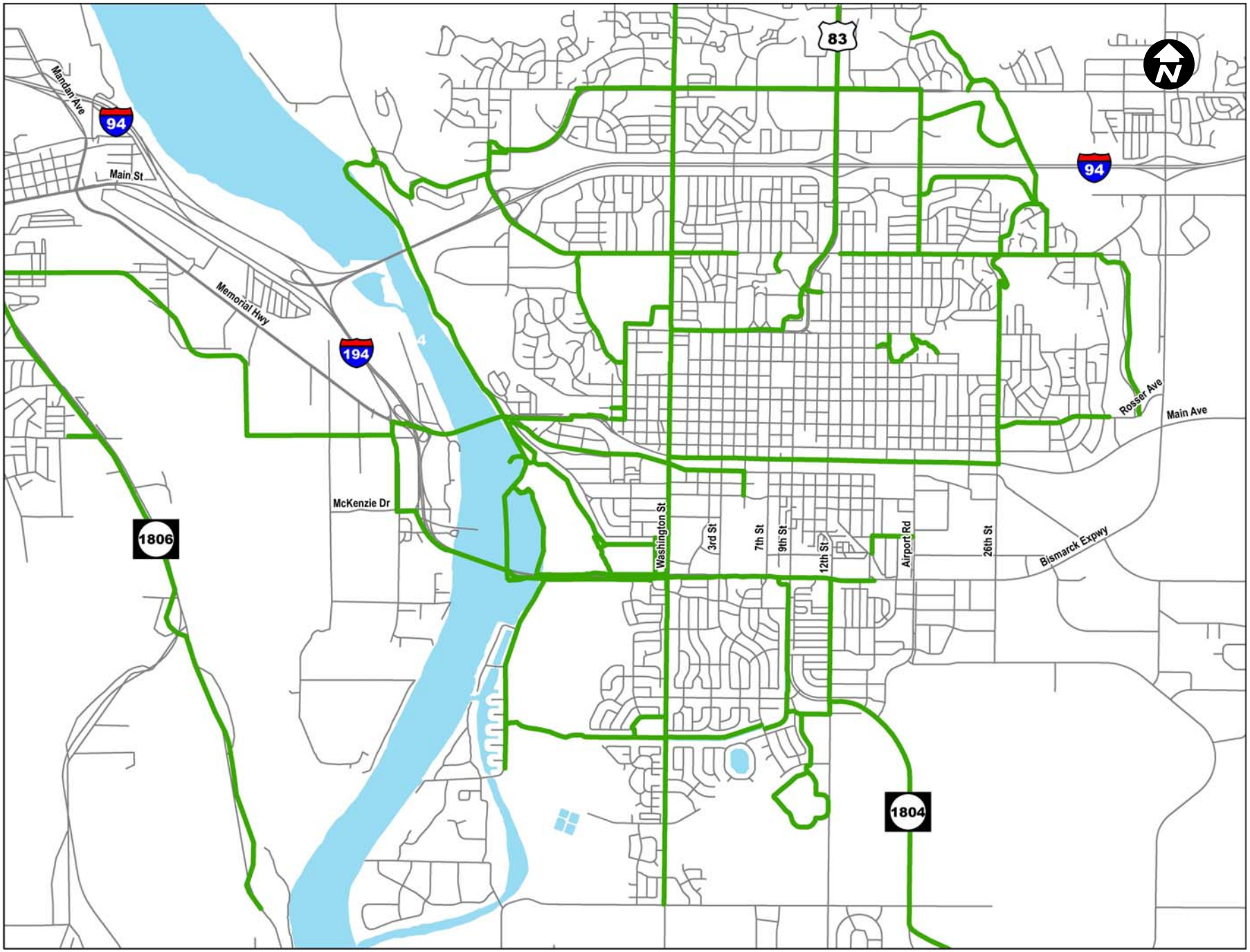

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Figure 12. Existing Multi-Use Trails

- All of the north-south cross streets that intersect with Bismarck Expressway in this segment have sidewalks or multi-use trails.
- Pedestrian activated push button and walk signals are provided at all of the signalized intersections along this segment. At some intersections, the pedestrian will not get a 'walk' signal if they do not push the pedestrian button.
- A school crosswalk is provided at 12th Street for Jeannette Myhre elementary. Crossing guards are on duty at this location before and after school.

East of 18th Street there are no pedestrian facilities provided along Bismarck Expressway. This segment of Bismarck Expressway includes small offices, small retail, industrial uses, considerable vacant land poised for development, and large retail establishments, also known as "big box retail" (e.g., Home Depot, Wal-Mart, Target, etc.). The fairgrounds and State Penitentiary are also located along this portion of the corridor. The recent addition of big box retail in the southeast quadrant of 26th Street could lead to more pedestrian/bicycle demand along the portion of the Bismarck Expressway corridor east of 19th Street.

A multi-use trail is provided along Hay Creek north of Rosser Avenue and runs parallel to Bismarck Expressway. A sidewalk is provided along most of Rosser Avenue between this trail and 26th Street. Another sidewalk is provided from this trail over to Bismarck Expressway along Rosser Avenue. The multi-use trails along this corridor experience a fair amount of usage. Field observations found pedestrian activity along and crossing Bismarck Expressway throughout the day. There is a large number of homes in close proximity to Bismarck Expressway between Washington Street and 18th Street and this has the potential to result in increased pedestrian activity.

On the west side of the Missouri River in Mandan there is a multi-use trail that follows the Bismarck Expressway to the McKenzie Drive interchange and then heads west to 46th Avenue SE. There is also a sidewalk/trail that crosses the Missouri River on the Memorial Highway Bridge and then goes through ND 810 (I-194) / Memorial Highway interchange.

Transit Routes

Fixed route transit service is offered in the corridor by Capital Area Transit (CAT), which began service in 2004. In Bismarck, the B-1 and B-2 routes provide service along approximately 2 miles of the Bismarck Expressway, with stops at Kirkwood Mall and the new Super Wal-Mart, running between 3rd Street and 26th Street. The Kirkwood Mall stop is a major hub for the CAT system with transfers between eight different routes. In Mandan, the M-1 and M-2 routes provide service to much of the city and cross the Bismarck Expressway at the Memorial Highway interchange. The transit routes that traverse or cross the corridor are shown in Figure 13.

Additional routes adjacent to the Bismarck Expressway corridor include:

- The Denver/Portland stop on the B-1 and B-2 routes.
- The Dan's South Washington stop on the E-2 route.
- The Midway Lanes stop on the M-1 and M-2 routes.
- The Q&R Clinic stop on the M-1 and M-2 routes.

In addition to CAT's fixed route service, Bis-Man Transit operates a demand responsive transit service in the study area. Bis-Man Transit offers door-to-door service to senior citizens and those with disabilities.

Traffic Operation Analysis Methodology

In support of this existing conditions evaluation, a traffic operations analysis of intersections and freeway facilities was conducted. The freeway operations evaluation was conducted using the Highway Capacity Software (HCS), which utilizes the procedures and methodologies documented in the *2000 Highway Capacity Manual* (HCM). The freeway facilities analyzed included basic freeway segments, ramp junctions, and weaving segments. The intersection analyses were conducted using the Synchro software program that also utilizes the methodologies found in the 2000 HCM.

Observations of traffic volumes provide an understanding of the general nature of traffic, but are insufficient to indicate either the ability of the street network to carry additional traffic or the quality of service provided by the street system. For this reason, the concept of level of service (LOS) has been developed to correlate quantitative traffic volume data to subjective descriptions of traffic performance at intersections, along freeway segments, at ramp junctions, and within weaving segments. Level of service is a term used to qualitatively describe roadway and intersection traffic operations. LOS categories range from A (best) to F (worst) as shown in Tables 4 through 7.

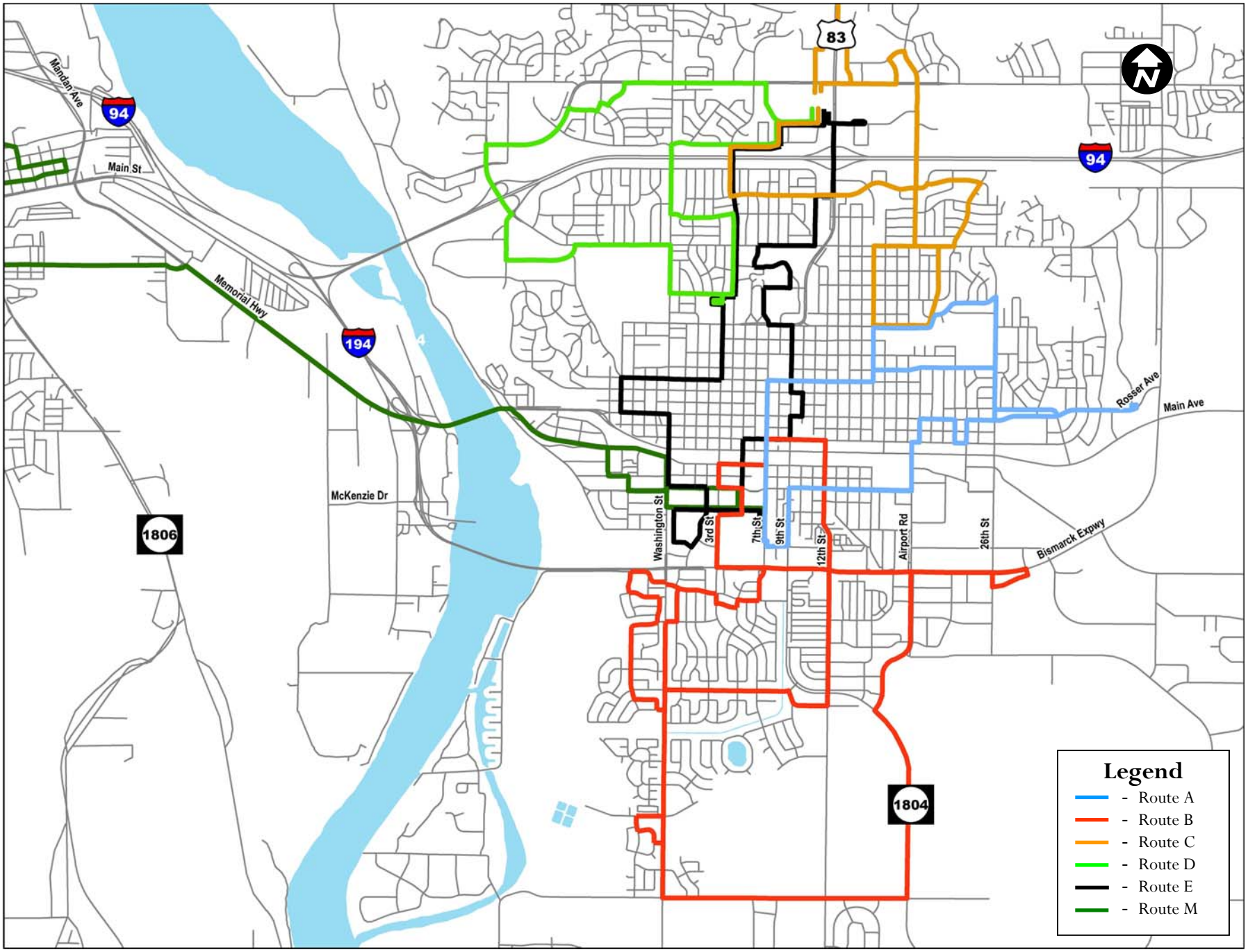

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Figure 13. Capital Area Transit (CAT) Bus Routes

TABLE 4: LEVEL OF SERVICE DESCRIPTIONS FOR INTERSECTIONS

Level of Service	Delay Per Vehicle (Seconds)		Description
	Signalized	Unsignalized	
A	≤10	≤10	Free flow, minimal delays
B	>10 and ≤20	>10 and ≤15	Stable flow, occasional delays
C	>20 and ≤35	>15 and ≤25	Stable flow, periodic delays
D	>35 and ≤55	>25 and ≤35	Restricted flow, regular delays
E	>55 and ≤80	>35 and ≤50	Maximum capacity, extended delays
F	>80	>50	Forced flow, excessive delays

Source: 2000 Highway Capacity Manual, Transportation Research Board
Signalized LOS Criteria taken from Exhibit 16-2; Unsignalized LOS Criteria taken from Exhibit 17-2

TABLE 5: LEVEL OF SERVICE DESCRIPTIONS FOR BASIC FREEWAY SEGMENTS

Level of Service	Performance Measures		Description
	Maximum Density [1]	Minimum Speed (mph)	
A	≤11	65	Free flow, minimal delays
B	>11 and ≤18	65	Stable flow, occasional delays
C	>18 and ≤26	64.6	Stable flow, periodic delays
D	>26 and ≤35	59.7	Restricted flow, regular delays
E	>35 and ≤45	52.2	Maximum capacity, extended delays
F	>45	---	Forced flow, excessive delays

Note: 1: pc/mi/lane = passenger cars/mile/lane
Source: 2000 Highway Capacity Manual, Transportation Research Board
Maximum density and minimum speed criteria taken from Exhibit 23-2
Minimum speed criteria based on a free-flow speed of 65 mph

TABLE 6: LEVEL OF SERVICE CRITERIA FOR RAMP JUNCTIONS

Level of Service	Density (pc/mi/ln)
A	≤ 10.0
B	> 10.0 – 20.0
C	> 20.0 – 28.0
D	> 28.0 – 35.0
E	> 35.0
F	Demand exceeds Capacity

Note: Density is the primary determinant of LOS for ramp junctions. Other factors (e.g., maximum volumes for merge/diverge area) can result in lower LOS.
Source: 2000 Highway Capacity Manual, Exhibit 25-7

TABLE 7: LEVEL OF SERVICE CRITERIA FOR WEAVING SEGMENTS

Level of Service	Density (pc/mile/lane)
A	≤ 10.0
B	> 10.0 – 20.0
C	> 20.0 – 28.0
D	> 28.0 – 35.0
E	> 35.0 – 43.0
F	> 43.0

Note: Density is the primary determinant of LOS for weaving segments. Other factors (e.g., maximum weaving volumes) can result in lower LOS.
Source: 2000 Highway Capacity Manual, Exhibit 24-2.

The measures of effectiveness for freeway facilities and intersections are discussed below:

- *Intersections* – At signalized intersections, level of service is based on the weighted average of all approach delays. For unsignalized intersections, the LOS is based on the worst condition minor street movement delay (usually the left turn movements on the cross street). Table 4 provides the LOS criteria for signalized and unsignalized intersections.
- *Basic Freeway Segments* – The LOS of a basic freeway segment is defined by the density of traffic flow in passenger cars per mile per lane (pc/mi/ln). Density is a measure of the quality of the speed of flow, the ability to maneuver, and the proximity to other vehicles on the freeway (described in Table 5).
- *Ramp Junctions* – The LOS of a ramp junction is also defined by the density of traffic flow in passenger cars per mile per lane (pc/mi/ln) within the

influence (merge or diverge) area of the ramp junction (described in Table 6).

- *Weaving Segments* – The level of service for a weaving segment is also defined by the density of traffic flow in passenger cars per mile per lane (pc/mile/lane) within the weaving segment. Table 7 provides the LOS criteria for weaving segments.

For the purposes of this project, a deficiency is defined as level of service D (LOS D) or worse. This threshold was developed based on discussions with representatives from the City of Bismarck, North Dakota DOT, and the Bismarck-Mandan MPO.

Findings of Traffic Operations Analyses

The results of the freeway and intersection capacity analyses for the Mandan portion of the corridor for each peak period are summarized in Tables 8 through 11. There are three weaving segments within the Mandan portion of the corridor. Each direction of ND 810 between the Memorial Highway and McKenzie Drive interchanges is a weaving segment. Another weaving segment is located along westbound I-94 between the I-194 and Main Street interchanges. The traffic analyses indicate that acceptable levels of service (LOS B or better) are provided within these three weaving segments. There is a perception of congestion caused by weaving vehicles on eastbound I-94 between the Main Street and I-194 interchanges, however, this segment is technically not a weaving segment because the ramps are more than a ½-mile apart. A weaving analysis was still conducted for this segment at the maximum length for a weaving segment and the results indicate LOS B or better is currently provided.

The existing conditions analyses indicate that acceptable levels of service are provided throughout the study area with the exception of a few intersection movements.

TABLE 8: EXISTING CONDITIONS BASIC FREEWAY OPERATIONS ANALYSIS

Basic Freeway Segment	Number of Lanes	Level of Service	
		AM Peak	PM Peak
Eastbound			
I-94 west of Mandan Ave off-ramp	2	A	A
I-94 east of Mandan Ave off-ramp	2	A	A
I-94, east of Mandan Ave on-ramp	2	A	A
I-94 east of Main St on-ramp	3	B	A
I-94 east of I-194 off-ramp	2	A	A
I-94 east of I-194 on-ramp	2	B	A
I-194 east of I-94 off-ramp	2	A	A
I-194 east of I-94 on-ramp	2	B	A
I-194 east of Memorial Hwy off-ramp	2	A	A
I-194 east of Memorial Hwy loop on-ramp	2	A	A
ND 810 east of Memorial Hwy on-ramp	3	A	A
ND 810 east of McKenzie Dr off-ramp	2	A	A
ND 810 east of McKenzie Dr on-ramp	2	A	A
Westbound			
ND 810 east of McKenzie Dr off-ramp	2	A	A
ND 810 west of McKenzie Dr off-ramp	2	A	A
ND 810 west of McKenzie Rd on-ramp	3	A	A
I-194 west of Memorial Hwy off-ramp	2	A	A
I-194 west of Memorial Hwy loop on-ramp	2	A	A
I-194 west of Memorial Hwy on-ramp	2	A	B
I-194 west of I-94 off-ramp	2	A	A
I-94 west of Divide Ave	2	A	B
I-94 west of I-194 off-ramp	2	A	A
I-94 west of I-194 on-ramp	3	A	B
I-94 west of Main St off-ramp	2	A	A
I-94 west of Mandan Ave off-ramp	2	A	A
I-94 west of Mandan Ave on-ramp	2	A	A

Note: Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway level of service criteria

TABLE 9: EXISTING CONDITIONS RAMP JUNCTIONS OPERATIONS ANALYSIS

Basic Freeway Segment	Number of Lanes	Level of Service	
		AM Peak	PM Peak
Eastbound			
I-94, Mandan Ave off-ramp	2 / 1	B	A
I-94, Mandan Ave on-ramp	2 / 1	B	B
I-94, Main St on-ramp (lane add)	2 / 1	C	B
I-94, I-194 EB off-ramp (major diverge) [c]	3 / 2	B	A
I-94, I-194 WB on-ramp	2 / 1	B	B
I-194, I-94 WB on-ramp	2 / 1	B	B
I-194, Memorial Hwy off-ramp	2 / 1	B	B
I-194, Memorial Hwy loop on-ramp	2 / 1	A	A
ND 810, Memorial Hwy on-ramp (lane add) [b]	2 / 1	A	B
ND 810, McKenzie Dr off-ramp (lane drop) [b]	3 / 1	A	A
ND 810, McKenzie Dr on-ramp	2 / 1	B	B
Westbound			
ND 810, McKenzie Dr off-ramp	2 / 1	A	A
ND 810, McKenzie Dr on-ramp(lane add)[b]	2 / 1	A	A
ND 810, Memorial Hwy off-ramp (lane drop) [b]	3 / 1	A	A
I-194, Memorial Hwy loop on-ramp	2 / 1	A	A
I-194, Memorial Hwy on-ramp	2 / 1	B	B
I-194, I-94 EB off-ramp	2 / 1	A	B
I-94, I-194 EB off-ramp	2 / 1	A	B
I-94, I-194 WB on-ramp (lane add) [b]	2 / 1	B	B
I-94, Main St off-ramp (major diverge) [c]	3 / 2	A	B
I-94, Mandan Ave off-ramp	2 / 1	A	B
I-94, Mandan Ave on-ramp	2 / 1	A	B

Notes:

a - 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

TABLE 10: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – MORNING (AM) PEAK HOUR

Intersection	MOE (1)	Overall	Intersection Approach (2)			
			EB	WB	NB	SB
Mandan Ave / I-94 WB (3)	Delay (Sec)			13.4		
	LOS			B		
Mandan Ave / I-94 EB (3)	Delay (Sec)		11.8			
	LOS		B			
Memorial Hwy / I-194 WB	Delay (Sec)	8.2	5.3	3.3	30.5	
	LOS	A	A	A	C	
Memorial Hwy / I-194 EB (3)	Delay (Sec)				94.8	21.6
	LOS				F	C
McKenzie Dr / ND 810 WB (3)	Delay (Sec)				10.1	
	LOS				B	
McKenzie Dr / ND 810 EB (3)	Delay (Sec)					9.4
	LOS					A

Notes:

(1) MOE = Measures of Effectiveness

(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

(3) Unsignalized intersection

TABLE 11: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – AFTERNOON (PM) PEAK HOUR

Intersection	MOE (1)	Overall	Intersection Approach (2)			
			EB	WB	NB	SB
Mandan Ave / I-94 WB (3)	Delay (Sec)			17.7		
	LOS			C		
Mandan Ave / I-94 EB (3)	Delay (Sec)		21.9			
	LOS		C			
Memorial Hwy / I-194 WB	Delay (Sec)	8.6	4.0	3.8	33.4	
	LOS	A	A	A	C	
Memorial Hwy / I-194 EB (3)	Delay (Sec)				43.7	20.9
	LOS				E	C
McKenzie Dr / ND 810 WB (3)	Delay (Sec)				9.6	
	LOS				A	
McKenzie Dr / ND 810 EB (3)	Delay (Sec)					9.7
	LOS					A

Notes:

(1) MOE = Measures of Effectiveness

(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

(3) Unsignalized intersection

The results of the signalized and unsignalized intersection capacity analyses for the Bismarck portion of the corridor for each peak period are summarized in Tables 12 and 13.

The existing condition intersection capacity analyses indicate that acceptable levels of service are provided along the arterial portion of the corridor with the exception of Bismarck Expressway/7th Street (LOS D) and a few intersection movements. Generally within the Bismarck/Mandan Metro Area, LOS C is the acceptable threshold of signalized intersection operations. While LOS C or better is observed when all intersection approaches are summed, there are individual movements within selected intersections that fall below the local threshold of acceptable operations. The movements are listed below:

- Bismarck Expressway/Washington Street: Northbound and southbound approaches in both the AM and PM peak periods.
- Bismarck Expressway/7th Street: All approaches in the AM period and the southbound approach in the PM period.
- Bismarck Expressway/9th Street: Westbound and northbound approaches in the AM peak .

It should be noted that the level of service measures in Tables 12 and 13 reflect the operations over the entire peak hour of the AM and PM periods. Based on URS staff field observations and review of the 15-minute disaggregated traffic counts, is can be concluded that for short periods in both the AM and PM peak periods (generally less that 20 minutes) traffic operations at all of the signalized intersections on Bismarck Expressway from 9th Street through Washington Street operate at LOS E and F conditions. When weighted over the hour (which is the typical reporting method) the estimated traffic operations are likely better than expected if you where to ask the typical traveler. This is because in the corridor the peak of the peak period occurs in a very concentrated portion (15 to 25 minute) of the peak hour, not over the entire hour. The peak of the peak is what many drivers experience on a daily basis. Thus, it is what is used to describe the conditions. More detailed observations of the current conditions are listed below:

- Bismarck Expressway intersections with Washington Street and 7th and 9th Street currently experience the most congestion with this corridor.
- Bismarck Expressway/Washington Street: Currently operating at or approaching LOS D on all approaches. This is due in part to the delay associated with protected only left-turn phasing on all approaches that reduce the effective green time for through movements.
- Congestion observed at the Bismarck Expressway intersections with 7th Street and 9th Street occurs because of high turning volumes (both right and left) and traffic volume/signal operations conditions associated with the transition from two-way flow south of Bismarck Expressway to the one-way pair to the north.

TABLE 12: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – MORNING (AM) PEAK HOUR

Intersection	MOE (1)	Overall	Intersection Approach (2)			
			EB	WB	NB	SB
Bismarck Expressway /Washington St	Delay (Sec)	29.2	25.7	23.9	31.4	36.1
	LOS	C	C	C	C	D
Bismarck Expressway /2nd St (3)	Delay (Sec)					12.2
	LOS					B
Bismarck Expressway / 3rd St	Delay (Sec)	16.7	15.3	8.3	28.6	21.0
	LOS	B	B	A	C	C
Bismarck Expressway /Kirkwood Mall&Bozeman Dr (3)	Delay (Sec)				88.0	60.1
	LOS				F	F
Bismarck Expressway / 7th St	Delay (Sec)	45.2	35.2	34.0	99.2	32.2
	LOS	D	D	C	F	C
Bismarck Expressway /9th St & University Dr	Delay (Sec)	31.6	23.1	37.5	44.3	--
	LOS	C	C	D	D	--
Bismarck Expressway / 12th St	Delay (Sec)	10.8	0.8	9.7	27.5	26.2
	LOS	B	A	A	C	C
Bismarck Expressway /Airport Rd & 19th St	Delay (Sec)	20.2	15.7	23.5	18.7	27.8
	LOS	C	B	C	B	C
Bismarck Expressway / 26th St	Delay (Sec)	12.2	8.2	7.8	29.7	27.0
	LOS	B	A	A	C	C
Bismarck Expressway / Main Ave	Delay (Sec)	11.9	26.5	24.6	6.0	4.3
	LOS	B	C	C	A	A
Bismarck Expressway / Rosser Ave	Delay (Sec)	4.1	9.9	--	3.8	3.4
	LOS	A	A	--	A	A

Notes:
(1) MOE = Measures of Effectiveness
(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound
(3) Unsignalized intersection

TABLE 13: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – AFTERNOON (PM) PEAK HOUR

Intersection	MOE (1)	Overall	Intersection Approach (2)			
			EB	WB	NB	SB
Bismarck Expressway /Washington St	Delay (Sec)	30.5	29.8	27.6	32.1	34.2
	LOS	C	C	C	C	C
Bismarck Expressway /2nd St (3)	Delay (Sec)					*
	LOS					F
Bismarck Expressway / 3rd St	Delay (Sec)	17.8	22.9	12.0	19.0	24.0
	LOS	B	C	B	B	C
Bismarck Expressway /Kirkwood Mall&Bozeman Dr (3)	Delay (Sec)				*	*
	LOS				F	F
Bismarck Expressway / 7th St	Delay (Sec)	33.6	26.7	21.8	34.7	45.8
	LOS	C	C	C	C	D
Bismarck Expressway /9th St & University Dr	Delay (Sec)	21.7	13.9	29.0	29.2	--
	LOS	C	B	C	C	--
Bismarck Expressway / 12th St	Delay (Sec)	14.6	1.1	15.6	26.7	24.1
	LOS	B	A	B	C	C
Bismarck Expressway /Airport Rd & 19th St	Delay (Sec)	23.8	23.3	26.3	26.5	18.8
	LOS	C	C	C	C	B
Bismarck Expressway / 26th St	Delay (Sec)	19.3	17.6	16.1	33.1	18.7
	LOS	B	B	B	C	B
Bismarck Expressway / Main Ave	Delay (Sec)	15.4	33.0	18.3	6.9	7.3
	LOS	B	C	B	A	A
Bismarck Expressway / Rosser Ave	Delay (Sec)	5.8	10.5	--	5.6	4.6
	LOS	A	B	--	A	A

Notes:
(1) MOE = Measures of Effectiveness
(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound
(3) Unsignalized intersection

- Eastbound left-turn movement at Bismarck Expressway and 9th Street / University Drive. This movement frequently exceeds the storage capacity of the left-turn bay and often results in spillback into the through lanes. For short periods of time, eastbound traffic queues beyond the Bismarck Expressway and 7th Street intersection.
- Southbound right-turn movement at Bismarck Expressway and 7th Street exceeds the available capacity of the movement for a short period of time during the PM peak period. The split phase signal timing at this intersection limits the amount of available green time for this particular movement.
- Northbound right-turn movement at Bismarck Expressway and 7th Street exceeds the available capacity of the movement for a short period of time during the AM peak period. There is a considerable amount of school-related traffic making this turn during this peak period.
- There is also a weaving problem for eastbound Bismarck Expressway between 7th and 9th Street during the AM peak period. This results from the northbound right turning vehicles at 7th Street that want to make an eastbound left-turn at 9th Street.
- The unsignalized intersections at 2nd Street and the Kirkwood Mall entrance experience congestion due to a lack of acceptable gaps during the peak 15 to 30 minutes of each peak period. The projected delay for these movements is likely overstated because the HCM methodology assumes random arrivals on the main street (resulting in fewer gaps), but in reality traffic on Bismarck Expressway travels in platoons allowing for more acceptable gaps.

Crash Data Review

A review of the crash history for the intersections and freeway segments for the study corridor was conducted to determine whether any high crash locations are present and to identify crash trends within the study area. Accident data for the three-year period from 2002 through 2004 was obtained from the North Dakota DOT. A summary of the 2002 to 2004 crash data analysis for key intersections and roadway segments within the arterial and freeway portions of the study corridor is provided in Tables 14 and 16.

The key findings of the crash data review for the freeway portion of the study corridor are summarized below:

- Within the three years of data analyzed a total of 164 crashes occurred along the freeway segments and at freeway junctions within the corridor.
- The proportions of crashes were 20 percent injury crashes, 79 percent property damage only crashes and less than one percent fatal crashes.
- The one fatal collision involved a pedestrian who was hit while trying to cross I-94 near the I-194 interchange.

- The crash rate for freeway segments ranged from 0.17 to 5.32 crashes per million vehicle miles (MVM). The segment with the highest crash rate (for both directions of travel) was I-94 between the I-194 and the Divide Avenue interchanges (5.3 crashes/MVM). Other freeway segments with crash rates above 1.0 include ND 810 between McKenzie Drive and Missouri River bridge (2.71), ND 810 between McKenzie Drive and Memorial Highway (1.17), and I-94 west of Mandan Avenue (1.32).
- The most common crash type seen throughout the study corridor was single vehicle collisions with fixed objects (46% of all crashes). Most of the fixed object crashes occurred at interchange areas where fixed objects (e.g., light poles, guardrail, signs) are more common.
- The segment of ND 810 between the McKenzie Drive interchange and the Missouri River bridge also has a number of fixed object crashes, with more crashes in the eastbound direction (14 crashes) than westbound direction (5 crashes), as shown in Table 14. A contributing factor at this location is the relatively sharp horizontal curve.
- The second most common crash type is rear end collisions (19% of all crashes) involving two or more vehicles. Again, a majority of these types of collisions occurred at interchange areas where vehicle speeds vary the most due to merging/diverging vehicles.
- The third most common type of crash is collisions with animals (12% of all crashes). The majority of these collisions occur on I-94 west of the Main Street interchange.
- Sideswipe collisions involving vehicles traveling in the same direction were noted for eastbound I-94 at the I-194 off-ramp and for westbound ND 810 at the Memorial Highway off-ramp.
- Under the 'other' crash category there were a number of overturn crashes involving a single vehicle. A number of these overturn crashes occurred on the westbound I-94 to eastbound (southbound) I-194 loop ramp.

The key findings of the crash data review for the arterial portion of the study corridor are summarized below:

- During the three years for when data was collected a total of 262 crashes occurred at the 17 signalized and unsignalized intersections along Bismarck Expressway. The majority (78 percent) of the crashes occurred at the eight signalized intersections.
- The crash rate for signalized intersections ranged from 0.53 to 1.27 crashes per million entering vehicles (MEV). For unsignalized intersections the crash rates range from 0.14 to 1.05 crashes/MEV. A typical crash rate for an urban intersection typically falls in the range of 0.7 to 1.0 crashes/MEV.
- The intersections with the highest crash rates include Washington Street, 2nd Street and Main Avenue. Crash rates of just over 1.0, as found at these intersections, suggest a crash will occur at these intersections once every 3 to 4 weeks.

- The predominant crash type at signalized intersections within the study area was the rearend collision (42 percent of all crashes). Rearend collisions are commonly associated with signalized intersections. These types of collisions typically result from traffic congestion and/or driver inattention. The percentage of crashes of this type within the study area is similar to those noted in a Minnesota DOT (MnDOT) study on crash types[2].
- The other common crash types (i.e., left-turn and angle crashes) at signalized intersections are related to turn movements. These types of crashes result when a driver chooses a gap that is too short to complete their turn or driver inattention.
- Accidents involving left-turning vehicles are common at the intersection of 12th Street, accounting for 37 percent of all crashes at this intersection. These types of crashes occur because a left-turning vehicle attempts to use a gap in opposing traffic that is too short or a left-turning vehicle tries to make their turn toward the end of yellow phase and the opposing traffic enters the intersection during the yellow/ all-red phase or later. This high percentage of left-turning crashes may be of some concern because these types of crashes generally have a higher likelihood of resulting in injuries.
- Signalized intersections with a high percentage of the angle crashes include 9th Street, Airport Road, and 26th Street.
- The most common type of crash at unsignalized intersections is angle collisions, accounting for 80 percent of all crashes.
- Only two collisions involving a pedestrian/bicyclists and motor vehicles occurred over the three-year period.
- The proportion of injury crashes for intersections within the study area typically fell under 33 percent of total crashes with a few exceptions. This rate is consistent with the findings of the MnDOT crash study.
- An additional 121 crashes occurred in roadway segments located between intersections along Bismarck Expressway or on cross street roadway segments. Typical crash types on these roadway segments include rear end (37 percent), fixed objects (20 percent), animals (10 percent), and crashes typically associated with driveway activity (i.e., angle and left-turn crashes).
- The segment with the highest number of crashes is west of Washington Street to the Missouri River Bridge. In this segment the most common crash types include fixed object and rear ends.

[2] Minnesota Department of Transportation, Traffic Safety Fundamentals Handbook, April 2001

TABLE 14: CRASH DATA REVIEW SUMMARY FOR MANDAN FREEWAY SEGMENTS AND INTERCHANGES

Segment	Direction	Number of Crashes	Accident Type (1)					Accident Severity (2)		
			An	SS	FO	RE	O	PDO	I	F
I-94, West of Mandan Ave Interchange	EB	4	3				1	3	1	
	WB	0								
I-94, Mandan Ave Interchange	EB	14	3	1	5	1	4	12	2	
	WB	18	4		9	4	1	17	1	
I-94, Mandan Ave to Main St	EB	7	2		3	1	1	6	1	
	WB	0								
I-94, Main St Interchange & Ramps	EB	5			3	2		3	2	
	WB	3	1		1	1		2	1	
I-94, Main St to I-194	EB	8	1	1	1	4	1	6	2	
	WB	4			2	1	1	3	1	
I-94 / I-194 Interchange	EB	16		5	8	1	2	11	4	1
	WB	18	2		7	4	5	12	6	
I-94, I-194 to Divide Ave	EB	5	1		1	3		4	1	
	WB	8			4	2	2	6	2	
I-194, I-94 to Memorial Hwy	EB	0								
	WB	1				1		1		
I-194/ND 810, Memorial Hwy Interchange	EB	5		1	4			5		
	WB	15	1	3	2	3	6	14	1	
ND 810, Memorial Hwy to McKenzie Dr	EB	2			1		1		2	
	WB	1			1			1		
ND 810, McKenzie Dr Interchange	EB	5		1	3	1		3	2	
	WB	2		1	1			2		
ND 810, McKenzie Dr to Missouri River Bridge	EB	15			14	1		13	2	
	WB	8	1	1	5	1		6	2	

Notes:

(1) An = Animal; SS = Sideswipe; FO = Fixed object; RE = Rearend; O = Other (e.g., angle/left-turn [driveway related], head-on)

(2) PDO = Property Damage Only; I = Injury; F = Fatality

TABLE 15: CRASH DATA REVIEW SUMMARY FOR BISMARCK EXPRESSWAY INTERSECTIONS

Intersection	Number of Crashes	Accident Type (1)					Accident Severity (2)			3-Year Accident Rate (3)
		LT	A	RE	P/B	O	PDO	I	F	
Bismarck Expwy / Washington St	42	5	5	27		5	26	16		1.16
Bismarck Expwy / 2nd St (4)	15		11	2	1	1	12	3		1.05
Bismarck Expwy / 3rd St	32	7	6	19			22	10		0.92
Bismarck Expwy / Mall & Bozeman (4)	9	1	8				6	3		0.30
Bismarck Expwy / 7th St	35	1	12	13		9	29	6		1.07
Bismarck Expwy / 9th St & University	23	1	10	8		4	15	8		0.67
Bismarck Expwy / 11th St (4)	6		6				4	2		0.26
Bismarck Expwy / 12th St	27	10	6	9	1	1	18	9		1.00
Bismarck Expwy / 18th St (4)	5		3	1		1	5			0.28
Bismarck Expwy /Airport Rd &19th St	14	1	8	4		1	12	2		0.57
Bismarck Expwy / 22nd St (4)	3		2	1			2	1		0.39
Bismarck Expwy / 23rd St (4)	1		1				1			0.14
Bismarck Expwy / 26th St	10	1	6	3			10			0.66
Bismarck Expwy / Vermont Ave (4)	1		1				1			0.19
Bismarck Expwy / Apple Creek Rd (4)	3		1			2	2	1		0.28
Bismarck Expwy / Main Ave	22	5	7	3		7	14	8		1.27
Bismarck Expwy / Rosser Ave (4)	14		12	1		1	10	4		0.88

Notes:

(1) LT = Left-turn; A = Angle; RE = Rearend; P/B = Pedestrian/Bicycle; O = Other (e.g., sideswipe, fixed-object)

(2) PDO = Property Damage Only; I = Injury; F = Fatality

(3) Accidents per million entering vehicles

(4) Unsignalized intersection

TABLE 16: CRASH DATA REVIEW SUMMARY FOR BISMARCK EXPRESSWAY SEGMENTS

Segment	Number of Crashes	Accident Type (1)					Accident Severity (2)		
		An	SS	FO	RE	O	PDO	I	F
Expressway: Missouri River Bridge to Washington	29	1	1	13	11	2	14	15	
Expressway: Washington to 2nd	2		1		1		2		
Expressway: 2nd to 3rd	6			1	5		4	2	
Expressway: 3rd to Mall	1				1			1	
Expressway: Mall to 7th	5				5		2	3	
Expressway: 9th to 11th	2				2		1	1	
Expressway: 11th to 12th	5			1	3	1	4	1	
Expressway: 12th to Airport Rd & 19th	7		1	1	3	2	5	2	
Expressway: Airport Rd to 26th	4			1	3		1	3	
Expressway: 26th to Vermont	1	1					1		
Expressway: Vermont to Apple Creek	2	1		1			2		
Expressway: Apple Creek to Main	9	7		1		1	8	1	
Expressway: Rosser to Industrial	4				2	2	2	2	
2nd St: Expressway to Ivy	1					1	1		
3rd St: Expressway to Denver	2		2				2		
3rd St: Expressway to Arbor	5					5	5		
7th St: Expressway to Arbor	1					1	1		
9th St: Expressway to Denver	8			1	2	5	4	4	
9th St: Expressway to Arbor	9		3	1	2	3	8	1	
12th St: Expressway to 7th Ave	6				3	3	3	3	
12th St: Expressway to Arbor	5			1	2	2	4	1	
23rd St: Expressway to Lee	1					1	1		
Main Ave: Expressway to 52nd	3	2				1	3		
Rosser Ave: Expressway to Channel Dr	3		1	2			3		

Notes:

(1) An = Animal; SS = Sideswipe; FO = Fixed object; RE = Rearend; O = Other (e.g., angle/left-turn [driveway related], head-on)

(2) PDO = Property Damage Only; I = Injury; F = Fatality

2030 Traffic Forecasts

Daily Traffic Forecasts

The 2030 traffic volume forecasts for the Bismarck Expressway corridor rely on the Bismarck-Mandan computer traffic model. The Advanced Traffic Analysis Center (ATAC) at the University of North Dakota developed and maintains the Bismarck-Mandan MPO traffic model. The latest version of the MPO's traffic model was used to support the 2005 Long Range Transportation Plan (LRTP) update.

There are four major planned or recently built developments along the Bismarck Expressway that were not incorporated into the traffic model land development assumptions used for the 2005 LRTP. These developments are:

- Wal-Mart and Sam's Club Development at 26th Street / Bismarck Expressway
- Visconsi Retail Stores Development at Burlington Dr / Bismarck Expressway
- Northern Plains Commerce Centre northeast of the Bismarck Municipal Airport.
- Relocation and expansion of the Target store at the Kirkwood Mall

The forecasts completed for this study include these land developments as part of the future land development scenario. As the traffic forecasts developed for the LRTP, did not assume these developments were in place, forecasts developed for this study will vary from the 2030 traffic volumes presented in the LRTP.

The first step in developing 2030 traffic forecasts, URS staff reviewed the traffic model assignment output from both: 1) 2000 base year model, and 2) the 2030 traffic model to determine the level of corridor growth predicted by the model, which yielded traffic forecasts similar to those presented in the LRTP.

In the next step, the traffic model's socioeconomic (housing and employment) inputs were reviewed to determine to what extent the traffic model's input data reflected the proposed developments listed above. Traffic impact studies have been completed for all four developments, and each traffic study included documentation of expected traffic volumes associated with each development.

Based on this review, it was determined that the 2030 traffic model accounts for only approximately 25 percent of the new trips documented in the traffic studies for the Wal-Mart, Visconsi and Northern Plains Commerce Center development areas, and to a lesser extent under-represents the Target redevelopment at Kirkwood Mall. Thus, the 2030 traffic model was found to "under predict" traffic levels oriented to /

from these development areas because it under represented the level of development in these development areas. Traffic was added into the corridor forecasts developed for the Bismarck Expressway corridor based on the level of model "under prediction" by TAZ. The additional development-area traffic was assigned to the corridor according to distribution information provided in the traffic impact studies and according to travel patterns projected in the traffic model.

PEAK HOUR FORECASTS

Traffic forecasts for the 2030 AM and PM peak hours were developed by:

- Evaluating existing peak hour traffic characteristics, including:
  - Determining the portion of the daily traffic that occurs during the morning and afternoon traffic peaks.
  - Determining the peak hour directional flow of traffic, including the proportion of right-turns, through movements and left-turns by intersection, during each traffic peak.
  - Applying those characteristics, with some modifications, to the future year 2030 daily traffic forecasts. Modifications to these patterns included slight adjustments to the peak hour direction of travel and the peak hour percentage of daily traffic. These modifications were completed to account for the new development on the east end of the Bismarck Expressway that would alter.

TRAFFIC FORECAST RESULTS

The daily traffic forecasts are documented in Figures 14 and 15. The amount of traffic growth projected in the Bismarck Expressway corridor ranges between approximately 40 and 200 percent when compared to the base year. The preliminary 2030 AM traffic forecasts west of the Missouri River are shown in Figure 16 and east of the Missouri River are shown in Figure 17. The preliminary 2030 PM traffic forecasts west of the Missouri River are shown in Figure 18 and east of the Missouri River are shown in Figure 19.

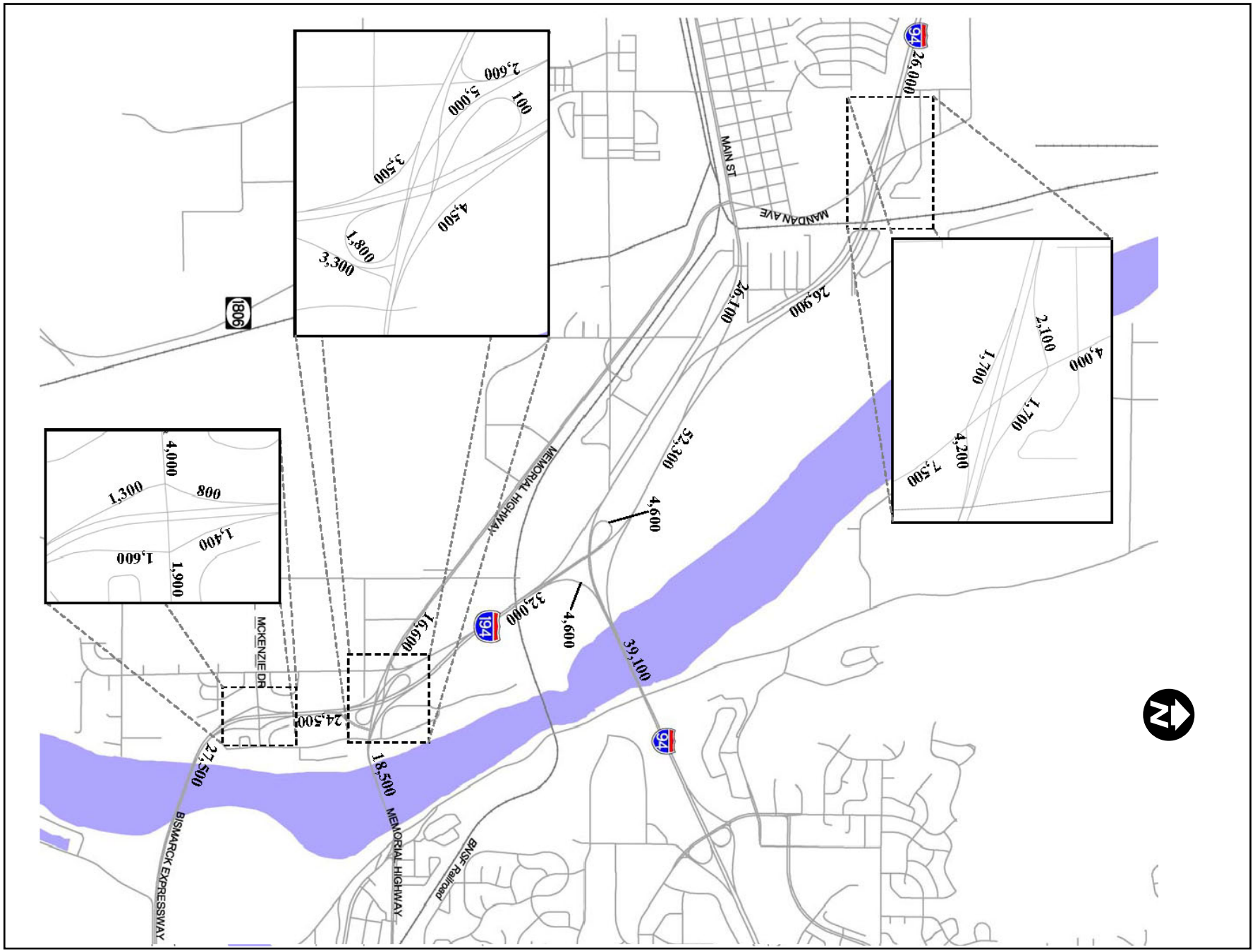


Figure 14. Future (2030) Average Daily Traffic Volumes West of Missouri River

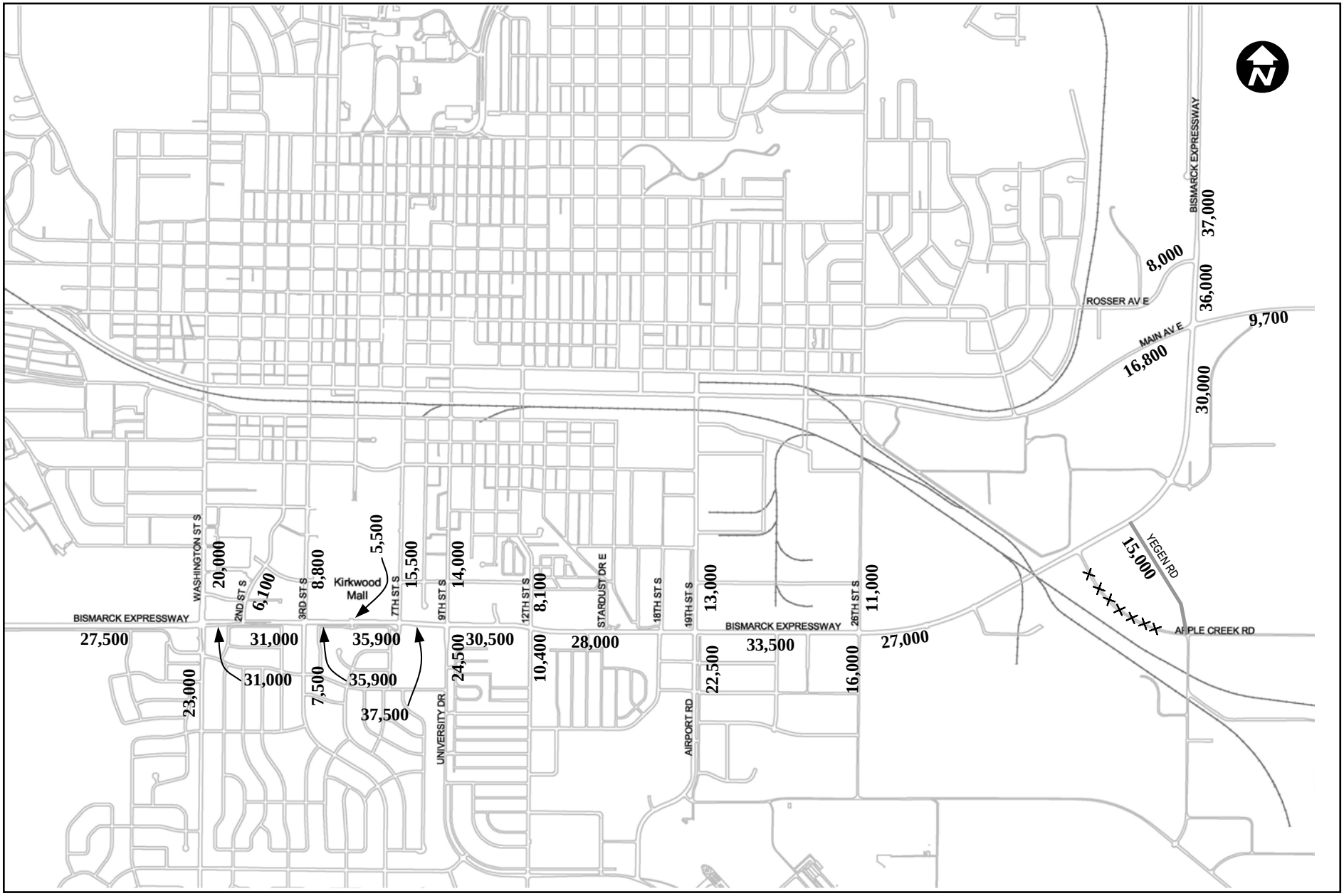


Figure 15. Future (2030) Average Daily Traffic Volumes East of Missouri River

Bismarck-Mandan
Metropolitan Planning Organization

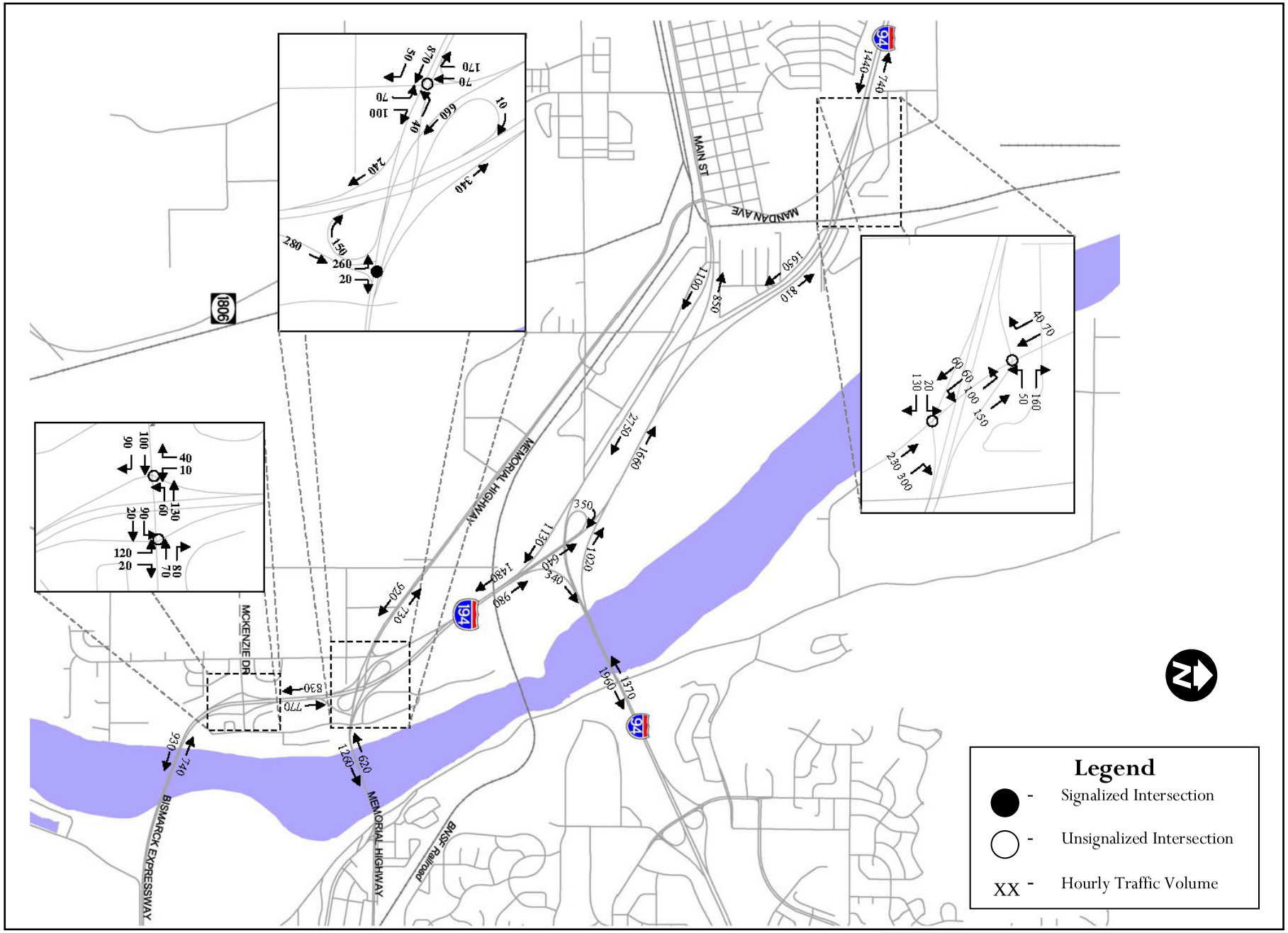


Figure 16. Future (2030) Morning (AM) Peak Hour Volumes West of Missouri River

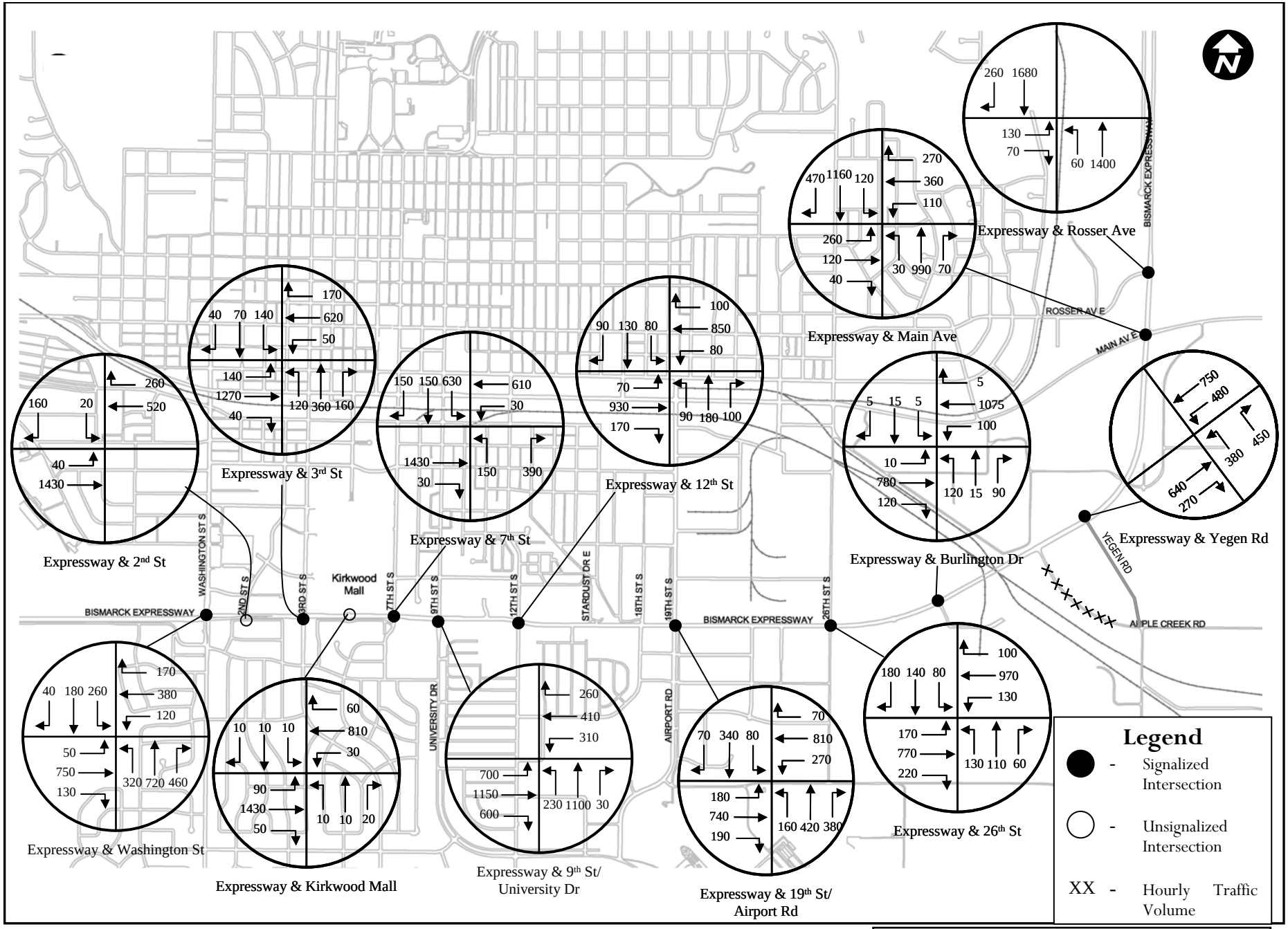


Figure 17. Future (2030) Morning (AM) Peak Hour Volumes East of Missouri River

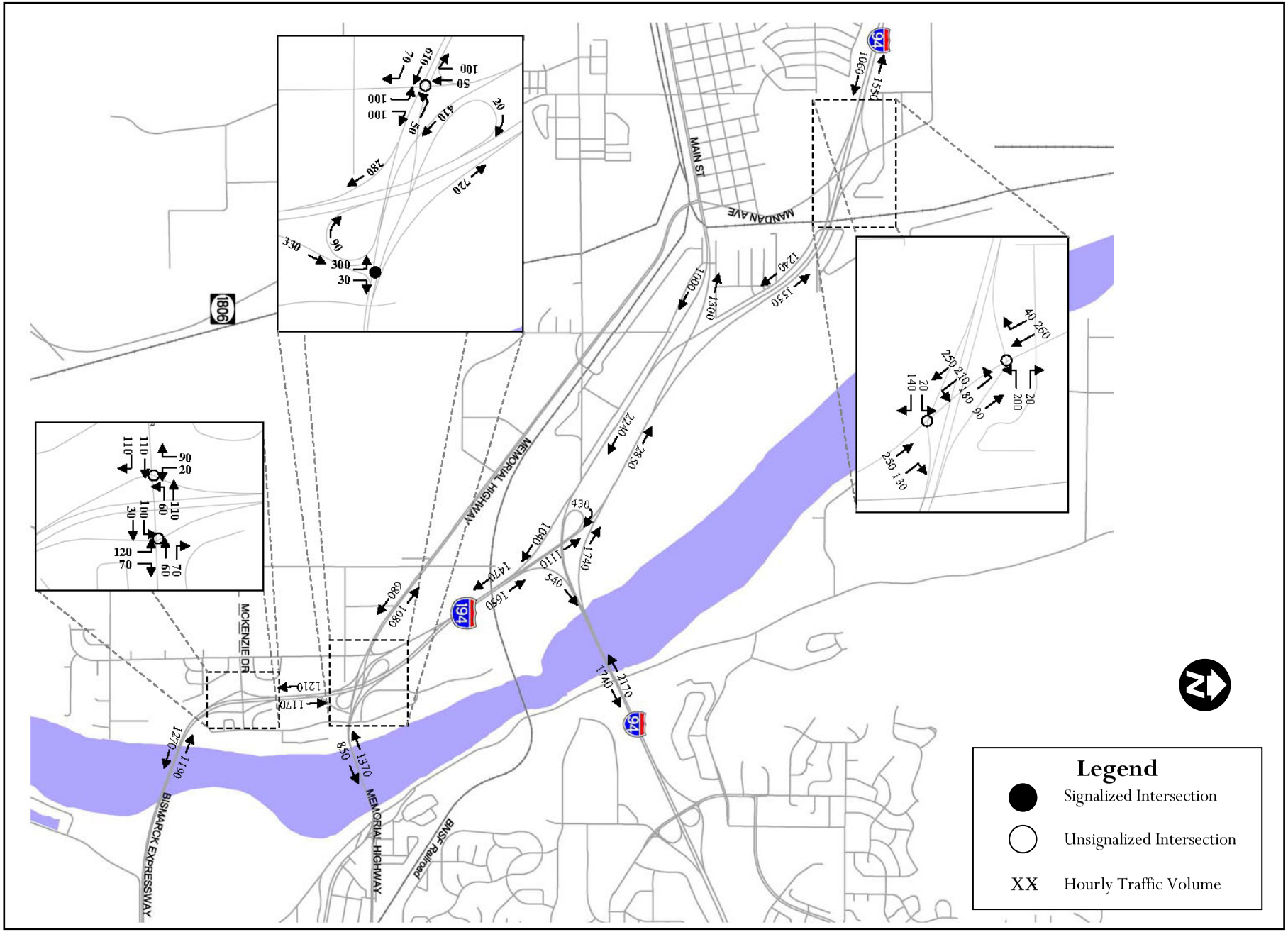


Figure 18. Future (2030) Afternoon (PM) Peak Hour Volumes West of Missouri River

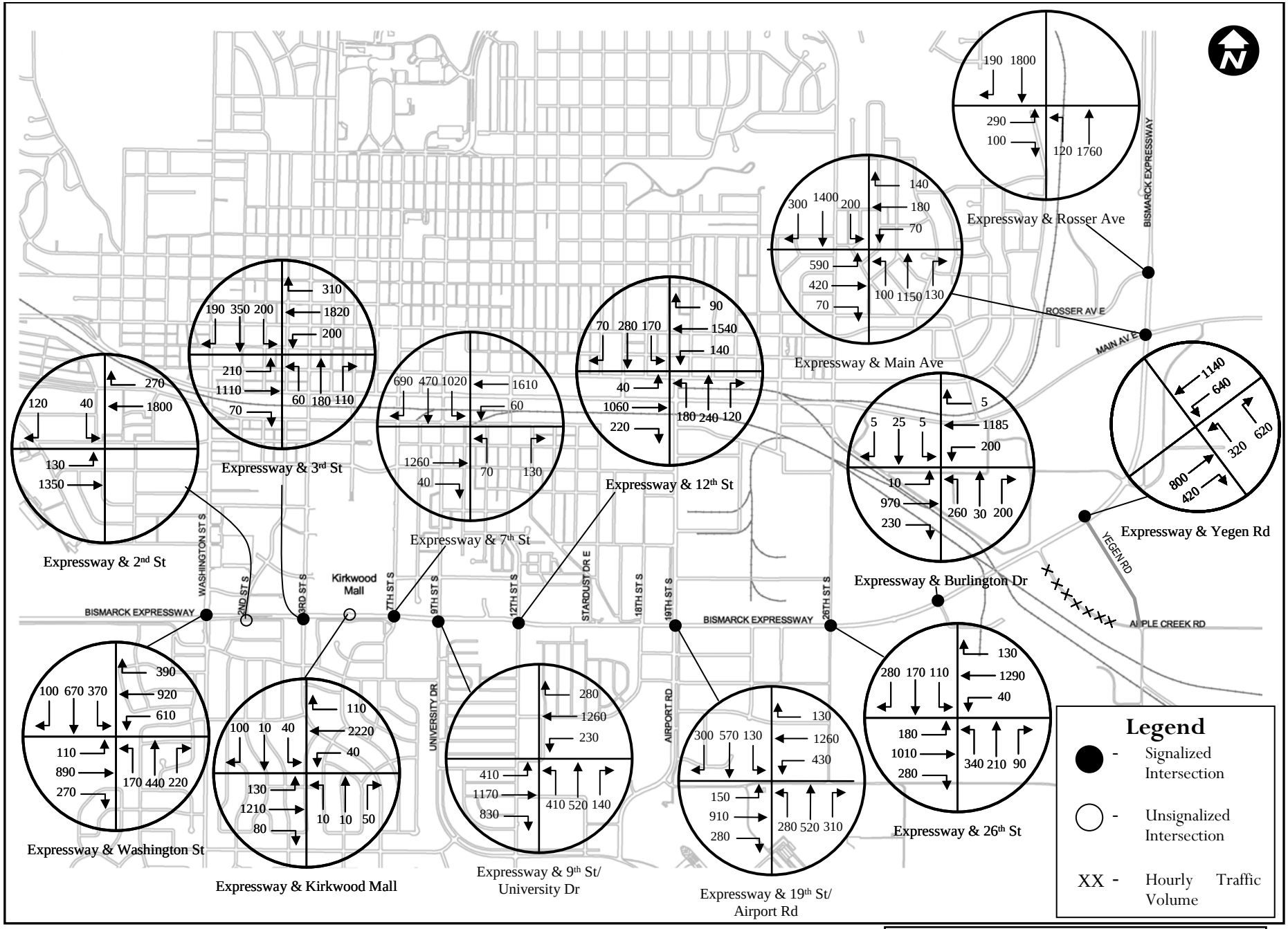


Figure 19. Future (2030) Afternoon (PM) Peak Hour Volumes East of Missouri River

2030 No-Build Traffic Operations

The purpose of the Future Year No-Build Conditions Chapter is to provide a summary of the projected traffic operations for the corridor in 2030. Assumimg no significant improvements to intersection configuration or traffic control beyond those proposed as part of the Wal-Mart, Visconsi, and NPCC and Memorial Birdge Relocation projects.

The results of the freeway and intersection capacity analyses for the Mandan portion of the corridor for each peak period are summarized in Tables 17 through 21. A majority of the freeway facilities in the Mandan portion of the study area are projected to continue to experience acceptable levels of service under the 2030 No-Build scenario. The segments of I-94 between Main Street and the I-94/I-194 interchanges are projected to have the most congestion within this timeframe.

The results of the intersection capacity analysis for the Bismarck Expressway arterial portion of the corridor for each peak period are summarized in Tables 22 and 23. A summary of the No-build Conditions findings for the 2030 capacity analyses is provided below:

- By 2030 traffic volumes in the Bismarck Expressway corridor is forecasted to increase by approximately 40 to more than 100 percent. While the corridor generally operates under acceptable conditions based on current traffic, future operations are projected to degrade significantly when the anticipated traffic growth through 2030 is added. Today only a few intersections reflect <u>unacceptable</u> operations, but by 2030 only a few intersections are predicted to reflect <u>acceptable</u> conditions. By 2030, intersections forecasted to operate at LOS C or better are limited to:
  - Bismarck Expressway/3rd Street: AM period only.
  - Bismarck Expressway/12th Street: AM period only.
  - Bismarck Expressway/26th Street: AM period only (with currently programmed improvements).
  - Bismarck Expressway/Yegen Road: Both the AM and PM peak periods (with currently programmed improvements).
- Observations of the 2030 No-build condition traffic operations results include:
  - Intersections at the east end of the Bismarck Expressway corridor are projected to see the larger increases in congestion between now and 2030. This is due in part to significant developments that are planned for that portion of the corridor.

- Key Bismarck Expressway intersections of 7th and 9th Street are projected to experience very heavy congestion. The resulting queues from these intersections are expected to extend back to and negatively impact operations at the adjacent signalized intersections of 3rd and 12th Street.
- Several of the intersections have multiple intersection approaches that exceed available capacity. This makes it difficult to find a traffic signal timing solution for these intersections.

TABLE 17: EXISTING CONDITIONS AND YEAR 2030 NO-BUILD CONDITIONS BASIC FREEWAY OPERATIONS ANALYSIS

Basic Freeway Segment	Number of Lanes	Level of Service			
		AM Peak		PM Peak	
		Existing	2030	Existing	2030
Eastbound					
I-94 west of Mandan Ave off-ramp	2	A	B	A	B
I-94 east of Mandan Ave off-ramp	2	A	B	A	A
I-94, east of Mandan Ave on-ramp	2	A	B	A	B
I-94 east of Main St on-ramp	3	B	C	A	B
I-94 east of I-194 off-ramp	2	A	B	A	B
I-94 east of I-194 on-ramp	2	B	C	A	B
I-194 east of I-94 off-ramp	2	A	B	A	A
I-194 east of I-94 on-ramp	2	B	B	A	B
I-194 east of Memorial Hwy off-ramp	2	A	A	A	A
I-194 east of Memorial Hwy loop on-ramp	2	A	A	A	A
ND 810 east of Memorial Hwy on-ramp	3	A	A	A	A
ND 810 east of McKenzie Dr off-ramp	2	A	A	A	A
ND 810 east of McKenzie Dr on-ramp	2	A	A	A	B
Westbound					
ND 810 east of McKenzie Dr off-ramp	2	A	A	A	B
ND 810 west of McKenzie Dr off-ramp	2	A	A	A	A
ND 810 west of McKenzie Dr on-ramp	3	A	A	A	A
I-194 west of Memorial Hwy off-ramp	2	A	A	A	A
I-194 west of Memorial Hwy loop on-ramp	2	A	A	A	A
I-194 west of Memorial Hwy on-ramp	2	A	A	B	B
I-194 west of I-94 off-ramp	2	A	A	A	A
I-94 west of Divide Ave	2	A	B	B	C
I-94 west of I-194 off-ramp	2	A	A	A	B
I-94 west of I-194 on-ramp	3	A	B	B	B
I-94 west of Main St off-ramp	2	A	A	A	B
I-94 west of Mandan Ave off-ramp	2	A	A	A	B
I-94 west of Mandan Ave on-ramp	2	A	A	A	B

Note: Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway level of service criteria

TABLE 18: EXISTING CONDITIONS AND 2030 NO-BUILD CONDITIONS RAMP JUNCTION LEVEL OF SERVICE ANALYSIS

Ramp Junction	Number of Lanes	Level of Service			
		AM Peak		PM Peak	
		Existing	2030	Existing	2030
Eastbound					
I-94, Mandan Ave off-ramp	2 / 1	B	B	A	B
I-94, Mandan Ave on-ramp	2 / 1	B	C	B	B
I-94, Main St on-ramp (lane add)	2 / 1	C	D	B	C
I-94, I-194 EB off-ramp(major diverge)[c]	3 / 2	B	C	A	B
I-94, I-194 WB on-ramp	2 / 1	B	C	B	B
I-194, I-94 WB on-ramp	2 / 1	B	B	B	B
I-194, Memorial Hwy off-ramp	2 / 1	B	B	B	B
I-194, Memorial Hwy loop on-ramp	2 / 1	A	B	A	B
ND 810, Memorial Hwy on-ramp (lane add) [b]	2 / 1	A	B	B	B
ND 810, McKenzie Dr off-ramp (lane drop) [b]	3 / 1	A	A	A	A
ND 810, McKenzie Dr on-ramp	2 / 1	B	B	B	B
Westbound					
ND 810, McKenzie Dr off-ramp	2 / 1	A	A	A	B
ND 810, McKenzie Dr on-ramp (lane add) [b]	2 / 1	A	B	A	B
ND 810, Memorial Hwy off-ramp (lane drop) [b]	3 / 1	A	A	A	A
I-194, Memorial Hwy loop on-ramp	2 / 1	A	B	A	B
I-194, Memorial Hwy on-ramp	2 / 1	B	B	B	B
I-194, I-94 EB off-ramp	2 / 1	A	B	B	B
I-94, I-194 EB off-ramp	2 / 1	A	B	B	C
I-94, I-194 WB on-ramp (lane add)[b]	2 / 1	B	B	B	C
I-94, Main St off-ramp (major diverge) [c]	3 / 2	A	B	B	B
I-94, Mandan Ave off-ramp	2 / 1	A	B	B	B
I-94, Mandan Ave on-ramp	2 / 1	A	B	B	B

Notes:

a - 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

TABLE 19: EXISTING CONDITIONS AND 2030 NO-BUILD CONDITIONS WEAVING SEGMENT OPERATIONS ANALYSIS

Facility	Segment	Direction [2]	Level of Service			
			AM Peak		PM Peak	
			Existing	2030	Existing	2030
ND 810	Memorial Hwy to McKenzie Dr	EB	A	A	A	A
ND 810	McKenzie Dr to Memorial Hwy	WB	A	A	A	A
I-94	Main to I-194 [1]	EB	B	C	B	B
I-94	I-194 to Main	WB	A	B	B	C

Notes:
(1) This segment length is greater than 2500' between ramps and is technically not a weaving segment.
(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

TABLE 20: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS - MORNING (AM) PEAK HOUR FOR EXISTING CONDITIONS AND 2030 NO-BUILD CONDITIONS

Intersection	MOE [1]	Overall	Level of Service			
			Intersection Approach [2]			
			EB	WB	NB	SB
Mandan Ave / I-94 WB [3]	Existing			B		
	2030			B		
Mandan Ave / I-94 EB [3]	Existing		B			
	2030		B			
Memorial Hwy / I-194 WB	Existing	A	A	A	C	
	2030	B	B	A	C	
Memorial Hwy / I-194 EB [3], [4]	Existing				F	C
	2030	B	A	A	B	A
McKenzie Dr / ND 810 WB [3]	Existing				B	
	2030				C	
McKenzie Dr / ND 810 EB [3]	Existing					A
	2030					B

Notes:
(1) MOE = Measures of Effectiveness
(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound
(3) Unsignalized intersection
(4) Traffic signalization assumed for 2030 No Build conditions.

TABLE 21: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS - AFTERNOON (PM) PEAK HOUR FOR EXISTING CONDITIONS AND 2030 NO-BUILD CONDITIONS

Intersection	MOE [1]	Overall	Level of Service			
			Intersection Approach [2]			
			EB	WB	NB	SB
Mandan Ave / I-94 WB [3]	Existing			C		
	2030			F		
Mandan Ave / I-94 EB [3]	Existing		C			
	2030		C			
Memorial Hwy / I-194 WB	Existing	A	A	A	C	
	2030	A	A	A	C	
Memorial Hwy / I-194 EB [3], [4]	Existing				E	C
	2030	A	A	A	B	B
McKenzie Dr / ND 810 WB [3]	Existing				A	
	2030				B	
McKenzie Dr / ND 810 EB [3]	Existing					A
	2030					B

Notes:
(1) MOE = Measures of Effectiveness
(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound
(3) Unsignalized intersection
(4) Traffic signalization assumed for 2030 No Build conditions.

TABLE 22: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS - MORNING (AM) PEAK HOUR FOR EXISTING CONDITIONS AND 2030 NO-BUILD CONDITIONS

Intersection	Scenario [1]	Overall	Level of Service			
			Intersection Approach [2]			
			EB	WB	NB	SB
Bismarck Expressway / Washington St	Existing	C	C	C	C	D
	2030	D	D	C	E	D
Bismarck Expressway / 2nd St [3]	Existing					B
	2030					C
Bismarck Expressway / 3rd St	Existing	B	B	A	C	C
	2030	C	D	B	C	D
Bismarck Expressway /Kirkwood Mall & Bozeman Dr [3]	Existing				F	F
	2030				F	F
Bismarck Expressway / 7th St	Existing	D	D	C	F	C
	2030	F	F	D	F	F
Bismarck Expressway /9th St & University Dr	Existing	C	C	D	D	--
	2030	F	F	F	F	--
Bismarck Expressway / 12th St	Existing	B	A	A	C	C
	2030	B	A	C	C	C
Bismarck Expressway /Airport Rd & 19th St	Existing	C	B	C	B	C
	2030	E	F	E	E	C
Bismarck Expressway / 26th St	Existing	B	A	A	C	C
	2030	C	B	C	C	C
Bismarck Expressway / Burlington Drive [4]	Existing	n/a				
	2030	A	A	A	C	C
Bismarck Expressway/Yegen Rd [4]	Existing	n/a				
	2030	B	B	C	C	--
Bismarck Expressway / Main Ave	Existing	B	C	C	A	A
	2030	F	F	F	E	F
Bismarck Expressway /Rosser Ave	Existing	A	A	--	A	A
	2030	C	C	--	B	D

Notes:

(1) Existing = Current conditions in the corridor; 2030 = Year 2030 No-Build conditions for the corridor

(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

(3) Unsignalized intersection

(4) Traffic signalization assumed for 2030 No Build conditions.

TABLE 23: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – AFTERNOON (PM) PEAK HOUR FOR EXISTING CONDITIONS AND 2030 NO-BUILD CONDITIONS

Intersection	Scenario [1]	Overall	Level of Service			
			Intersection Approach [2]			
			EB	WB	NB	SB
Bismarck Expressway / Washington St	Existing	C	C	C	C	C
	2030	D	E	E	D	D
Bismarck Expressway / 2nd St [3]	Existing					F
	2030					F
Bismarck Expressway / 3rd St	Existing	B	C	B	B	C
	2030	D	D	D	B	C
Bismarck Expressway /Kirkwood Mall & Bozeman Dr [3]	Existing				F	F
	2030				F	F
Bismarck Expressway / 7th St	Existing	C	C	C	C	D
	2030	F	D	E	D	F
Bismarck Expressway /9th St & University Dr	Existing	C	B	C	C	- -
	2030	F	E	F	E	- -
Bismarck Expressway / 12th St	Existing	B	A	B	C	C
	2030	D	A	D	D	E
Bismarck Expressway / Airport Rd & 19th St	Existing	C	C	C	C	B
	2030	F	F	F	F	F
Bismarck Expressway / 26th St	Existing	B	B	B	C	B
	2030	E	C	F	F	C
Bismarck Expressway / Burlington Drive	Existing	n/a				
	2030	B	A	B	C	C
Bismarck Expressway/ Yegen Rd [4]	Existing	n/a				
	2030	C	A	C	C	- -
Bismarck Expressway / Main Ave	Existing	B	C	B	A	A
	2030	F	F	F	F	F
Bismarck Expressway / Rosser Ave	Existing	A	B	- -	A	A
	2030	D	D	- -	C	E

Notes:

(1) Existing = Current conditions in the corridor; 2030 = Year 2030 No-Build conditions for the corridor

(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

(3) Unsignalized intersection

(4) Traffic signalization assumed for 2030 No Build conditions.

Alternatives Analysis Process

The purpose of this chapter is to present the range of alternatives that were developed to address identified corridor deficiencies. These alternatives were developed based on the input received through meetings and workshops with the public and stakeholders, from meetings with MPO, the Cities, and NDDOT staff and through operations and safety analysis. Concepts that were developed as part of this study include the following:

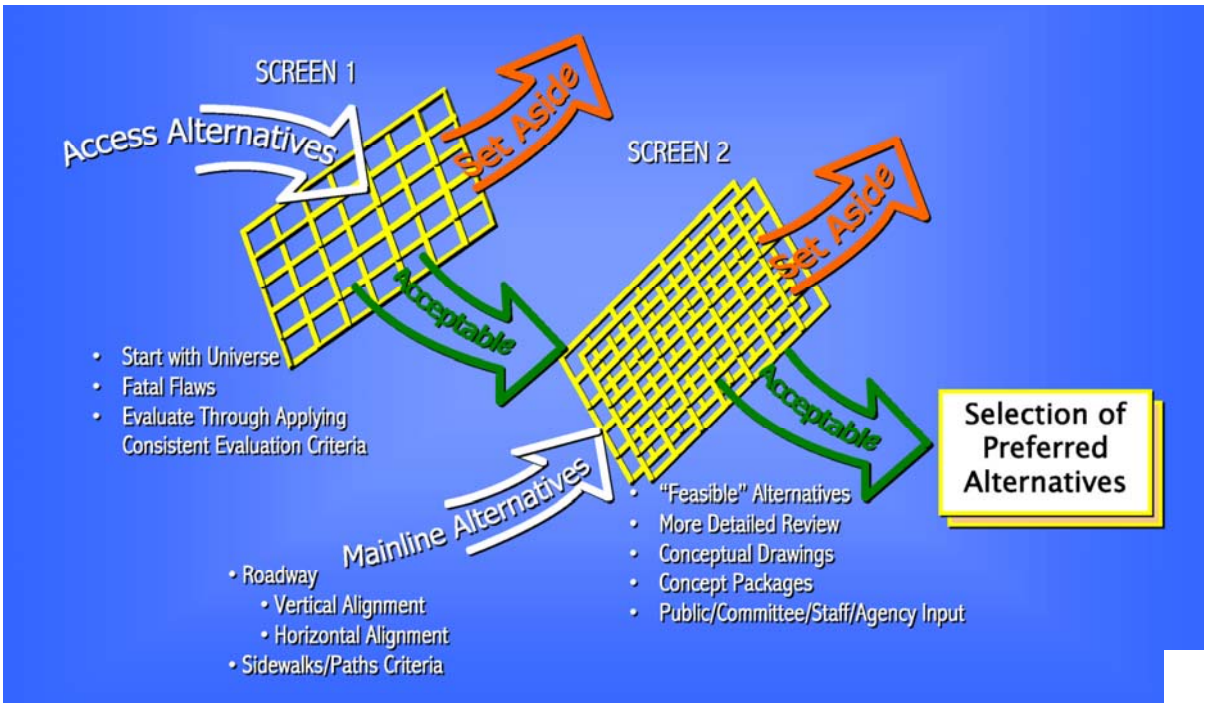
- *Transportation System Management* (TSM) Alternatives: These concepts are relatively small-scale, lower-cost improvements that do not attract/divert traffic to a corridor, but improve intersection capacity and/or corridor safety. These alternatives include intersection improvements such as additional turn lanes, traffic signal improvements, and access management.
- *Transportation System Expansion*: These concepts are larger-scale improvements that increase corridor capacity and/or address safety concerns and these projects have the potential to divert traffic to the "expansion" corridor. These alternatives include construction of new facilities or reconstruction of existing facilities to add new lanes.
- *Non-Motorized Facilities*: These alternatives include new or improved pedestrian and bicycle facilities within and crossing the study corridor.

Screening Process

The alternative analysis phase of this study was completed using a two-step screening of a broad range of alternatives for the arterial and freeway mainlines and cross routes along the corridor. The overall flow of the alternatives screening process is displayed in the chart shown on the next page. During the initial (first-level) screening a wide range of alternatives for improving operations and safety within the corridor were evaluated with the end product of placing an alternative into one of three categories:

1. Maintain the alternative for the second-level screening process.
2. Eliminate the alternative from further consideration due to an identified fatal flaw that could not be avoided without substantially reducing the concept's utility.
3. Modify the concept initially presented prior to deciding to maintain the alternative into the second-level screening.

During the second phase of the screening process the alternatives retained were evaluated in greater detail. Based on the technical reviews of the data and input from all parties involved the preferred alternatives were selected. Additional information on the preferred alternatives is provided in the next chapter.



Two-Step Alternatives Screening Process

Evaluation Criteria

The initial screening of the alternatives applied a set of evaluation criteria that would allow review of the concepts from the following perspectives:

- Social:
  - Economics.
  - Public support.
  - Consistency with other plans.
- Engineering feasibility.
- Environmental impacts:
  - Impacts to surroundings.

Alternatives Evaluated

A complete set of improvement alternatives were evaluated as part of the alternatives analysis process described above. The alternatives evaluated included both roadway system improvements and non-motorized system improvements. Different sets of roadway improvement alternatives were evaluated for the freeway sections of the corridor in Mandan and the arterial sections of the corridor in Bismarck. Complete documentation of the alternatives evaluated as a part of this study is included in Appendix A.

RECOMMENDATIONS

The primary purpose of the Interstate and Bismarck Expressway Corridor Study was to identify improvements that can be implemented to improve safety and traffic flow within and through the corridors. This corridor improvement plan provides a multimodal program for addressing current and forecasted future transportation needs for roadways and non-motorized facilities. The study process was carried out in way that allowed the study team to identify a corridor-wide strategy for addressing identified needs that:

- Meet the locally identified transportation goals and objectives. The study goals were to:
  - Develop a corridor transportation plan that looks to the future, anticipating increased traffic volume in the corridor, and provides a prioritized action plan to address current and future needs.
  - Establish a plan that addresses the multimodal transportation needs of the corridor, including autos, trucks, pedestrians, bicyclists and buses.
  - Provide a corridor transportation plan that addresses traffic operations, safety for vehicles and non-motorized travelers and corridor efficiency through enhanced access management.
- Support the mobility desires of the cities, region and state.
- Balance impacts and benefits of each concept.

RECOMMENDED CONCEPTS

An overarching goal of the study was to provide an integrated system of multimodal transportation improvements, rather than a series of standalone, isolated improvements. This integrated approach to project development offered a more efficient use of limited transportation dollars, because numerous projects can be combined to better address a specific issue. The recommended improvement alternatives for the Interstate and Bismarck Expressway Corridor Study roadways include the following:

- The preferred alternative for the Mandan Avenue interchange is Alternative I. This alternative would reconstruct Mandan Avenue to provide left-turn lanes and also construct islands on the ramps that would separate right-turning and left-turning traffic.
- The preferred alternative for the Memorial Highway and McKenzie Drive interchanges is Alternative B. This alternative would include several improvements, including new collector/distributor road and ramp replacements/reconstructions, that would address the current spacing conflicts between the Memorial Highway and McKenzie Drive interchanges.
- The preferred alternative for the I-94/I-194 and I-94/East Main Street interchanges is Alternative E-1. This alternative would

reconstruct/reconfigure the accesses and ramps on this segment of I-94 with the goals of:

1. Eliminating the non-standard left on-ramp from westbound I-94 to eastbound I-194,
2. Eliminating the weave movement for eastbound Main Street traffic destined for eastbound I-94 and,
3. Eliminating the weave movement for westbound I-194 traffic destined for westbound I-94.

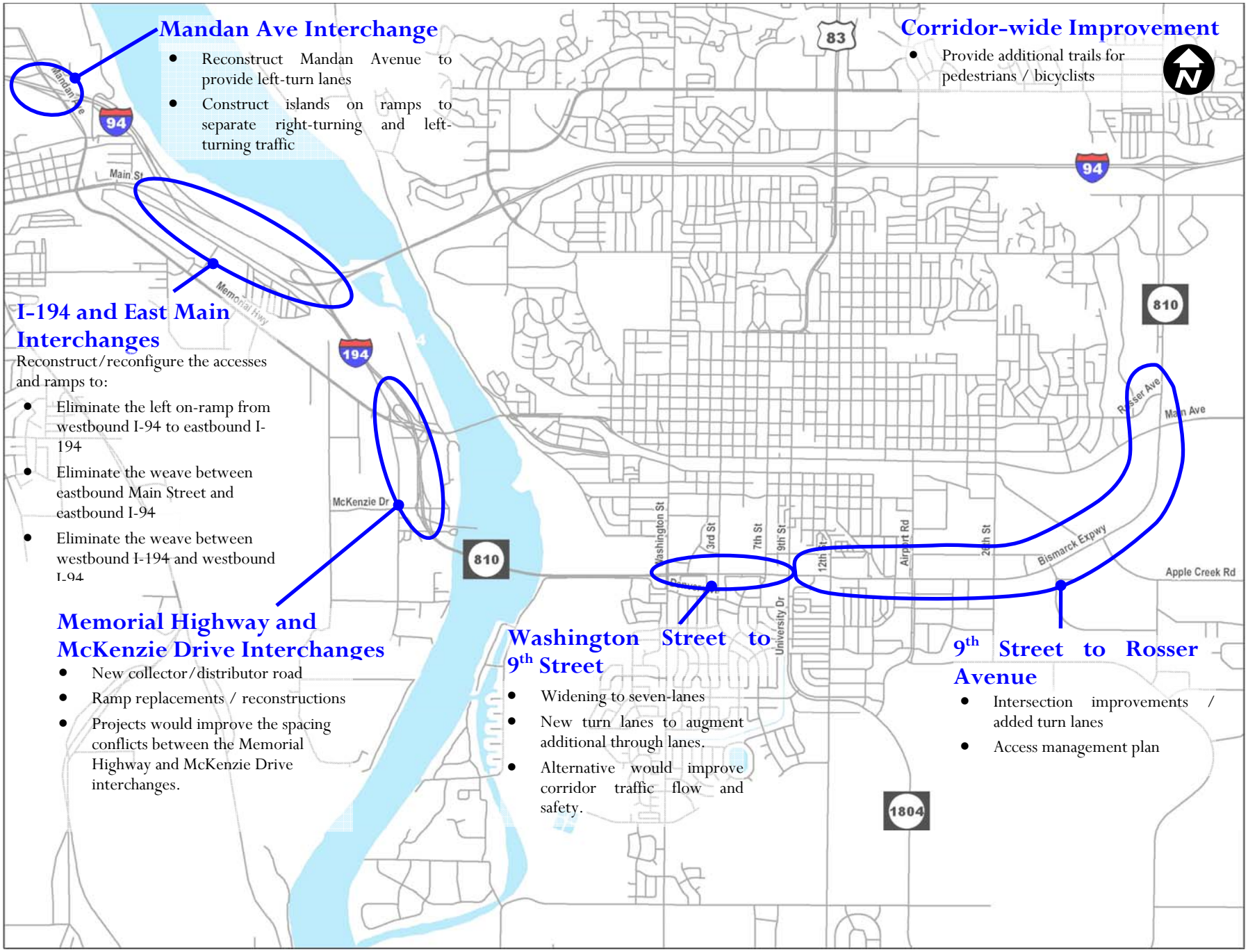
- Bismarck Expressway: Widen to a seven-lane cross section (i.e., 3 through lanes in each direction and a center left-turn lane) between Washington Street and 9th Street. This alternative would include new turn lanes in the corridor to augment the proposed additional through lanes.
- Intersection improvements only (i.e., turn lanes) for the Bismarck Expressway intersections east of 9th Street. These system management improvements would also improve the long-term traffic flow and safety operations in the corridor.
- Access management plan for Bismarck Expressway. The intended role of the Bismarck Expressway, as a principal arterial roadway, should favor mobility over access. When implemented, this plan would help preserve the corridor's long-term viability by reducing access-related crashes, preserving corridor mobility and extending the serviceable life of the at-grade arterial.
- Provide additional trails/sidewalks for pedestrians/bicyclists. As land development continues through the eastern portions of the corridor, there will be new/increased demands for pedestrian and bicycle access, particularly east of current non-motorized facilities in the corridor (which currently end at 18th Street).
- Incorporate pedestrian crossing timing adjustments and increase use of warning signs for pedestrians crossing Bismarck Expressway and for drivers traversing intersections.

The recommended projects for the Interstate and Bismarck Expressway study are displayed in Figure 20. More details on each of the recommended improvements are provided in the following sections of this chapter.

MANDAN INTERSTATE IMPROVEMENT RECOMMENDATIONS

Mandan Avenue Interchange

The preferred alternative for the Mandan Avenue interchange is Alternative I, shown as Figure 21. The addition of left-turn lanes on Mandan Avenue and the channelized islands help "organize" the turn movements at these intersections. Additionally, lengthening the on-ramps is recommended at the time of any substantial reconstruction of the interchange. The improvement would be considered longer term due to the proximity of the railroad bridge to the east and the need to widen the bridge to accommodate any substantive extension of the on-ramp.



Bismarck-Mandan
Metropolitan Planning Organization

Figure 20. Summary of Preferred Improvement Projects

Figure 21. Mandan Avenue Preferred Alternative (Alternative I)

I-94: I-194 Interchange to East Main Street Interchange

The preferred build alternative for the segment of I-94 between the I-194 and East Main Street interchanges is Alternative E-1, shown as Figure 22. This alternative separates Main Street traffic that is entering I-94 and I-194, thus eliminating the weaving movement on eastbound I-94. For westbound I-94, the proposed ramp from westbound I-194 to westbound I-94 eliminates the weave for that movement. The priority for implementation of Alternative E-1 is likely low in relation to other improvements in this study, since the crash rates in the segment do not exceed the study area average and congestion along the segment is not currently an issue (i.e. if implemented, this improvement should be constructed later in the 20-year planning period).

ND 810 / I-194: Memorial Highway Interchange to McKenzie Road Interchange

The preferred alternative for the Memorial Highway and McKenzie Road interchanges is Alternative B, shown as Figure 23. The key improvement element of this alternative is a collector-distributor (C-D) roadway for westbound ND 810 traffic. This roadway separates the ramp movements for the McKenzie Drive on-ramp and both Memorial Highway ramps from westbound mainline ND 810/I-194 traffic. This alternative also includes an eastbound I-194/ND 810 loop ramp in the northwest corner of the Memorial Highway interchange and would eliminate the on-ramp in the southwest quadrant of the interchange. These improvements for eastbound traffic would result in greater spacing between the Memorial Highway and McKenzie Drive interchange ramps.

Bismarck Expressway Improvement Recommendations

Bismarck Expressway: Washington Street to 9th Street

The following corridor and intersection improvements are recommended for the Bismarck Expressway corridor between Washington Street and 9th Street:

- Widen Bismarck Expressway to six-through lanes (7-lane cross section) between Washington Street and 9th Street. The third through lane replaces the existing right-turn lanes at the following intersection approaches:
  - 2nd Street westbound approach.
  - 3rd Street eastbound approach.
- Right-turn lanes will be maintained, added as part of the widening, at the following intersection approaches:
  - 3rd Street westbound approach.
  - Kirkwood Mall Entrance/Bozeman Drive westbound approach.
  - 9th Street eastbound and westbound approaches.

Figure 22. I-94: Main Street to I-194 Preferred Alternative (Alternative E-1)

Figure 23. McKenzie Drive to Memorial Highway Preferred Alternative (Alternative B)

- Correct the westbound direction offset for the through lanes at the Bismarck Expressway/Washington Street intersection by narrowing the median on the east approach on Bismarck Expressway to Washington Street.
- No intersection modifications, other than the third through lane in either direction are warranted at Bismarck Expressway and 2nd Street or at 3rd Street.
- Prohibit the southbound left-turn and through movement from the Mall entrance.
- Prohibit the northbound left-turn and through movement from the Bozeman Drive access point with Bismarck Expressway. In order to achieve a reasonable turning radius a larger bulb-out should be constructed at this access point.
- Remove the westbound left-turn lane at Bismarck Expressway/7th Street. This space would then be used to lengthen the eastbound left-turn lane(s) at 9th Street and Bismarck Expressway.
- Maintain the current split phase traffic signal control at Bismarck Expressway/7th Street. This will allow northbound 7th Street to function the same way as it does today. An additional right-turn lane on the southbound approach will be needed to achieve a reasonable level of service with the traffic signal operations. The additional lane results in a dual right-turn lane and is needed for the right-turn volumes on that approach.
- Add a left-turn lane to provide dual left-turn lanes for the eastbound/westbound approaches of the Bismarck Expressway/9th Street intersection. In order to improve the operations, the northbound departure lanes on 9th Street should be widened to 14 feet for the initial 100 to 200 feet north of Bismarck Expressway to better accept turn volumes. Lengthen the eastbound right-turn lane at this intersection. Also, restripe the northbound approach to provide three through lanes and one left-turn lane.
- As part of the alternatives analysis extensive discussion regarding the adjacent land use impacts of the 6-lane cross section alternative were held with MPO, city engineering, NDDOT, and fire department staff. The primary topic of the discussions was how to address the need to widen the corridor at this intersection and the impacts to commercial property to the north relative to the fire station on the south. As is detailed in the Alternatives Analysis appendix, outbound to a call movements and return from a call movements for the fire department are difficult to make. This is due to the proximity of the fire station north façade to Bismarck Expressway. In the current conditions there is minimal room to maneuver response vehicles and during the peak traffic hours returning vehicles are parked on the north side apron until Bismarck Expressway traffic volumes subside from the peak and the street can be accessed to back the vehicle into the parking bay. Parking the vehicle outside reduces the ability to replenish supplies and service the vehicle for the next run. Whether or not Bismarck Expressway is

widened there is concern as to whether the intersection with 9th Street/University Drive is the most appropriate location for a highly active fire station. Thus, providing a recommendation that holds the current south curb line may reduce the potential for impacts on the station itself, but it results in increased impacts on the commercial property to the north. If ultimately it is desirable to relocate the fire station, selecting the alternative that holds the south curbline would not necessarily be a desirable concept. Thus, three concepts are documented in the recommendations. The first retains the current south curbline location and locates all of the widening to the north. The second alternative reflects a symmetrical widening to the north and south and would likely require moving the fire station to another location. The third concept holds the north curbline consistent with the current location and widens the corridor to the south; resulting in the need to relocate the fire station.

- Provide a mid-block eastbound traffic signal between 7th and 9th Street for the fire station to improve emergency access/egress. This traffic signal will be coordinated with the traffic signals at 7th and 9th Street to clear the street area in front of the fire station driveway.
- Provide a mid-block northbound traffic signal on University Drive between Denver Avenue and Bismarck Expressway for the fire station to improve access/egress. The traffic signal will be coordinated with the traffic signal at Bismarck Expressway to clear the street area in front of the fire station driveway.

Bismarck Expressway: 9th Street to Main Avenue

The following corridor and intersection improvements are recommended for the Bismarck Expressway corridor between 9th Street and Main Avenue:

- Provide left-turn arrow signal phasing for the northbound/southbound approaches at 12th Street and Bismarck Expressway. Also, provide an eastbound right-turn lane at this intersection.
- Add a left-turn lane to provide dual left-turn lanes on both the eastbound/westbound approaches of the 19th Street (Airport Road) and Bismarck Expressway intersection. Also, provide right-turn lanes on all intersection approaches. The northbound and southbound departure lanes on 19th Street/Airport Road should be widened to 14 feet to better accept the two lanes of left turning traffic from Bismarck Expressway.
- Consolidate driveways on Bismarck Expressway between 19th Street and 22nd Street.
- No additional turn lanes other than those proposed as part of the Wal-Mart development plans are needed for the intersection of 26th Street and Bismarck Expressway. That study recommended that right-turn lanes be provided on the eastbound and westbound approaches and a northbound left-turn lane be added to the intersection.

- No additional turn lanes other than those proposed as part of the Wal-Mart and Visconsi development plans are needed for the intersection of Burlington Drive and Bismarck Expressway. Those studies recommend a traffic signal be installed at this intersection and that an eastbound right-turn lane and a southbound left-turn lane be added to the intersection. Those studies also recommend the northbound approach include a total of three lanes which includes dual left-turn lanes and a shared through/right-turn lane.
- No changes recommended for the intersection of Vermont Avenue and Bismarck Expressway.
- The proposed improvements for the Yegen Road intersection include an eastbound right-turn lane and an additional westbound left-turn lane in order to provide dual left-turn lanes on that approach. Presently, Yegen Road is being reconstructed with only one lane in the southbound direction. When the dual left turn lanes are constructed on Bismarck Expressway, a second southbound lane must be added to Yegen Road for a distance of 500 to 600 feet in order to provide a second lane to accept the two lanes of turning traffic. As the intersection includes dual left turn lanes on an approach, it is recommended that southbound departure lanes on Yegen Road be widened to include 14 foot lanes for approximately 100 to 200 feet to better facilitate turning traffic. The Yegen Road and the Northern Plains Commerce Center traffic impact study assumed the need for two left turn lanes from Bismarck Expressway and also recommends the northbound approach include two lanes with one lane each serving the left-turn and right-turn traffic.
- At the intersection of Main Avenue and Bismarck Expressway widen the eastbound approach to accommodate two through lanes and a dual left-turn lane. The additional lanes on the eastbound approach will require widening of a box culvert located about 700 feet west of the intersection. The roadway widening for the eastbound approach will also require widening on the east leg in order to maintain lane continuity. This concept would also provide right-turn lanes on the westbound and southbound approaches.
- No changes recommended for the intersection of Rosser Avenue and Bismarck Expressway.

The proposed Bismarck Expressway improvements are illustrated in Figures 24 through 38. The proposed cross-section for the Bismarck Expressway between Washington Street and 9th Street is shown in Figure 39.

Figure 24. Bismarck Expressway Preferred Alternative, Washington Street to 2nd Street

Figure 25. Bismarck Expressway Preferred Alternative, 3rd Street to Mall Entrance

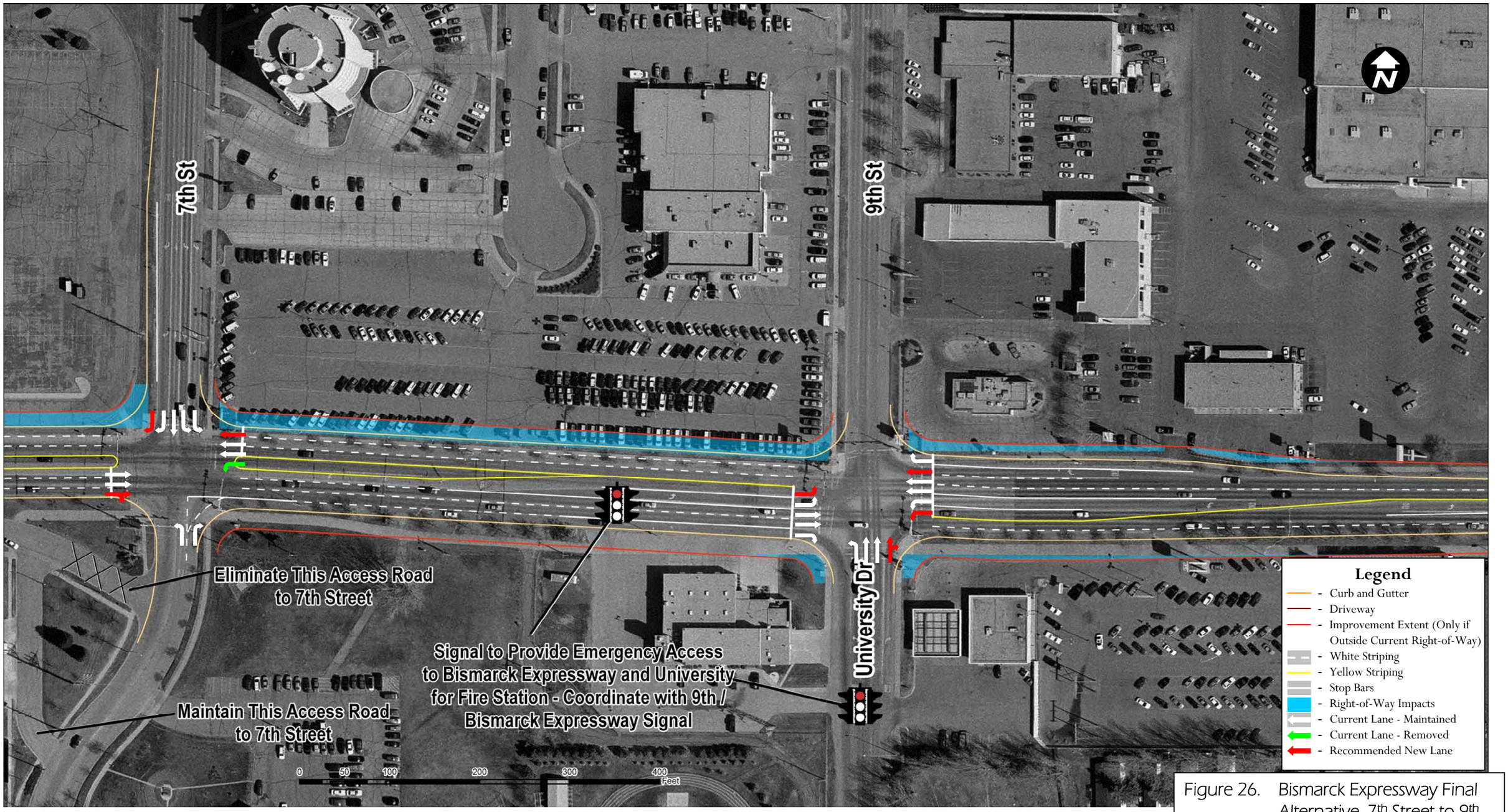


Figure 26. Bismarck Expressway Final Alternative, 7th Street to 9th Street/University Drive North Widening

Figure 27. Bismarck Expressway Final Alternative, 7th Street to 9th Street/University Drive Symmetrical Widening

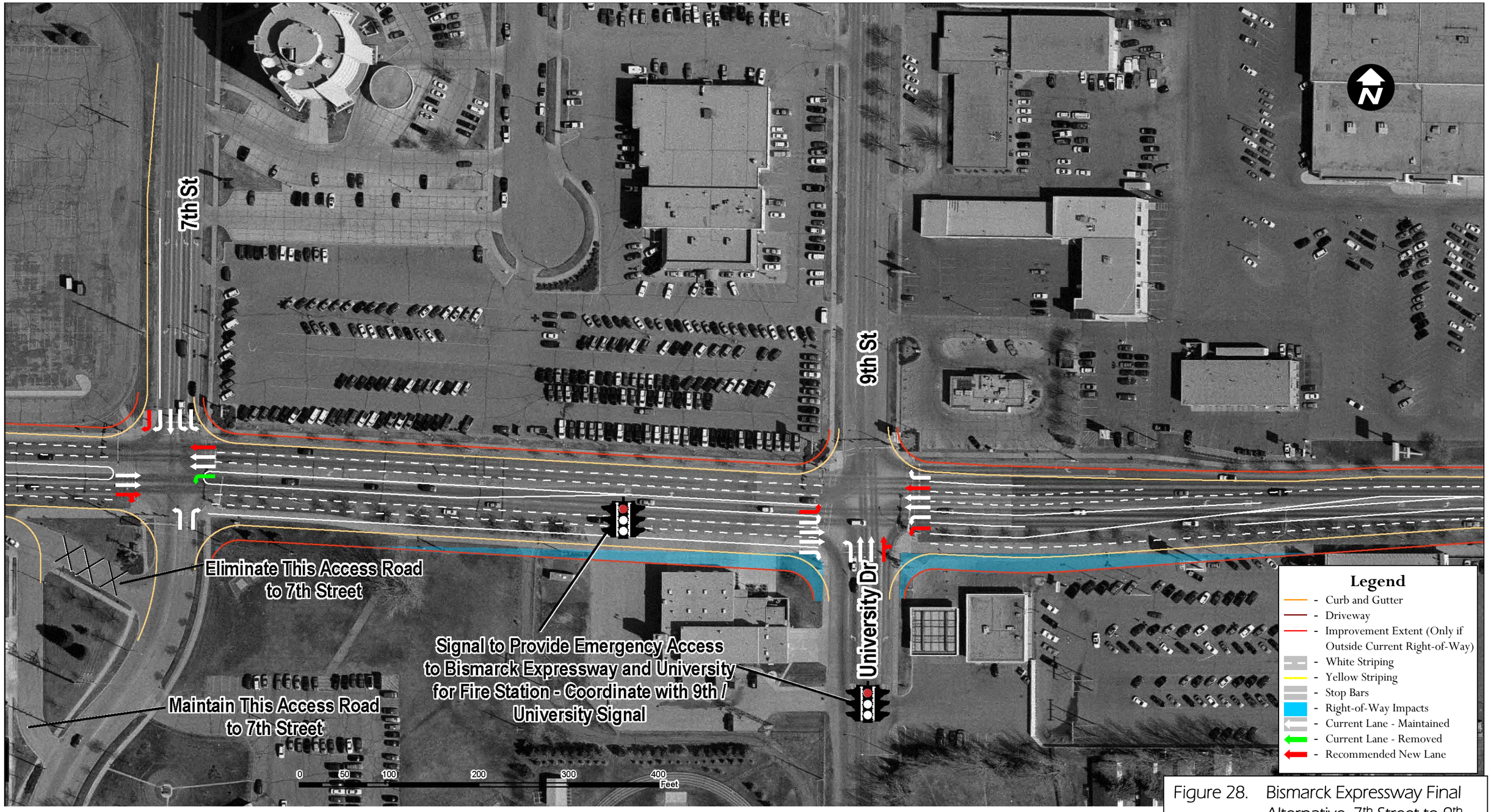


Figure 28. Bismarck Expressway Final Alternative, 7th Street to 9th Street/University Drive, South Widening

Figure 29. Bismarck Expressway Preferred Alternative, 12th Street

Figure 30. Bismarck Expressway Preferred Alternative, 18th Street

Figure 31. Bismarck Expressway Preferred Alternative, 19th Street to 22nd Street

Figure 32. Bismarck Expressway Preferred Alternative, 22nd Street to 26th Street

Figure 33. Bismarck Expressway Preferred Alternative, 26th Street to Burlington Drive

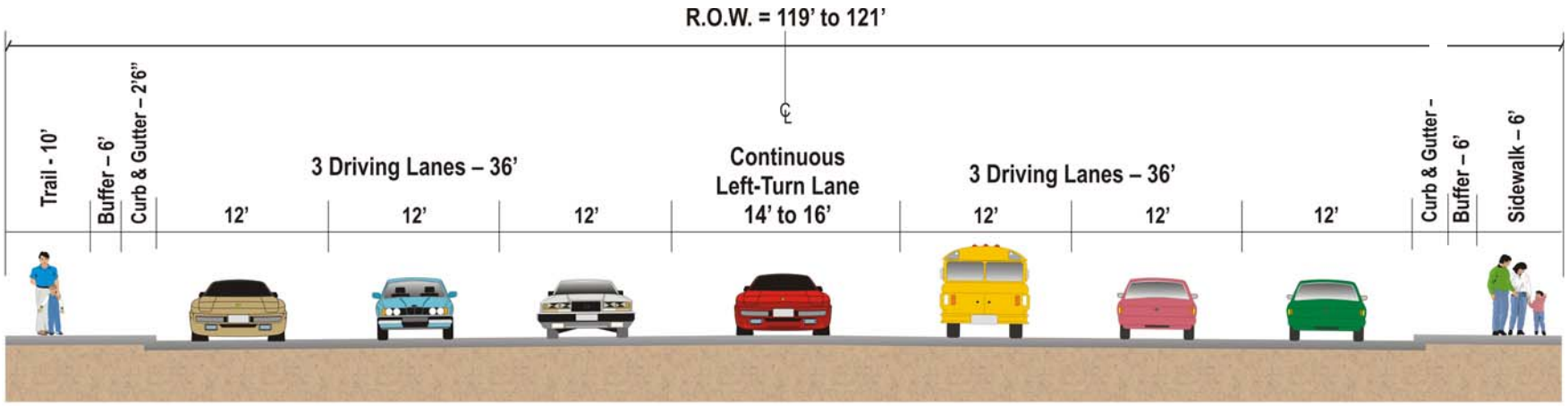
Figure 34. Bismarck Expressway Preferred Alternative, Vermont Avenue

Figure 35. Bismarck Expressway Preferred Alternative, Apple Creek Road

Figure 36. Bismarck Expressway Preferred Alternative, East of Apple Creek Road

Figure 37. Bismarck Expressway Preferred Alternative, South of Main Avenue

Figure 38. Bismarck Expressway Preferred Alternative, Main Avenue to Rosser Avenue



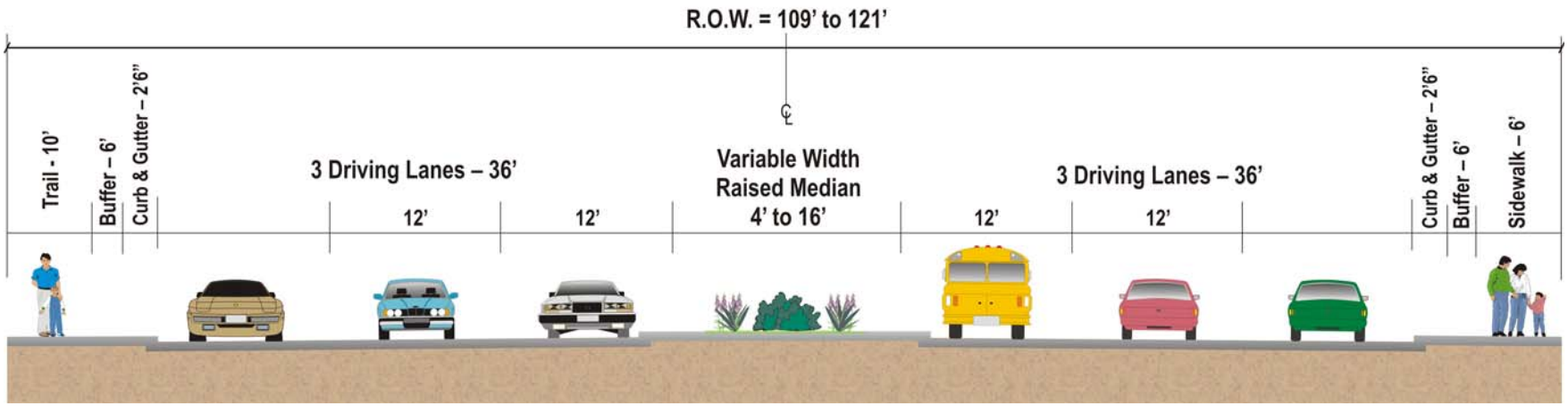


Figure 39. Bismarck Expressway, Washington Street to 9th Street: Preferred Cross-Section

PEDESTRIAN/BICYCLE SYSTEM RECOMMENDATIONS – PARALLEL TO BISMARCK EXPRESSWAY

As documented in Chapter 6, there are several study area multi-use trail and sidewalk improvements recommended in both the *Bismarck-Mandan Metropolitan Area Long Range Transportation Plan* and the Bismarck Parks and Recreation *The Path to 2005* plan. To augment the improvements recommended in these local plans, this study recommends additional trail improvements that are documented below:

- 19th Street / Airport Road – continue the trail south from Michigan Avenue to Bismarck Expressway. There is currently a 30-36' boulevard separating the frontage road from Airport Road where a trail could be built. This trail connection would also provide a traffic signal to cross Bismarck Expressway.
- Bismarck Expressway – continue the trail and sidewalks from 18th Street to a minimum of 26th Street and preferably to Burlington Drive. This would provide critical pedestrian access to a new retail area in Bismarck.
- 26th Street – At a minimum a sidewalk should be provided along this street from Main Avenue to Bismarck Expressway.

The proposed multi-use trail system is shown in Figure 40.

The segment of Bismarck Expressway between Burlington Drive and Main Avenue is relatively undeveloped. In this segment there is also a major bridge structure that traverses the railroad that currently does not have adequate width to accommodate sidewalks or a trail. It is not recommended that pedestrian facilities be provided along this segment of Bismarck Expressway since pedestrian trails are already proposed along both Main Avenue and Rosser Avenue.

The proposed roadway improvement plan for Bismarck Expressway recommends a six-lane facility between Washington Street and 9th Street. A wider street requires more time for pedestrians to cross safely. It is recommended that the required time for pedestrian crossing only be provided when the pedestrian button is activated. If a pedestrian button is not activated the 'walk' signal is not displayed.

PEDESTRIAN/BICYCLE SYSTEM RECOMMENDATIONS – CROSSING BISMARCK EXPRESSWAY

The proposed roadway improvement plan for Bismarck Expressway recommends a six-lane facility between Washington Street and 9th Street. A wider street requires more time for pedestrians to cross safely. It is recommended that the required time for pedestrian WALK indication only be provided when the pedestrian push button is activated. If a pedestrian push button is not activated the WALK signal is not displayed and signage should be added to the pedestrian push button to inform the

pedestrian they must use the pedestrian push button. The pedestrian crossing time will be adequate to cross all of the travel lanes. Additional regulatory signage should also be installed informing motorists they must yield to pedestrians in the crosswalks. The use of adult crossing guards at the 12th Street intersection should be continued for this school crossing.

RIGHT-OF-WAY ESTIMATES

It is anticipated that the Mandan interchanges can all be reconstructed with minimal right-of-way acquisitions. The Bismarck Expressway improvements will require additional right-of-way, however, the cost for the right-of-way is not included in the cost estimates contained in the previous section. The estimated right-of-way impacts for the Bismarck Expressway improvements are provided in Table 24.

TABLE 24: ESTIMATED RIGHT-OF-WAY IMPACTS FOR BISMARCK EXPRESSWAY

Segment	South Side of Roadway		North Side of Roadway	
	Total (Square Feet)	Average. Width (Feet)	Total (Square Feet)	Average. Width (Feet)
Washington St to 2nd St	0	0	6,765	12
2nd St to 3rd St	0	0	7,830	9
3rd St to 7th St	0	0	22,815	16
7th St to 9th St				
North Widening Option	860	1	9,585	14
Symmetrical Widening Option	3,430	5	2,370	3
South Widening Option	8,530	13	320	0
9th St to 12th St	9,205	8	7,140	6
12th St to 18th St	16,645	8	18,520	9
18th St to 19th St	12,200	25	3,625	8
19th St to 26th St	24,335	10	26,405	11

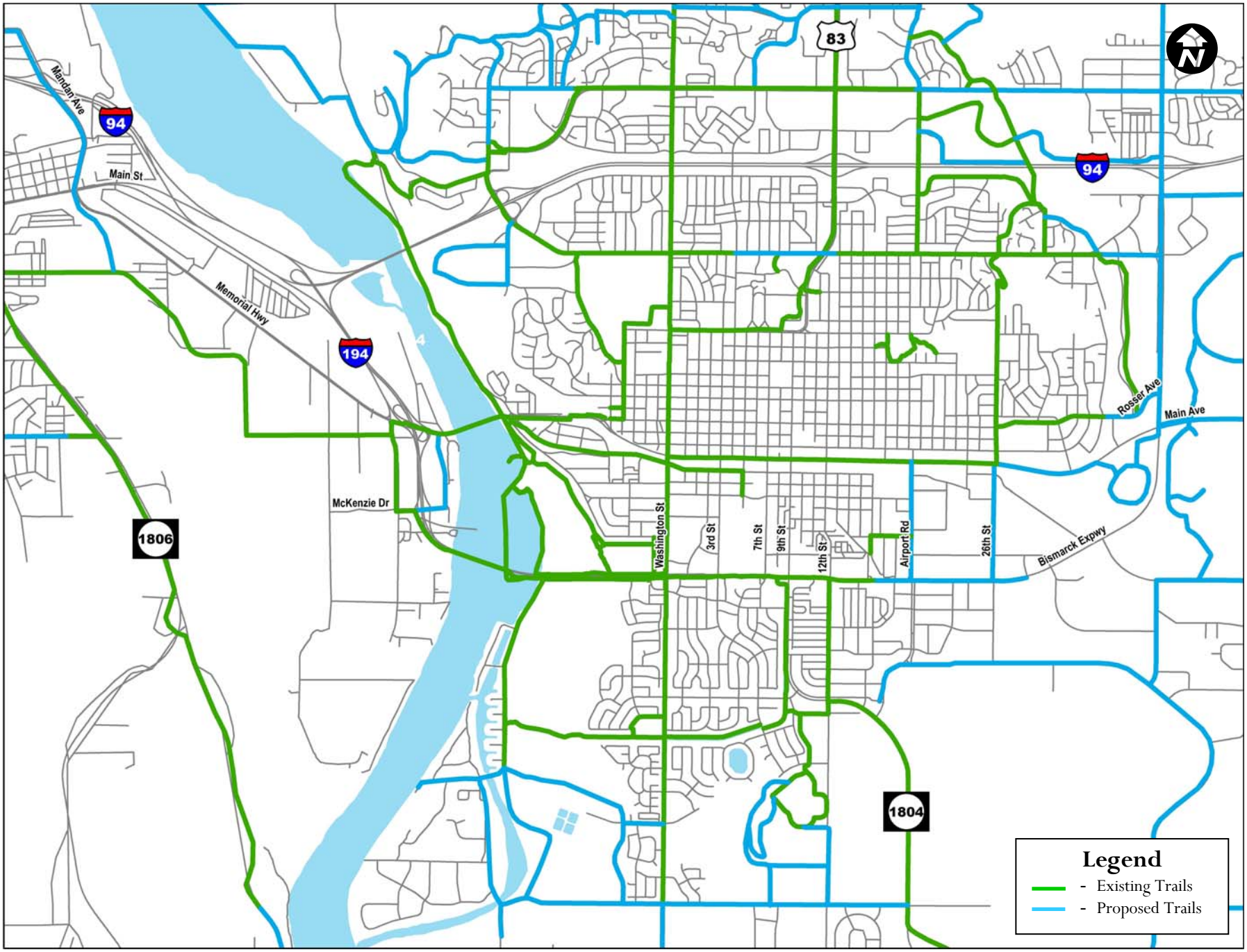


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FIGURE 40. Existing and Proposed Multi-Use Trails

Cost Estimates

A preliminary set of cost estimates have been developed for the recommended alternatives. The cost estimates have been developed to a level appropriate for a planning level corridor study, through four steps:

- *Development of Unit Costs*: These are the cost associated with general types of improvements (e.g., roadway surfacing or bridge cost) on a per-unit basis.
- *Application of Unit Costs to the Various Alternatives*: The quantity of the various improvement types (e.g., square feet of roadway surfacing and bridge deck) were calculated for each alternative and the unit costs were applied. This step establishes the cost for the big ticket items (e.g., pavement, bridges) included for each alternative.
- *Development of Other Project Cost Elements*: Additional cost elements (e.g., drainage/utilities, signing/striping, traffic control during construction) are included in each construction project. Each of these cost elements are calculated as a percentage of the total cost for the big ticket items. For example, the drainage/utilities cost element would be 3-10% of the cost for the big ticket items.
- *Development of Total Project Cost Estimate*: The total project cost estimate for each alternative is the cost of the big ticket items plus the various cost elements.

A primary source of data for the unit costs used in developing the preliminary cost estimates was the construction unit costs (i.e., bid tabs) information available from the NDDOT. That information was supplemented with unit-cost data from other sources. A summary of the estimated cost associated with each of the recommended alternatives is provided below:

- Mandan Avenue Interchange (Alternative I) = $4.13 million
- I-94: I-194 Interchange to East Main Street Interchange (Alternative E-1) = $9.14 million
- ND 810 / I-194: Memorial Highway Interchange to McKenzie Road Interchange (Alternative B) = $16.84 million
- Bismarck Expressway, Washington Street to Rosser Avenue = $19.50 million (for concrete pavement)
- Bismarck Expressway, Washington Street to Rosser Avenue = $13.05 million (for asphalt pavement)

Additional detail for the above cost estimates is provided in Appendix B.

Implementation of the Recommendations

As is documented in the Existing Conditions chapter, in general the corridor currently operates at acceptable levels-of-service and there are a limited number locations where higher crash rates are currently observed. While it was not a part of this traffic operations and safety corridor study, NDDOT staff has commented that portions of the corridor currently approach or are below established NDDOT guidelines for initiating a pavement rehabilitation project. The scheduling for corridor maintenance projects has been setback until the completion of this corridor study. There are a number of corridor improvements in the current STIP for the period from 2007 through 2010, including:

- Bismarck Expressway over the Missouri River: Deck overlay in the 2008-2010 period at a cost of $1.9 million.
- Installation of an anti-icing system on the Bismarck Expressway bridge over the Missouri River in the 2008-2010 period at a cost of $1.3 million.
- Expansion of Mandan Avenue from Main Street to I-94 in the 2008-2010 period at a cost of $6 million.
- Overlay of the McKenzie Drive interchange in 2007 at a cost of $104,000.
- Overlay of I-194 and ND 810 in the 2008-2010 period at a cost of $1.2 million.
- In 2011, 2013 and 2015 the Department has budgeted for pavement rehabilitation projects along Bismarck Expressway. Specific segments have not been identified at this point in time. Following completion of the corridor study and review of the Public Ride Perception Index (PRPI) information, specific segments will be identified and improvement plans will be prepared.

Thus, whether it is to address current or future operations/safety concerns or to address pavement conditions, an action involving at least partial corridor reconstruction/ reconstruction is warranted at this time.

Cost estimates for the recommended improvements associated with this study total over $62 million, and these improvements have not been incorporated into the MPO LRTP or the State Transportation Improvement Program (STIP). As corridor improvements would likely include use of federal funds, which requires that the projects be first included in the LRTP and the STIP, it is unlikely that substantial portions of the recommended improvement plan would be implemented within the next 5 to 10 years. It may be possible, however, to implement lower cost improvements in a more near term period.

Support for implementation of the majority of the recommended improvements is tied to the results of the traffic operations analyses that were completed using traffic reflective of the current (2005) and the future (2030) conditions. In the period from 2006 through 2030 traffic will increase incrementally as development projects directly adjacent to the corridor come on-line, and as regional development continues. Thus, the list of improvements will be warranted sometime in the period before 2030. The primary question to answer at this time is when in the period will the expansion improvements be needed. As there is no documented timeline for each portion (project) of the entire increment of regional development that generates the increment of traffic that results in the need for the corridor capacity improvement, the process employed for determining the general timing is documented below:

- Identify the locations currently in need of improvements based on current peak period traffic operations or identified safety concerns in the corridor.
- Based on current needs (safety/capacity) and the description of the recommended improvements, determine whether it is reasonable and feasible to segment the corridor-wide improvements. For example, in the current conditions, the intersection of Bismarck Expressway/7th Street operates at LOS D or worse and capacity improvements are included in the recommendations. The next step should be to determine if it is possible to separate out the Bismarck Expressway at 7th Street improvements for earlier implementation than improvements to Bismarck Expressway at 3rd Street, which are not warranted (based on traffic operations) until a later period.
- Develop a corridor-wide plan that addresses a combination of current and future needs and the scale of the improvements needed (i.e. more costly improvements that address needs that are likely to arise later in the planning period would be placed in a more future implementation period than lower-cost improvements that could address a current need).

Using the methodology listed above, the corridor recommendations were reviewed and placed into the following periods:

- Immediate: Within the next 5 years.
- Short-term: Within the next 5-10 years.
- Mid-term: Implemented 10 to 20 years into the future (before 2025)
- Longer-term: Implementation beyond 20 years or at a time that a substantial corridor maintenance project is completed.

Figure 41 displays the recommended implementation timing.

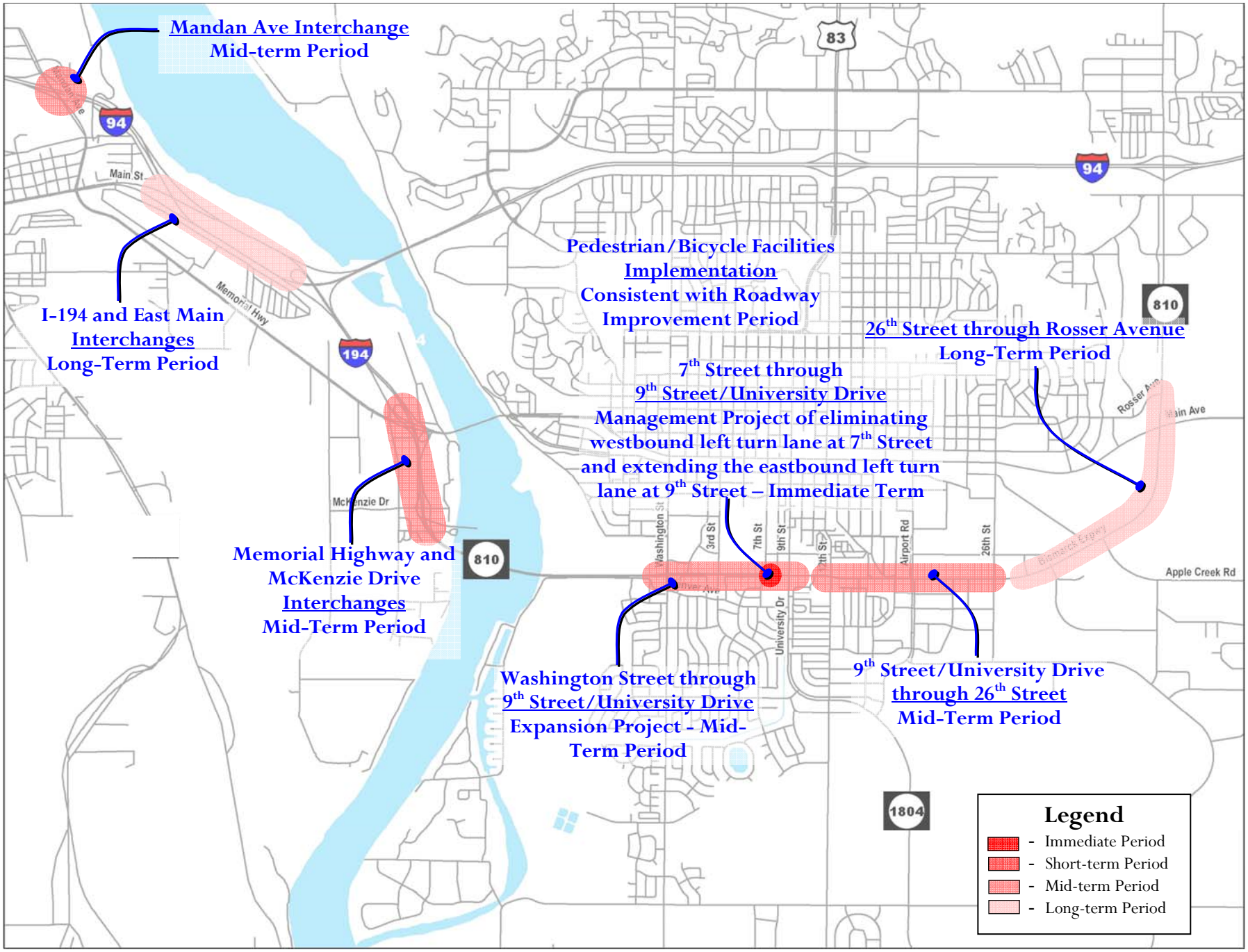

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Figure 41. Recommendation Implementation Schedule

APPENDIX A

ALTERNATIVES ANALYSIS

This appendix presents the universe of alternatives reviewed in the course of the Interstate and Bismarck Expressway Corridor Study. The alternatives analysis process mirrored the discussion included in the study report chapter titled "Alternatives Analysis". This appendix has divided the alternatives analysis into a discussion of the roadway improvements evaluated and a separate discussion of the non-motorized (pedestrian and bicycle) improvements evaluated.

Roadway Alternatives Considered

Mandan Interchange Alternatives

The interchange alternatives for the Mandan portion of the study corridor were developed by:

- Determining and documenting of the current and horizon year 2030 transportation issues and deficiencies.
- Reviewing information gained through the public involvement process and from agency coordination

A summary of issues and preliminary concepts associated with the Mandan interstate facilities is provided in Figure A1.

Mandan Interchanges Universe of Alternatives

The development of improvement alternatives for the freeways in Mandan focused on three sub-areas listed below:

- Mandan Avenue Interchange
- I-94: Main Street to I-194 Interchanges
- Memorial Highway and McKenzie Drive Interchanges

The current I-94 interchange at Mandan Avenue has relatively low traffic volumes, but a fairly high percentage of heavy vehicles. The current interchange configuration is an I-94 overpass of Mandan Avenue. This means that vehicles accessing I-94 from Mandan Avenue must go up a grade on the on-ramps. The space between the piers under the I-94 bridge is not wide enough to accommodate left-turn lanes for Mandan Avenue traffic.

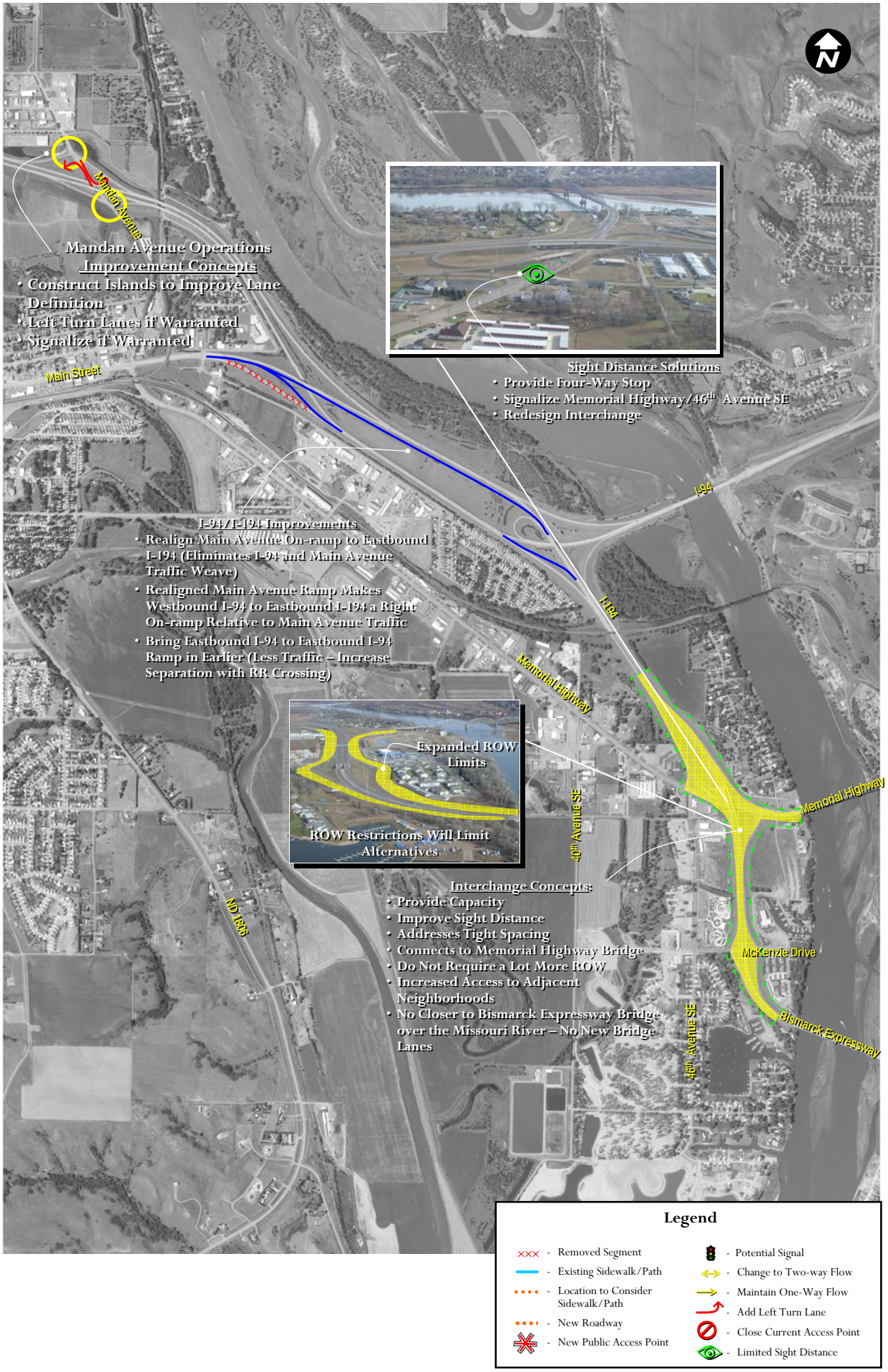

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Figure A1. Improvement Concepts Considered in Mandan

The segment of I-94 between the I-194 and East Main Street interchanges is the busiest stretch of I-94 within the Bismarck-Mandan region. During the morning and afternoon peak travel periods there is a considerable amount of weaving traffic within this segment of I-94. The predominant crash type in this segment of I-94 is sideswipe collisions, which indicates some motorists have difficulty with the weaving that occurs on this segment. Despite the relatively high traffic volumes on this segment, the traffic operations analysis and field observations did not find significant congestion or issues at the present time. In the future as traffic and weaving volumes continue to grow and the need to address the weaving issue should be addressed.

The McKenzie Drive and Memorial Highway interchanges are located in close proximity to one another along ND Highway 810 (I-194). Currently, the McKenzie Drive interchange serves a lower level of volume. However, traffic volumes are projected to increase significantly with the extension of McKenzie Drive to the west and new developments that will use the interchange to access the regional system. The increased traffic volumes at the McKenzie Drive interchange will result in degraded traffic operations along ND 810 due to the short weaving distances available between these two interchanges.

The interchange alternatives that were developed for the first level screening are shown graphically as Figures A2 through A11. A brief description of each alternative along with the positives and negatives for each alternative is provided in Table A1.

MANDAN INTERCHANGE FIRST-LEVEL ALTERNATIVES SCREENING

These alternatives were presented to members of Bismarck-Mandan MPO, Cities of Bismarck and Mandan, and NDDOT staff through a memorandum (dated January 10, 2006) and were reviewed during a workshop held on January 19, 2006. The purposes of the workshop was to discuss each of the issues, to discuss the alternatives developed to address the issues, to determine whether there are other alternatives that needed to be added, and to screen out those alternatives identified that do not reasonably address the transportation issues. The definition of "do not reasonably address" would include:

- Result in substantial impacts to adjacent uses/environment relative to the level of relief provided.
- Cost relative to the transportation budget and relative to the level of relief provided.
- The concept is inconsistent with local land use, environmental or transportation practices and/or policies.

The concept would not likely gain support from the community.

Figure A2. Alternative A – McKenzie Drive to Memorial Highway

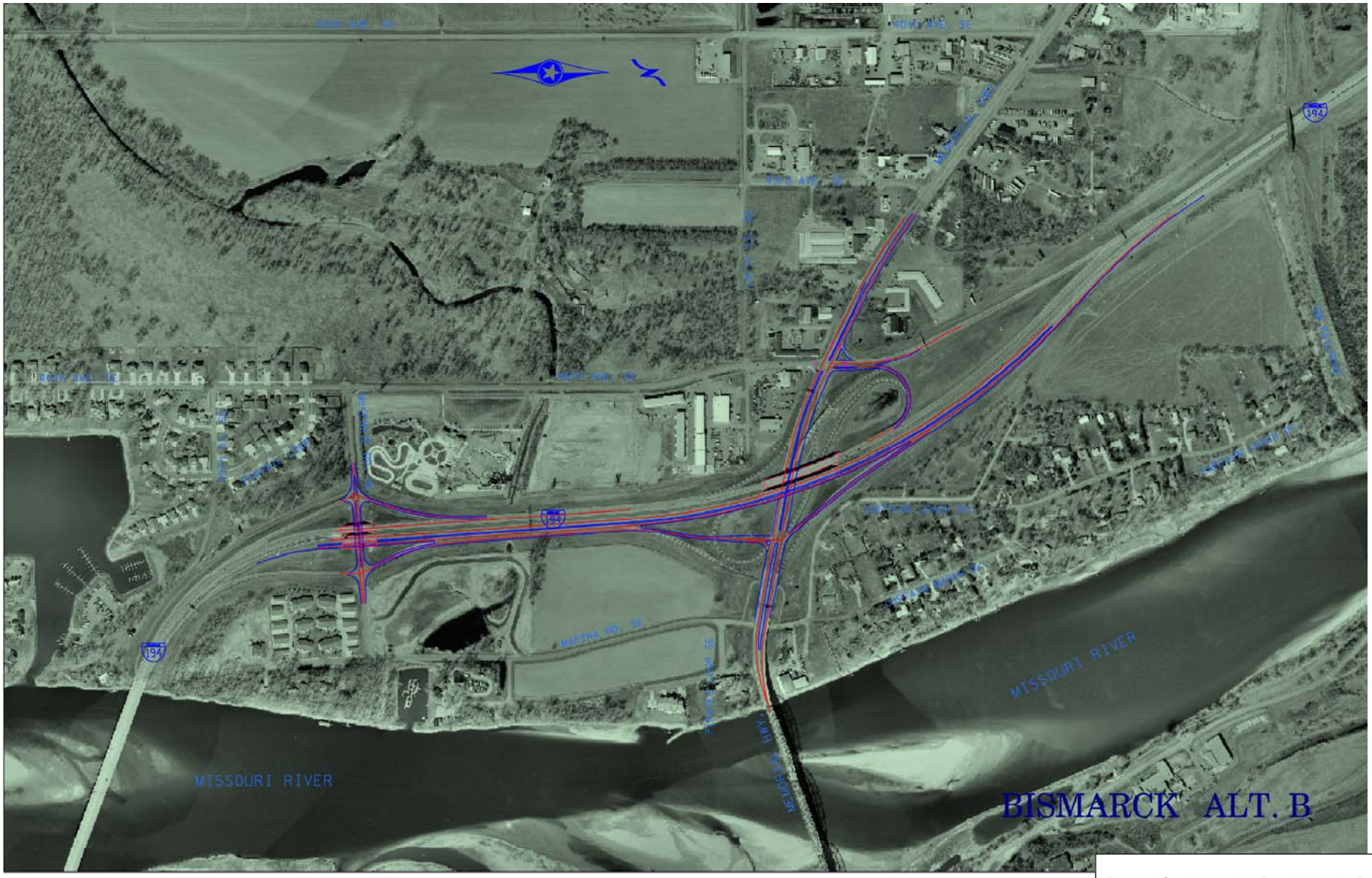

Figure A3. Alternative B – McKenzie Drive to Memorial Highway

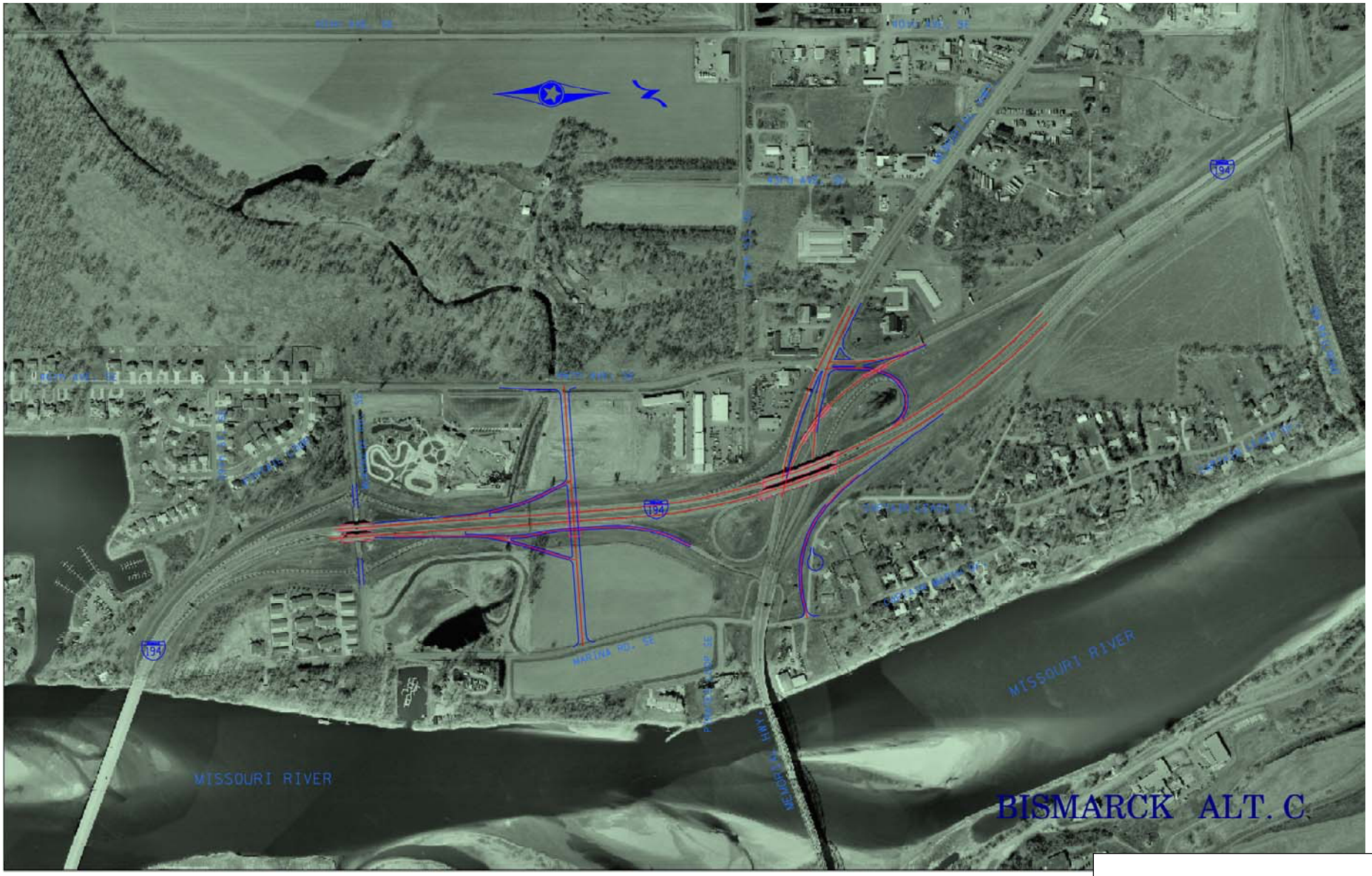

Figure A4. Alternative C – McKenzie Drive to Memorial Highway

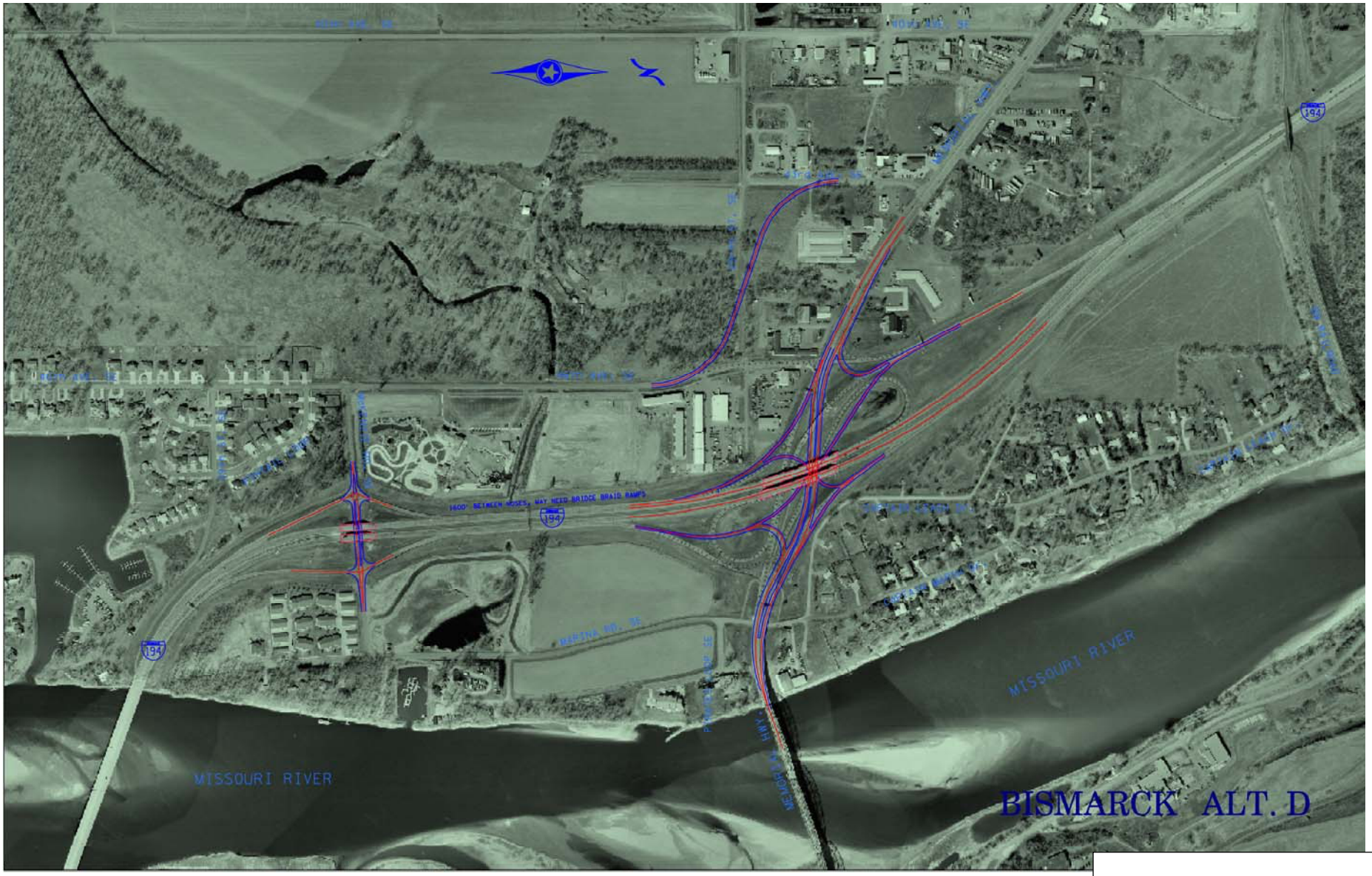

Figure A5. Alternative D – McKenzie Drive to Memorial Highway

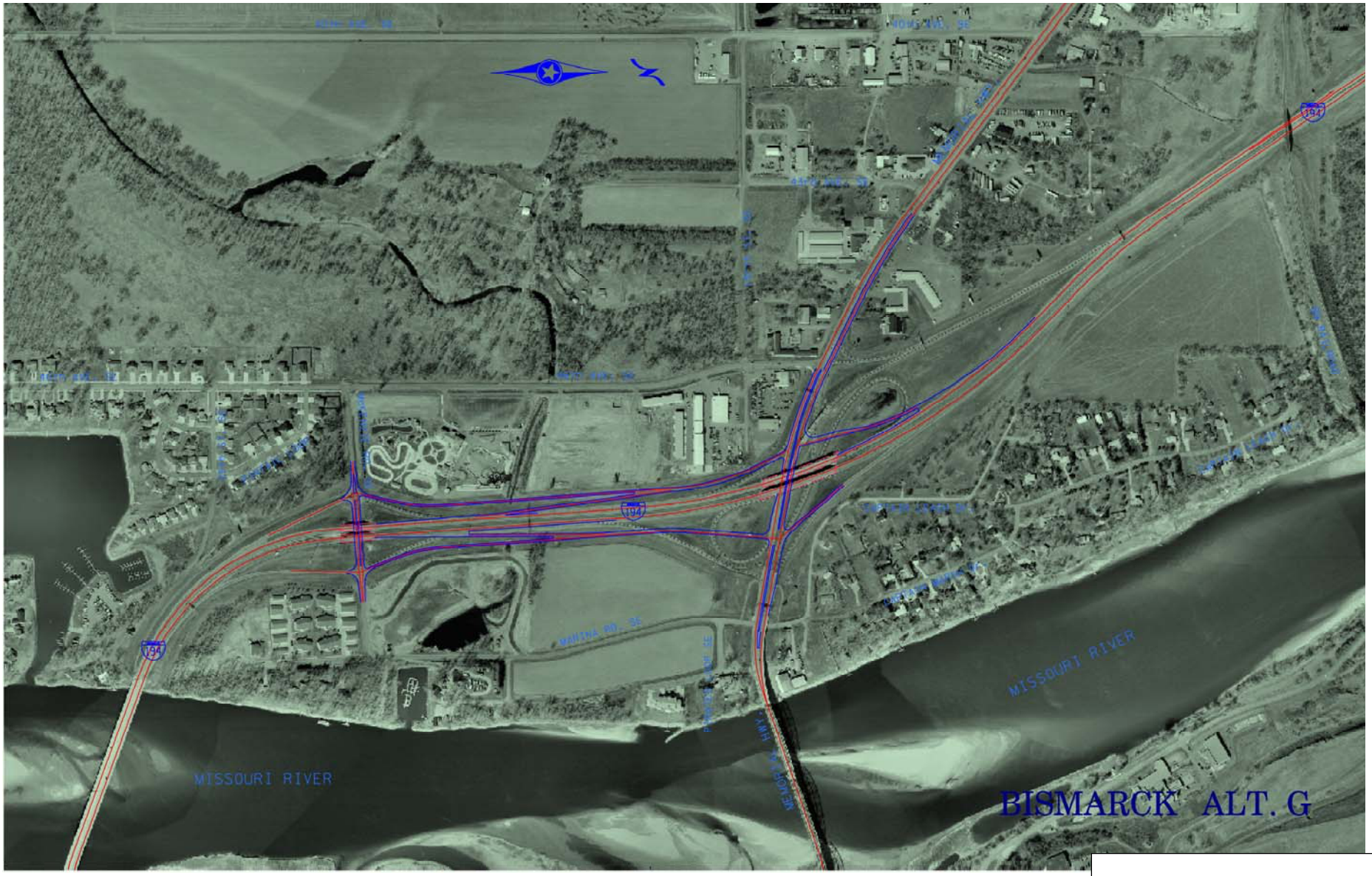

Figure A6. Alternative G – McKenzie Drive to Memorial Highway

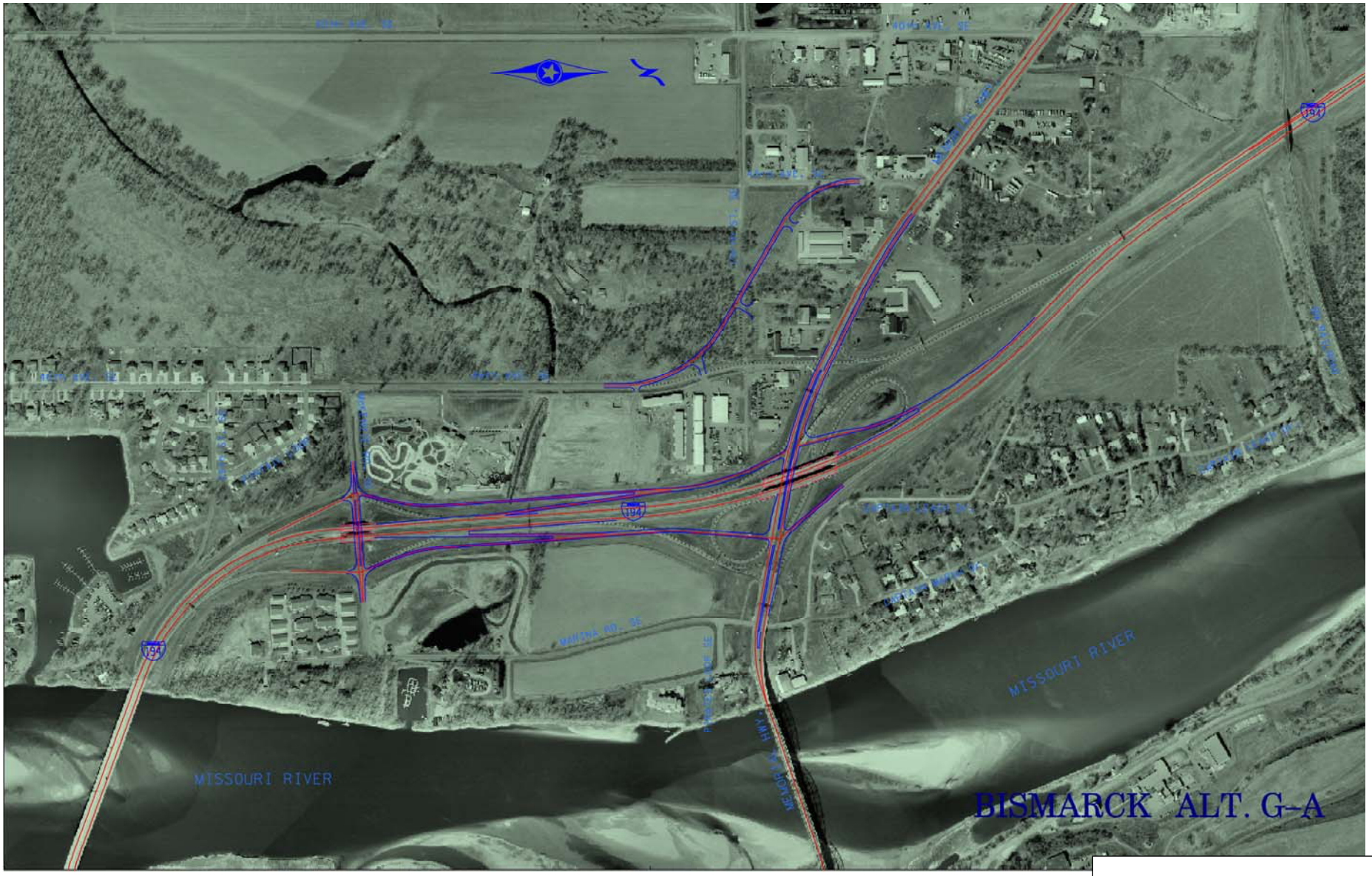

Figure A7. Alternative G –A – McKenzie Drive to Memorial Highway

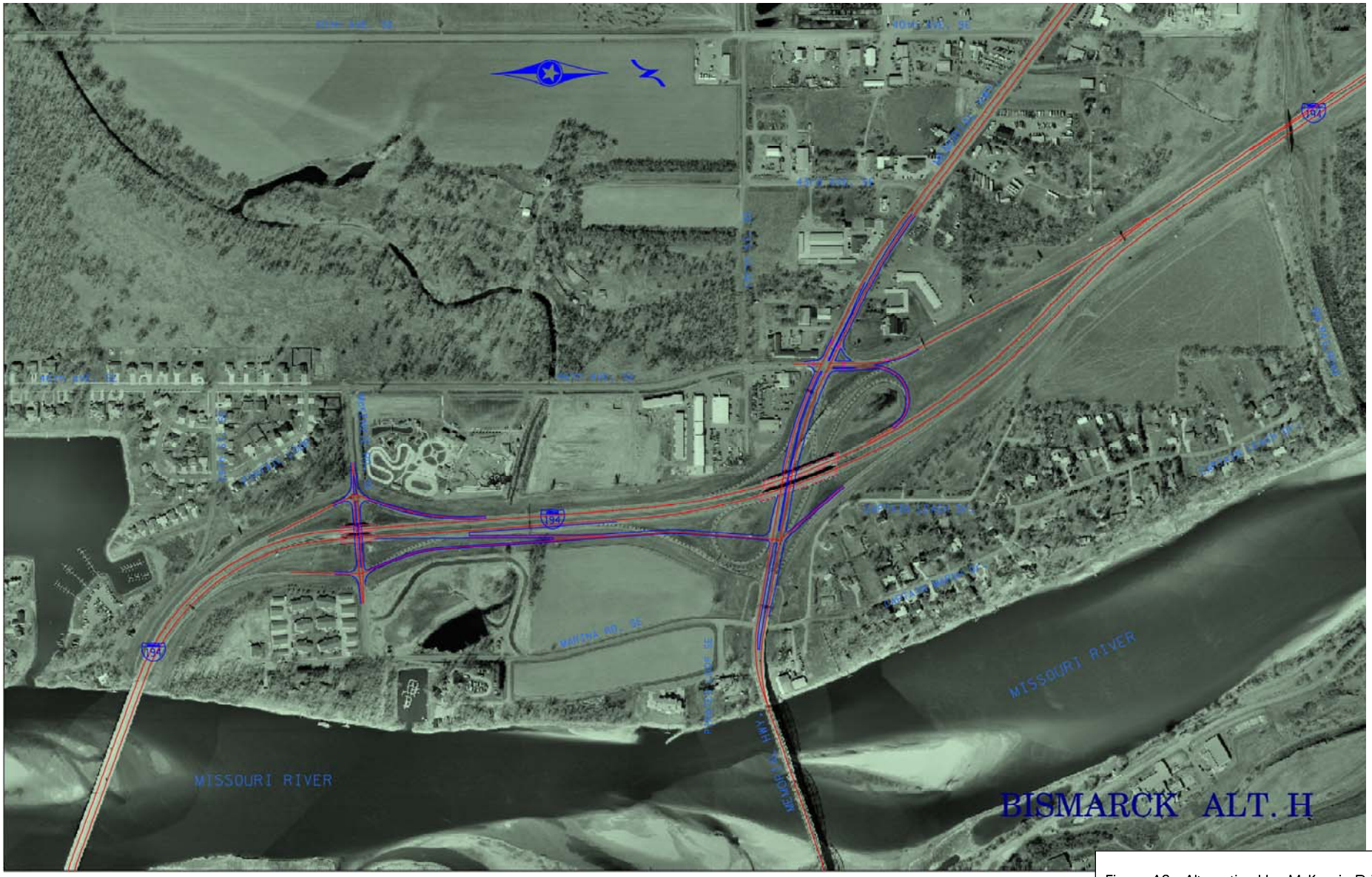

Figure A8. Alternative H – McKenzie Drive to Memorial Highway

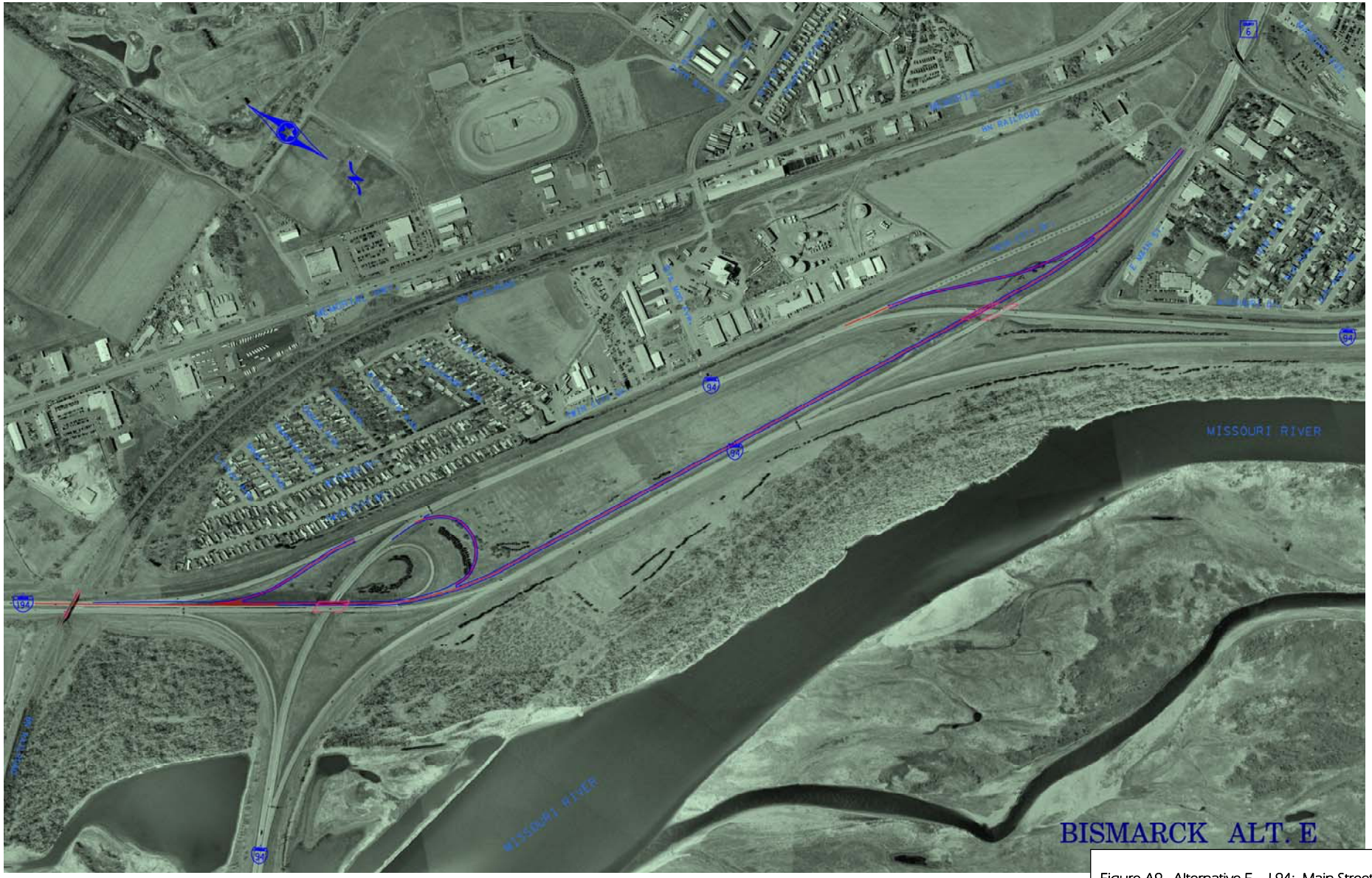

Figure A9. Alternative E – I-94: Main Street to I-194

Figure A10. Alternative F – Mandan Avenue

Figure A11. Mandan Avenue Preferred Alternative (Alternative I)

TABLE A1: SUMMARY OF INTERCHANGE CONCEPTS

Alternative	Description	Positives	Negatives
Memorial Highway and McKenzie Drive Interchanges			
A	Goal is to improve operations at McKenzie Drive/Expressway by: • Removing signal at Memorial Highway/I-194. • Replace the current diamond at McKenzie Drive with a SPUI. • Provide more direct NE quadrant neighborhood access through an interchange/overpass. • Relocate the 46th Avenue SE connection at 43rd Avenue SE. • Remove eastbound to northbound loop to free up lane for eastbound I-194 to Memorial Highway freeflow movement.	+ No signals on Memorial Hwy at I-194. + Memorial Hwy to/from I-194 is free flow. + Improved local between I-194 and the Missouri River + 46th Ave SE/Memorial Hwy intersection is removed. Corrects existing sight distance problem. + Higher capacity interchange at Expressway/ McKenzie Drive - Better accommodate anticipated growth.	– Proposed northbound on-ramp –shortens weaving section to the NB I-194 ramp to I-94. – Potential conflict between railroad bridge and proposed northbound on-ramp. – Westbound Memorial Highway to eastbound Expressway movement is more circuitous.
B	Goal is to improve the spacing conflicts between Memorial Highway and McKenzie Drive by: • Establishing westbound collector-distributor road integrating McKenzie Drive and Memorial Highway. • Replacing eastbound Expressway on-ramp with a loop in NW quadrant. • Eastbound I-194 to eastbound Memorial Highway flyover replaced with ramp to Memorial Highway (signalized). • Assume signalization of both Memorial Highway ramp terminals.	+ Collector-distributor (C-D) removes the westbound weaving from mainline of Expressway. + Loop in NE quadrant increases the eastbound weaving distance on Expressway. + Provides a more "standard' diamond. + Greater Memorial Highway interchange signal spacing. + Opportunities to improve Memorial Highway sight distance deficiencies. + Improved traffic operations between McKenzie Drive and Memorial Highway.	– Higher volume exiting at McKenzie; may need to lengthen off-ramp auxiliary lane – which may extend to Missouri River bridge (widen bridge?). – Still require two signals at Memorial Highway interchange – Most Memorial Highway movements from I-194 and Expressway requires traversing two signals. – Not a substantial increase in McKenzie Drive ramp terminal capacity. – Requires reconstruction (widening) of the westbound bridges at the McKenzie Drive and Memorial Highway interchanges.

Alternative	Description	Positives	Negatives
C	Goal is to increase the separation between McKenzie Drive and the Missouri River Bridge and to improve the weave between McKenzie Drive and Memorial Highway: • Modify the McKenzie Drive interchange to a half diamond from/to the south and relocated approximately ¼ mile north. • A westbound Expressway to Memorial Highway ramp would be combined with the McKenzie Drive off-ramp. • McKenzie Drive access to north I-194 would be provided at the Memorial Highway interchange. • The eastbound Memorial Highway to eastbound Expressway ramp would be replaced with a loop. • The westbound Memorial Highway to eastbound Expressway entrance point would be moved from the east side of the interchange to 46th Avenue SE. • Signals are assumed for the Memorial Highway and McKenzie Drive ramp terminal intersections.	+ Improved ramp spacing between Memorial Highway and McKenzie Drive.	– McKenzie Drive accessibility negatively impacted. – Significant negative impact to western extension of McKenzie Drive. – Two signals at Memorial Highway terminals. – 46th Avenue SE sight distance issues, only marginally improved. – Relocating McKenzie Drive negatively impacts developable land. – New roadway alignment / interchange negatively impacts developable land.

Alternative	Description	Positives	Negatives
D	Goal of concept is improve I-194/Memorial Highway operations, while attempting to reuse as many bridge components as possible at Memorial Highway: • Single Point Urban Interchange with the signalized intersection located below the Interstate/Expressway mainline. • Replace all ramps at Memorial Highway. • Retain both I-194/Expressway bridges. • Maintain independent McKenzie Drive/ Expressway interchange. • To accommodate the eastbound Memorial Highway to eastbound Expressway ramps, relocate 46th Avenue SE to 43rd Avenue SE. • Add left turn lanes to the east and west ramp terminals at McKenzie Drive.	+ MAY be able to retain Memorial Highway bridges. + Only one Memorial Highway/I-194 signal. + Positive drive expectancy on movements. + Eliminates sight distance issues at Memorial Highway/I-194. + Left turn lanes at McKenzie Drive terminals increase capacity (Also assume signals).	– Memorial Highway/Memorial Bridge alignment. It would be desirable to move the interchange to the south to better line up with bridge. This shortens the separation between the McKenzie Drive and Memorial Highway interchanges. – Will need to relocate 64th Avenue SE. – No improvement to the limited separation between McKenzie Drive and Memorial Highway interchanges. Weaving concerns not resolved.
G G-A	Goal is to reduce vehicle weaving concerns between McKenzie Drive and Memorial Highway interchanges: • Replace west (north) on/off-ramps at McKenzie with ramps to/from Memorial Highway. Vehicles from Bismarck desiring to exit at Memorial Highway would exit Expressway at McKenzie Drive. • Reconstruct the I-194/Memorial Highway interchange as a diamond. The east (south side) ramps would ties to McKenzie Drive. • To reduce impact of 46th Avenue SE traffic on Memorial interchange, relocate it to 43rd Avenue SE (Alt. G-A).	+ Improves weaving concerns. + Very conventional design (drivers are familiar with flow). + Addresses the sight distance concerns at Memorial Highway.	– Westbound McKenzie Drive AND Memorial Highway exit/enter at McKenzie Drive. The west (south side) ramps are very close to the Missouri River Bridge and increasing ramp traffic may require auxiliary lanes (difficult to add). – Little improvement in operations at McKenzie (future concern as volume increases) without reconstructing the interchange to include left turn lanes on McKenzie. – Eastbound I-194 to McKenzie and westbound Expressway to Memorial Highway traffic must traverse more signalized intersections.

Alternative	Description	Positives	Negatives
H	Goal is to improve the short interchange spacing conflicts between Memorial Highway and McKenzie Drive by: • Establishing westbound frontage road connecting McKenzie Drive and Memorial Highway (Similar to the C-D road, but allows separate westbound off ramps to McKenzie and Memorial Highway). • Replacing eastbound Expressway on-ramp with a loop in NW quadrant. • Eastbound I-194 to Memorial Highway flyover replaced with ramp to a signalized Memorial Highway intersection. • Assume signalization of both Memorial Highway ramp terminals.	+ Frontage road removes the westbound McKenzie Drive-Memorial Highway weaving from mainline of Expressway. + Loop in NW quadrant increases the eastbound weaving distance on Expressway. + Provides a more "standard' diamond. + Greater Memorial Highway interchange signal spacing. + Provides opportunities to improve Memorial Highway sight distance deficiencies. + Improved traffic operations on Expressway between McKenzie Drive and Memorial Highway.	– Still require two signals at Memorial Highway interchange – Most Memorial Highway movements from I-194 and Expressway requires traversing two signals. – Not a substantial increase in McKenzie Drive ramp terminal capacity.
I-94: I-194 and East Main Street Interchanges			
E	Goal of the concept is to eliminate the non-standard left on-ramp from westbound I-94 to eastbound I-194: • Construct a new East Main Street from Twin City Drive. The new East Main would parallel westbound I-94. By moving corridor closer to westbound I-94, the left on configuration is eliminated. • Eliminate the current segment of East Main from Twin City Drive to I-194. • Rebuild the westbound I-94 loop ramp with a larger radius to access the relocated Main Street. • Construct an East Main Street to eastbound I-94 ramp.	+ Separates I-94 traffic from local traffic entering I-94 from East Main Street. + Establishes more standard right hand entrance ramps. + Larger radius loop ramp for westbound I-94 to eastbound I-194 movement should be a safer design.	– Costly for correcting a left hand on concern. Cost includes a new bridge over I-94 at the East Main Street interchange and reconstruction of the bridge at the I-94/I-194 interchange.

Alternative	Description	Positives	Negatives
E-1	Goal of this concept is the same as for Alt. E plus remove the weave movement for westbound I-194 traffic destined for westbound I-94: • Construct a new East Main Street from Twin City Drive. The new East Main would parallel westbound I-94. By moving corridor closer to westbound I-94, the left on configuration is eliminated. • Eliminate the current segment of East Main from Twin City Drive to I-194. • Rebuild westbound I-94 loop ramp with a larger radius to access relocated Main Street. • Construct an East Main Street to eastbound I-94 ramp. • Construct additional ramp for westbound I-194 to westbound I-94 movement.	+ Removes weaving segments on I-94 between the East Main Street and the I-194 interchanges. + Establishes more standard right-hand entrances for most movements between East Main Street and I-194 + Larger radius loop ramp for westbound I-94 to eastbound I-194 movement should be a safer design.	– Would require construction of a new bridge over westbound I-94 ramp.
I-94 and Mandan Avenue Interchange			
F	Goal is to improve/maintain traffic operations at the I-94/Mandan Avenue interchange as volumes increase: • Provide intersection roundabouts at ramp terminal intersections.	+ Provide substantially more capacity than the current stop condition (especially with the skewed intersection angle). + Reduce the need for left-turn lanes under the I-94 overpass (costly improvement). + Safety enhancement at skewed intersection because of slower, but more continuously, moving traffic.	– Not a common application in ND. – Traffic volumes may not maximize benefits of a roundabout (lower percent of left turns from Mandan Avenue).
I	Goal: Improve safety and operations at I-94 / Mandan Avenue: • Reconstruct terminal intersections to include islands to separate right/through and lefts.	+ Low cost. + More "organized" intersections that will improve safety.	– Not a significant improvement to sight distance limitations. – Snow removal more difficult with islands.

Some of the key issues associated with this corridor and alternatives discussed at that workshop include the following:

- The level of new and redeveloped parcels near the McKenzie Drive and Memorial Highway interchanges.
- The planned extension of McKenzie Drive to the west.
- The possibility of extending the McKenzie Drive interchange ramps to the east and whether that would require widening of the ND 810 Missouri River bridge.
- The proposed I-194 overcrossing to provide better access between the Captian's Landing neighborhood and Memorial Highway.
- The reconstruction of the Memorial Highway bridge over the Missouri River.
- The weaving movements and aggressive driving on I-94 in both directions between the Main Street and I-194 interchanges.
- The existing radius for the loop ramp connecting westbound I-94 and eastbound I-194 is a safety concern.

The initial screening workshop resulted in the following alternatives being maintained for analysis in the second-level screening:

- Alternative A
- Alternative B
- Alternative E
- Alternative G & G-A
- Alternative H
- Alternative I

Following the first level screening workshop, the consultant adjusted alternatives per discussion at the workshop, added selected alternatives for review and initiated the second-level screening analysis.

MANDAN INTERCHANGES SECOND-LEVEL ALTERNATIVES SCREENING

During the second-levels screening the alternatives that advanced from the first-level screening were analyzed further. For each subarea the alternatives were evaluated for their ability to achieve goals, as listed below:

- *Mandan Avenue* – Improve traffic operations on Mandan Avenue.
- *I-94: I-194 to East Main Street* – Improve the weaving operations and aggressive driving that occurs within this segment.

- *Memorial Highway and McKenzie Drive* – Improve the weaving segment operations between the two interchanges and maintain/improve traffic operations along Memorial Highway and McKenzie Road.

The following alternatives were eliminated during the second-level screening evaluation:

- Alternative A – Eliminated because drivers are unfamiliar with the single point urban interchange design and out of direction travel created by the new Memorial Highway interchange.
- Alternatives G & G-A – Eliminated because the interchange configuration requires McKenzie Drive traffic to go through multiple signals and the extra traffic is projected to degrade traffic operations at the Memorial Highway intersections.
- Alternative F – Eliminated because drivers are unfamiliar with roundabouts and the amount of truck traffic using this interchange would make design of the roundabouts very difficult.

A revised version of Alternative E was developed for I-94 that addresses the westbound weaving maneuvers and is illustrated in Figure A12.

Figure A12. Alternative E-1 – I-94: Main Street to I-194

BISMARCK EXPRESSWAY ALTERNATIVES

The development of alternatives for the Bismarck Expressway arterial portion of the study corridor resulted from the following:

- Determining and documenting the current and horizon year 2030 transportation issues and deficiencies.
- Reviewing information gained through the public involvement process and from agency coordination

A summary of issues and preliminary concepts associated with the Bismarck Expressway is provided in Figures A13 and A14.

BISMARCK EXPRESSWAY UNIVERSE OF ALTERNATIVES

The development of improvement alternatives for the Bismarck Expressway focused on three sub-areas listed below:

- Transportation System Management – Intersection specific improvements
- Transportation System Expansion –Corridor widening and/or development of alternate corridors
- Non-Motorized Facilities – New or improved pedestrian and bicycle facilities within the corridor.

The Bismarck Expressway alternatives that were developed for the first level screening are shown graphically as Figures A15 through A19. A brief description of each alternative along with the positives and negatives for each alternative is provided in Table A2.

BISMARCK EXPRESSWAY FIRST-LEVEL ALTERNATIVES SCREENING

The alternatives for the Bismarck Expressway were reviewed during a workshop held on January 19, 2006. Some of the key issues associated with this corridor and alternatives discussed at that workshop include the following:

- Discussion on the speed limit for Bismarck Expressway if the roadway is widened to six lanes (seven lanes including a center left-turn lane).
- Discussion on the projected traffic volumes for the Bismarck Expressway corridor and the anticipated future traffic operations.
- Discussion on the mode of left-turn traffic signal operations with a six-lane Bismarck Expressway concept. Typically the left-turn movement is controlled by a protected only left-turn arrow for six-lane roadways.
- Discussion about the number of traffic signals already in the Bismarck Expressway corridor and the difficulty of achieving progression through the corridor.

- Discussion about eliminating or limiting the lane deflections across intersections.
- Possibly reducing access at 2nd Street (e.g., right-in/right-out access only) in order to limit right-of-way impacts associated with widening Bismarck Expressway to six lanes.
- Discussion about the current split phase signal operations used at 7th Street and Bismarck Expressway.
- Discussion about the fact that converting 7th and/or 9th Street to two-way operations would require an additional signal phase for the left-turn movements.
- Discussion about the current mode of operations for fire trucks entering/exiting the fire station in the southwest corner of 9th Street/Bismarck Expressway.
- Discussion about the various right-of-way constraints and grade differences that would potentially impact widening of the Bismarck Expressway corridor.
- Discussion about the proposed new developments along Bismarck Expressway east of 26th Street.

The initial screening workshop recommended the following alternatives be eliminated from consideration:

- Extend Denver Avenue from University Drive to 26th Street
- Remove short third eastbound through lane east of Washington Street
- Install traffic signal at 2nd Street
- Install traffic signal at Kirkwood Mall/Bozeman Drive
- Two-way conversion of 7th Street north of Bismarck Expressway
- Two-way conversion of 7th / 9th Street north of Bismarck Expressway
- Removal of no right-turn on red restriction for eastbound approach at 9th Street
- Time of day lane control for the eastbound approach at 9th Street

Following the first-level screening workshop, the consultant adjusted alternatives per discussion at the workshop, added selected alternatives for review and initiated the second-level screening analysis. For example, the six-lane Bismarck Expressway with an eastbound dual left-turn at 9th Street, as shown in Figure 38, assumed widening would be symmetrical around the existing centerline. This widening concept was adjust during the second-level screening in order to minimize impacts to the fire station located in the southwest corner of the 9th Street intersection.

FIGURE A13. Bismarck Expressway: Missouri River to 12th Street – Issues and Preliminary Concepts

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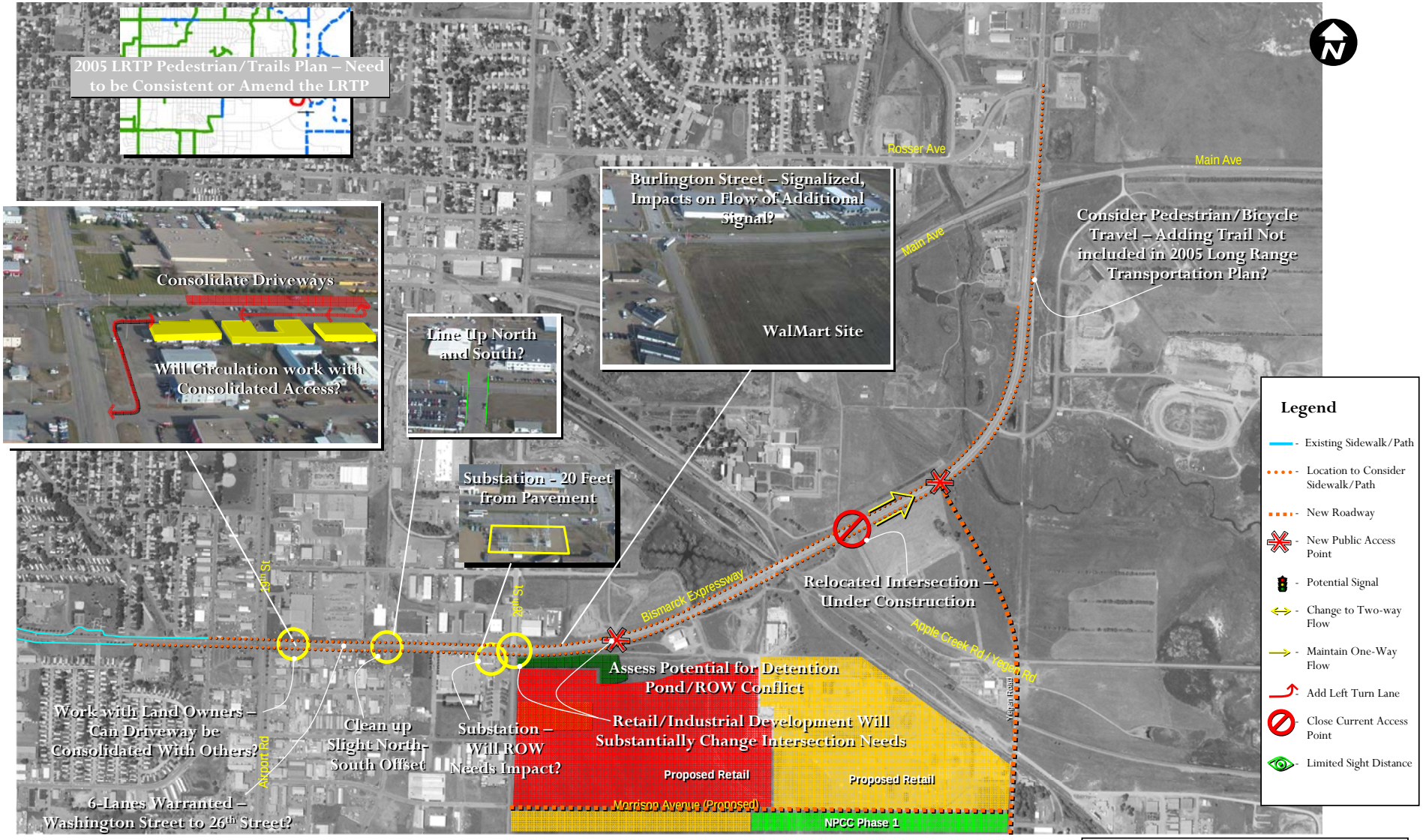

FIGURE A14. Bismarck Expressway: 19th Street to Rosser Avenue – Issues and Preliminary Concepts

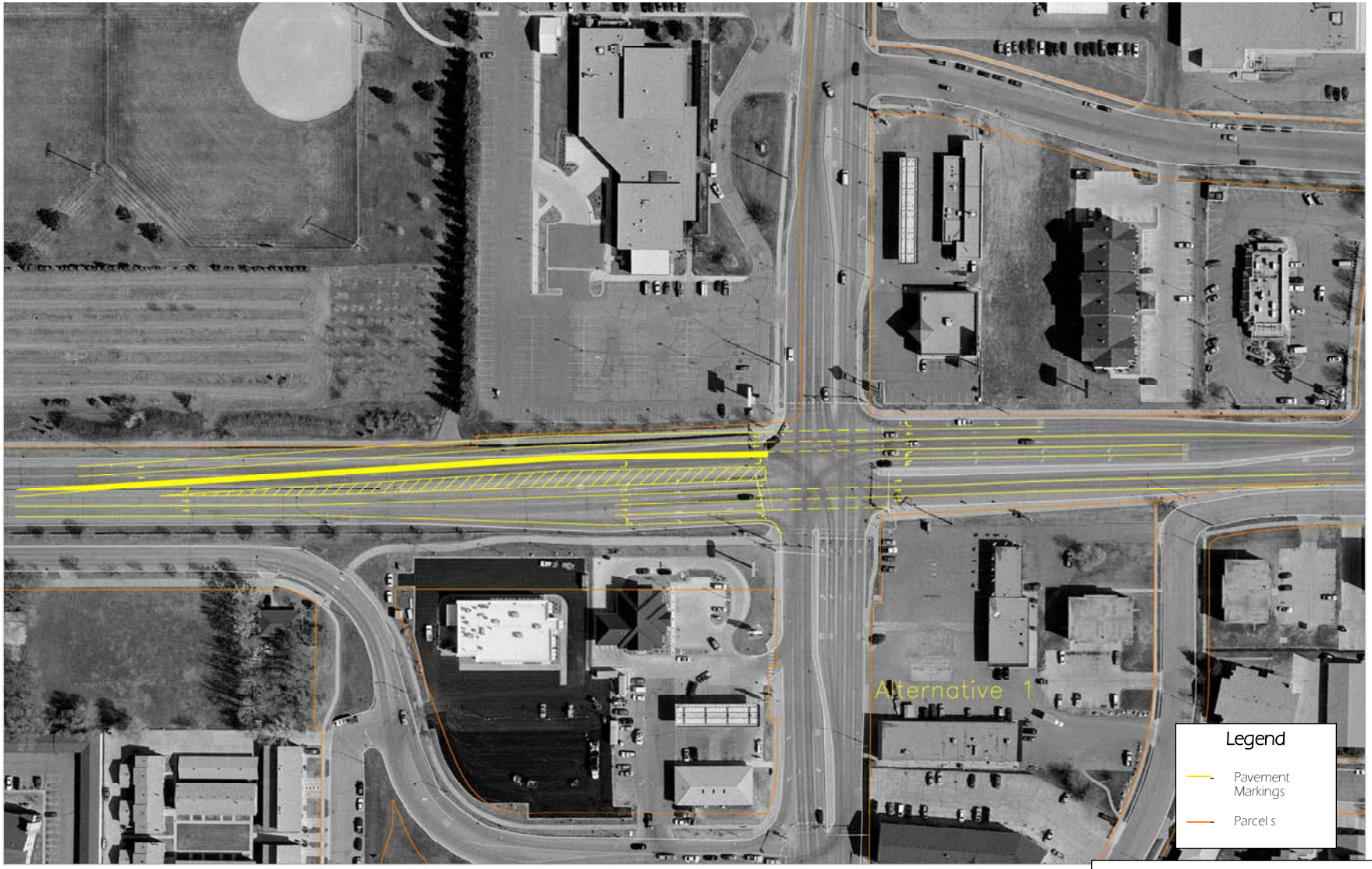

Figure A15. Washington Street: Realignment of Westbound Through Lanes

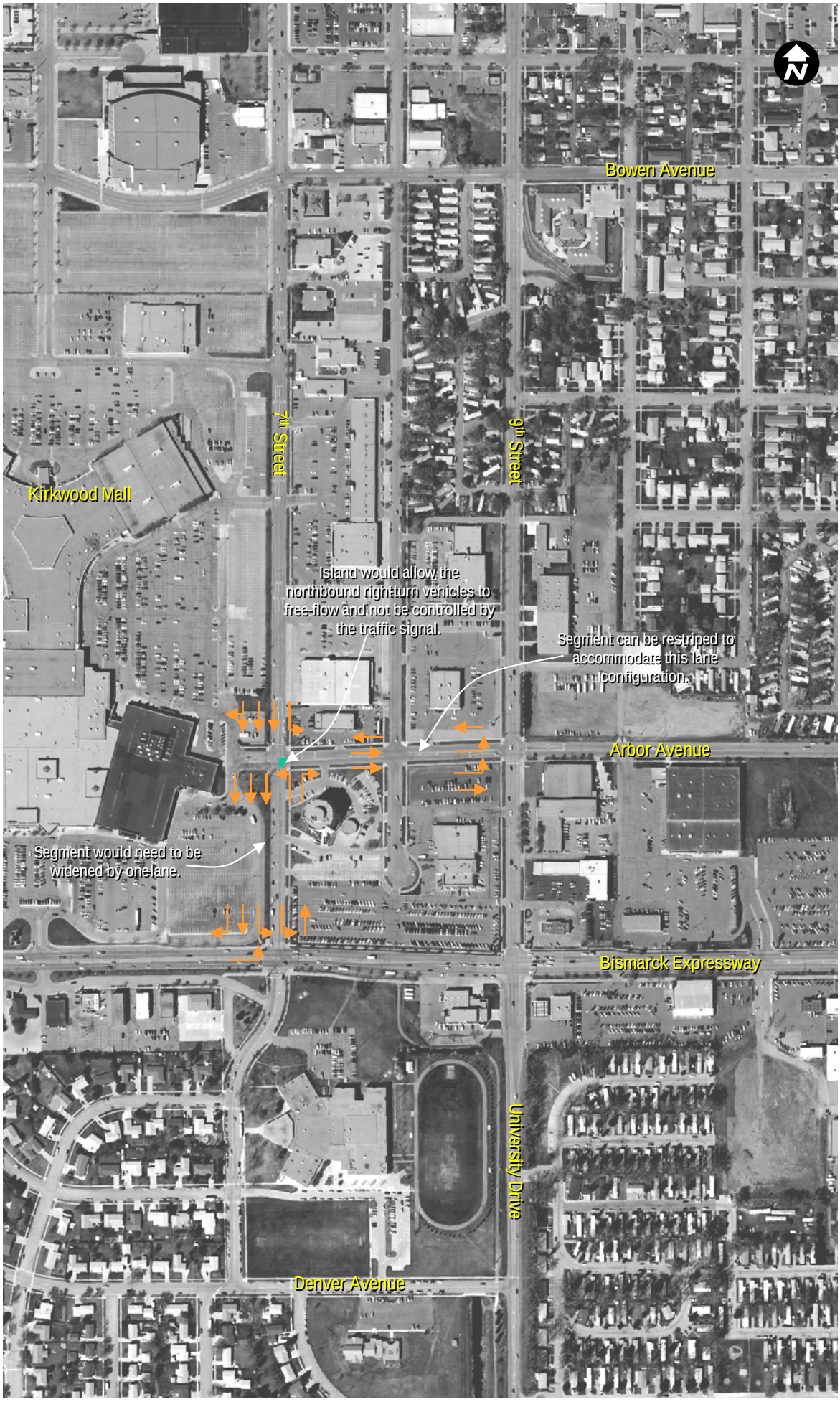

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Figure A16. 7th Street: Two-Way Operations
Bismarck Expressway to Arbor Avenue

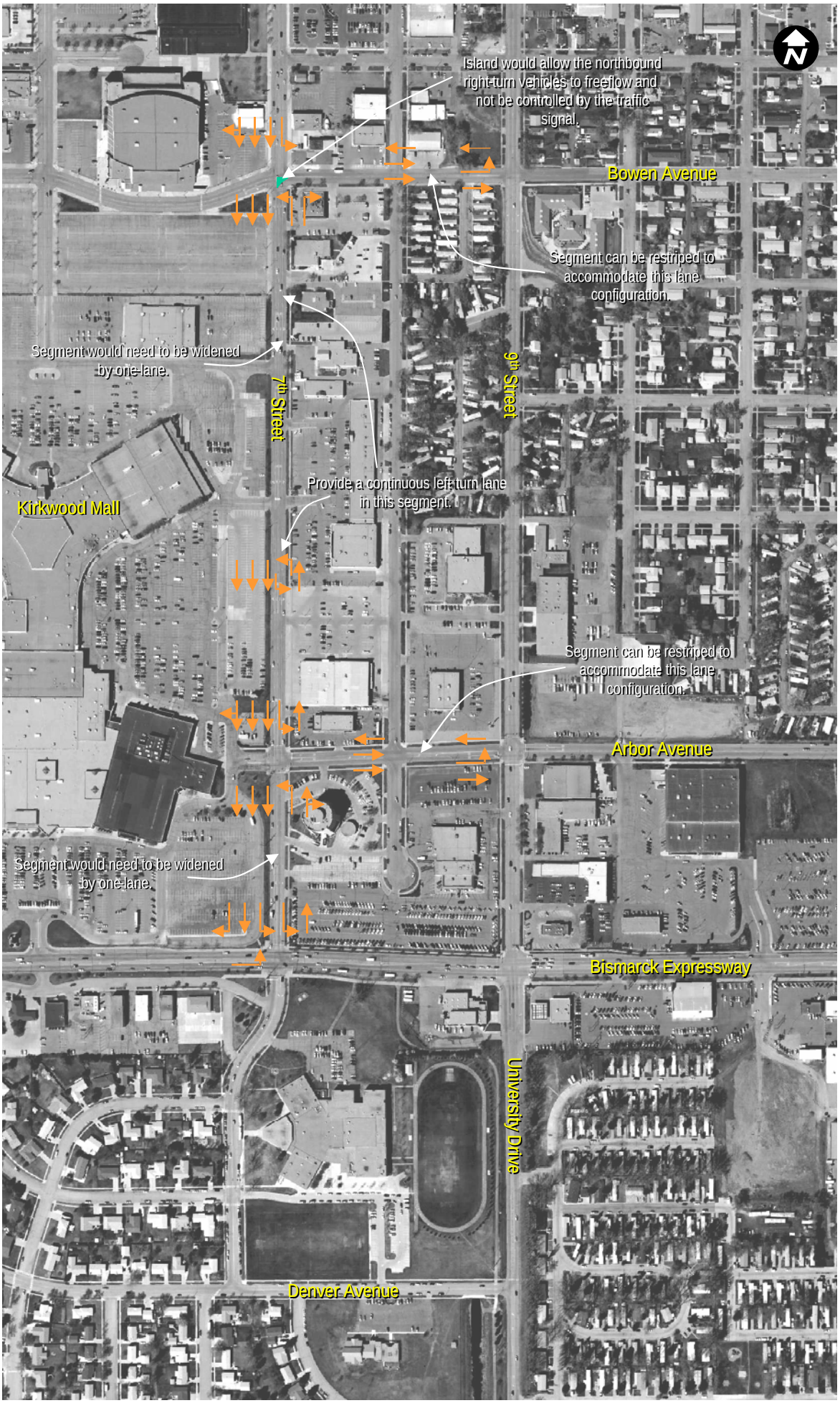

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Figure A17. 7th Street: Two-Way Operations
Bismarck Expressway to Bowen Avenue

Figure A18. 7th Street/9th Street: Two-Way Operations Bismarck Expressway to Arbor Avenue

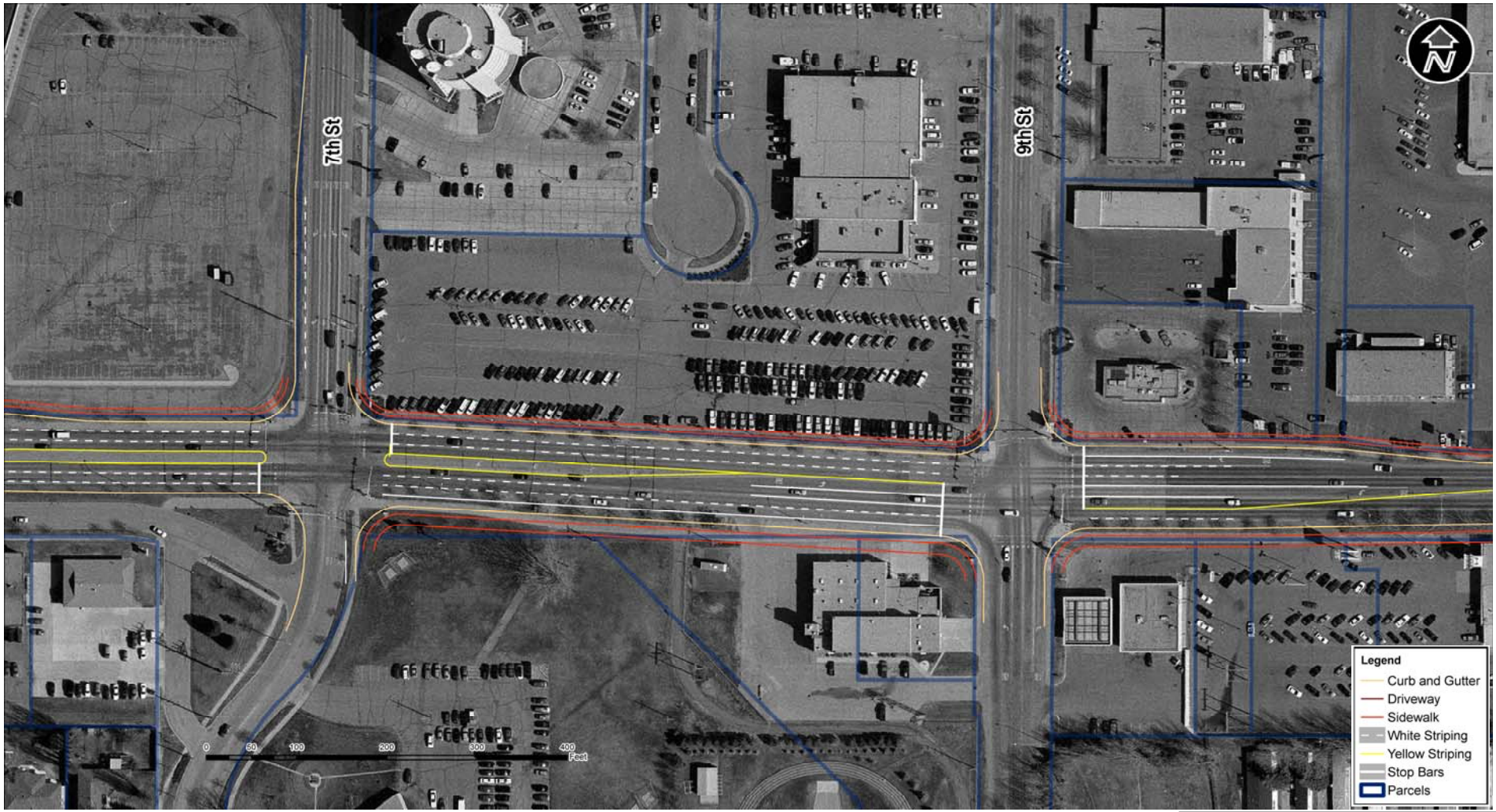


Figure A19. Eastbound Dual Left-Turn Lanes at 9th Street and Bismarck Expressway

TABLE A2: BISMARCK EXPRESSWAY PHASE I ALTERNATIVES REVIEW SUMMARY

Alternative Description	Positives	Negatives
Bismarck Expressway Corridor-wide Congestion		
Widen Bismarck Expressway to a 6-lane roadway; continuous center turn lane from Washington Street to Rosser Avenue	+ Results in "acceptable" peak hour traffic operations.	– Minimum of 108' of right-of-way width; significant property impacts / acquisitions throughout corridor. – A wider roadway would also impact many of the frontage roads along Bismarck Expressway and make access control more difficult. – More through lanes on Bismarck Expressway does not address all of the capacity issues associated with high turn movements onto cross routes.
Increase traffic signal cycle length; greater emphasis on traffic signal coordination.	+ Slight improvement in traffic operations for traffic on Bismarck Expressway, but congestion would still occur at key intersections.	– Many of the cross street approaches to Bismarck Expressway are at/above capacity. A longer cycle length without more green time for the cross streets will increase delays.
Extend Denver Avenue from University Drive to 26th Street	+ Provides an alternate route for short trips to destinations along Bismarck Expressway.	– Limited positive impact to Bismarck Expressway (ADT reduced 1,500 to 2,000). – Significant amount of property impacts/acquisitions required to establish route. – Results in more traffic in front of homes along Denver Avenue between Washington Street and University Drive. These homes would likely not allow an increase in the speed limit.
Washington Street Operations		
Realignment of Westbound Through Lanes	+ Positive impact on safety (removes lane shift across intersection) + Provides room for a 2nd eastbound left-turn lane when traffic volumes warrant.	– Right-of-way impacts in the northwest quadrant of this intersection. – Requires reconstruction of the trail located to the north of Bismarck Expressway.

Alternative Description	Positives	Negatives
Remove Short Third Eastbound Through Lane east of Washington Street	• Positive impact on safety. • May allow for the realignment of the eastbound through lanes? + Limited (if any) impacts on traffic operations; short length of the "drop" lane on the east side of this intersection results in few vehicles using this lane.	
Remove the No Right-Turn on Red (RTOR) Restrictions for the Northbound Right-Turn Movement.	+ Would increase the capacity of this movement; and result in a slight improvement in overall intersection traffic operations.	
2nd Street Operations		
Eliminate Left-out Movement	• Would remove the movement with the most potential conflicts. There were 11 angle crashes over 3 years at this intersection and most involved a left-turning vehicle from 2nd Street to Bismarck Expressway. + Alternate access to Bismarck Expressway is available at Washington and 3rd Street.	– Inconvenience for cross street lefts for the majority of the day when there is little congestion on Bismarck Expressway. – Circuitous travel (through residential areas) to obtain access at the adjacent Bismarck Expressway signalized intersections at Washington Street or 3rd Street.
Install Traffic Signal	+ A traffic signal would decrease delays for 2nd Street traffic.	– The traffic signal may result in more delay for Bismarck Expressway traffic. – The spacing between adjacent traffic signals (i.e., Washington Street and 3rd Street) would be poor and would further complicate the coordination of Bismarck Expressway traffic signals. – The westbound queue for the Washington Street traffic signal likely blocks the 2nd Street intersections at times during peak periods.
Kirkwood Mall Access / Bozeman Dr Operations		
Eliminate Left-out Movement	• Safety improvement (focuses on observed movement conflicts). There was 8 angle crashes over 3 years at this intersection and about half of them involved a left-turning vehicle going from the side streets to Bismarck Expressway. • Alternate access to Bismarck Expressway is available at 3rd or 7th Street. + Potential greater access compromise to right-in/right-out concept (allows left-in from Bismarck Expressway).	– Removal of this movement would be an inconvenience for the majority of the day when there is little congestion on Bismarck Expressway. – Requires more on-site circulation to access the southern parking lot from 3rd Street or 7th Street. – Reduced level of access from Bozeman Drive to the west and Kirkwood Mall to the east.

Alternative Description	Positives	Negatives
Right-in / Right-out Access	• Removes the conflicting left-turn movements from this intersection; safety improvement. • Alternate access to Bismarck Expressway is available at 3rd or 7th Street. + Removing lefts with long delay (during peaks) would improve overall corridor operations (slightly).	– Removal of these movements would be an inconvenience for the majority of the day when there is little congestion on Bismarck Expressway. – This traffic would be rerouted to the adjacent Bismarck Expressway signalized intersections at 3rd Street or 7th Street. – Reduction in Kirkwood Mall access through removing the driveway exacerbated by 7th Street being a one-way.
Traffic Signalization	+ A traffic signal would decrease delays for Kirkwood Mall access driveway and Bozeman Drive traffic (especially as volumes increase).	– The traffic signal would result in increased delay for Bismarck Expressway traffic; delay impact worse as volumes increase in future. Increase in delay on Bismarck Expressway has greater negative impact than the improvement on cross route. – The spacing between adjacent traffic signals (i.e., 3rd Street and 7th Street) would be poor and would further complicate the coordination of Bismarck Expressway traffic signals. – The eastbound queue for the 7th Street traffic signal probably would block the Mall access drive/Bozeman Drive intersections at times during peak periods.
7th Street Operations		
Eliminate the Left-in Movement from Westbound Bismarck Expressway	+ Provides additional storage room the eastbound left-turn movement at Bismarck Expressway and 9th Street. + Improves traffic operations at Expressway/7th St. (a key bottleneck in the corridor). + Improvement not likely a letter grade.	– This traffic would be rerouted to the adjacent Bismarck Expressway signalized intersections at 3rd Street or 9th Street. This volume is relatively small. – Still requires a separate signal phase (split phase) for northbound and southbound 7th Street traffic.

Alternative Description	Positives	Negatives
Make South Leg Right-in/Right-out Access	+ Allows for the elimination the separate signal phase for northbound 7th Street traffic. Although this would require a lane add on Expressway to better accommodate the northbound to eastbound right-turn movement. Lane add could be connected to the eastbound right-turn lane at 9th Street/Bismarck Expressway (longer west approach right turn lane).	– The left turn traffic would be rerouted to the adjacent Bismarck Expressway signalized intersections at 3rd Street or 9th Street (inconvenient). – Potential safety concern between southbound left-turn and northbound right-turn vehicles at this intersection. Would need to provide a physical separation between these two movements for a short distance.
Add Northbound and Southbound Dual Right-Turn Lanes	+ Provides sufficient capacity to high current and forecasted northbound and southbound right-turn movements. + Additional right-turn lane reduces necessary green time for northbound traffic movement – provides more green time to eastbound and westbound traffic.	– Potential right-of-way impact for southbound improvement to west side of 7th Street to Kirkwood Mall parking lot. – Potential right-of-way impact for northbound improvement to east side of 7th Street to school and park. – Likely would eliminate right-turn on red.
Make South Leg One-way Southbound for one block	+ Would eliminate the need for the northbound 7th Street signal phase. This would result in improved operations for this intersection. + Eliminates the 'weaving' movement on Bismarck Expressway between 7th and 9th Street during the morning peak period. This weaving movement involves northbound right-turn vehicles at 7th Street that than attempt to turn left at 9th Street. + Safety improvement by reducing conflicting vehicles.	– A significant amount of traffic would be rerouted to the adjacent Bismarck Expressway signalized intersections at 3rd St. and 9th St. – But, still likely better operations at both 7th St. and 9th St. – Changes the circulation pattern for Wachter middle school (no northbound movement).
7th Street/Kirkwood Mall Circulation		
Convert a Portion of 7th Street North of Bismarck Expressway to Two-Way Traffic Flow	+ A segment of 7th Street from Bismarck Expressway to Arbor Avenue or Bowen Avenue would be converted to two-way flow. + This would allow some of the eastbound left-turns at Bismarck Expressway and 9th Street to then make their left-turn at Bismarck Expressway and 7th Street and	– Widening of 7th Street would be required to provide an additional lane between Arbor/ Bowen Avenue and Bismarck Expressway. – The concept would reduce the capacity of 7th Street for southbound traffic. – The intersection operations at 7th and 9th Street with Arbor Avenue and/or Bowen Avenue would also

Alternative Description	Positives	Negatives
	then reenter 9th Street at either Arbor or Bowen Avenue; resulting in improved traffic operations at 9th Street and Bismarck Expressway. + Arbor Avenue is wide enough for four-lanes, which would be required. + Provides improved access to Kirkwood Mall from south (especially Target relocation).	degrade (one-way has much more capacity).
7th / 9th Street Operations		
Convert a Portion of 7th and 9th Street to Two-Way Traffic Flow – Expressway to Arbor Avenue	+ Allows eastbound left-turns at Bismarck Expressway/9th St. to be shared at 7th St. Vehicles would reenter 9th Street at either Arbor or Bowen Avenue. This should result in improved traffic operations at 9th Street and Bismarck Expressway. Could reduce the need for dual eastbound left turn lanes at 9th St. + Reduces the 'weaving' vehicles on Bismarck Expressway between 7th St. and 9th St. (from northbound 7th St. south of Expressway to northbound 9th St.). Some of these vehicles could make a southbound left-turn at 7th St./Arbor Ave. , followed by a right-turn (possibly free-flowing) at 9th St./Arbor Ave., and then southbound through at 9th St./Bismarck Expressway. + Arbor Avenue is wide enough for four lanes. + This concept would also provide improved access to Kirkwood Mall and 9th St. strip mall.	– 5-lanes required on 7th and 9th Streets for length of change. ROW impacts. – 9th St. expansion mainly to west to line up with lanes on University Dr. south of Expressway. Focuses negative ROW impacts to one side. – The concept would reduce the capacity of 7th Street for southbound traffic. – The intersection operations at 9th Street and Bismarck Expressway may degrade somewhat for the northbound approach because it would now have opposing traffic. – The intersection operations at 7th and 9th Street with Arbor Avenue would degrade somewhat.

Alternative Description	Positives	Negatives
9th Street Operations		
Dual Left-Turn for Eastbound (Westbound) Approach	+ Should provide a positive impact on traffic operations for both these movements, as well as, the overall intersections. Implementation of dual left-turn lanes would allow for some green time to be shifted to the northbound approach to this intersection.	– The right-of-way/acquisition impacts of this action would be significant. Right-of-way would be needed on both sides of the 9th Street intersection. – Impacts access/egress of the fire station, even if all widening is to the north.
Remove the No Right-Turn on Red (RTOR) Restrictions for the Eastbound Right-Turn Movement.	+ Would increase the capacity of this movement.	
Time of Day Lane Control for the Eastbound Approach	+ Allowing right-turns to take place from both the right-turn lane and from the outside through lane during peak period would increase the capacity for this movement slightly. This 'shared' through/right-turn lane would be controlled by a LED sign indicating the proper lane usage during peak/non-peak periods.	– The benefits not be as significant as the eastbound through volume on Bismarck Expressway increases and results in less right-turn vehicles using that lane. – There is some potential for driver confusion on the part of non-commuter vehicles.
Extend the Eastbound Right-Turn Lane	+ Increasing the storage capacity should have a positive impact on traffic operations. Benefits would increase as through volumes continue to increase. + Fits within the existing right-of-way along Bismarck Expressway (most likely).	– There could be a concern about safety with weaving vehicles potentially conflicting at the entry point to the right-turn lane. – Requires reconstruction of the trail located to the north of Bismarck Expressway.
Modify the Northbound Right-Turn Lane for Through Traffic	+ The northbound right-turn movement at this intersection is relatively small and this lane is underutilized. This lane could be modified to allow both through and right-turning vehicles. + This would have a positive impact on traffic operations for this approach. + There are four receiving lanes on the north leg of this intersection.	– Short-term - Likely increase delays for the northbound right-turning vehicles. In the long-term it will help because the right-turn lane would likely be blocked by northbound through vehicles. – May require additional widening and right-of-way acquisition north of Bismarck Expressway. – Potential impacts to trees along east side of University Drive.
Fire Station Operations (9th Street/ Bismarck Expressway)		
Add Fire Station Access/Egress Clearance Signal	+ Reduces/eliminates conflicts between the fire station driveway and vehicles on Expressway and University	– Does not address intersection traffic operations concerns.

Alternative Description	Positives	Negatives
	Drive.	– During response event, queues will grow.
12th Street Operations		
Add Eastbound Right-Turn Lane (Recommendation from 12th St Study)	+ Improves traffic operations for this approach by removing the right-turn vehicles from the through lane.	– Right-of-way impacts in the southwest quadrant of this intersection. – Requires reconstruction of the trail located to the south of Bismarck Expressway. – This movement crosses a school crosswalk and special care should be taken to ensure safety.
Restripe 12th Street to Provide a Continuous Left-Turn Lane (Recommendation from 12th St Study)	+ This would improve traffic operations and safety since there are many left-turns into the school and businesses along 12th Street north of Bismarck Expressway. + Road is currently wide enough to accommodate center turn lane.	
Right-Turn Lanes for Northbound/ Southbound Approaches (Recommendation from 12th St Study)	+ Provides additional capacity on each of these approaches and should a positive impact on intersection operations by allowing more green time to be used for Bismarck Expressway traffic.	– Results in significant right-of-way/acquisitions in the northwest and southeast quadrants of this intersection. – The new lanes result in longer school crosswalks and special care should be taken to ensure safety.
Left-turn Signal Phasing for Northbound/ Southbound Approaches	+ As these left-turn volumes increase it would be appropriate to provide a left-turn signal phase.	-
Jeanette Myhre School Operations		
Modify Circulation Pattern for Student Pick-up/Drop-off – Including right-in/right-out on Bismarck Expressway (First part a recommendation from 12th St Study)	+ Alter the student pick-up/drop-off to promote a one-way clockwise pattern around the school – improvement over combination of clockwise and counter clockwise circulation. + Improved access from school to Bismarck Expressway.	– The new circulation pattern results more trips on westbound Bismarck Expressway (small number). – Improving the access to Bismarck Expressway may lead to request for full access. Full access would negatively impact operations on Expressway.
Airport Road / 19th Street Operations		
Eastbound Right-Turn Lane	+ Improves traffic operations for this approach by removing the right-turn vehicles from the through lane.	– Right-of-way impacts in the southwest quadrant of this intersection.
Dual Left-Turn Lane for the	+ Traffic volumes are projected to increase significantly	– Right-of-way impacts would result on both sides of

Alternative Description	Positives	Negatives
Westbound (Eastbound) Approaches	for the westbound left-turn movement and to a lesser extent the eastbound left-turn. + Dual left-turn lanes would allow greater green time for the through volumes on Bismarck Expressway and should help overall intersection operations.	19th Street along the Bismarck Expressway.
Bismarck Expressway Access		
Implement access management along Bismarck Expressway from 19th Street to 22nd Street	+ Removal and/or consolidation of access points in this segment should improve corridor safety and to some extent improve traffic operations. + All businesses would still maintain direct access to Bismarck Expressway.	– Plan would maintain accessibility to corridor businesses. Some businesses may perceive consolidation as a negative. – Property cross easements required.
26th Street Operations		
Wal-Mart TIS Recommendations	+ Recommended intersection improvements result in better traffic operations, including: 1) right-turn lanes for the eastbound/westbound approaches; 2) a left-turn lane for the northbound approach; 3) increase storage length for southbound left-turn lane.	–
Dual Left-Turn Lane for Northbound Approach	+ Improvements to traffic operations. Peak hour volume for movement is over 300 vehicles during the PM peak hour. + Allow more green time for Bismarck Expressway traffic and should improve the overall intersection operations.	– There are potential right-of-way/acquisitions impacts if widening takes place to the west of 26th Street.
Burlington Street Operations (defer to recommendations from Wal-Mart and Visconsi traffic impact studies for improvements at this intersection)		
Yegen Road Operations (defer to the Northern Plains Commerce Centre traffic impact study for improvements at this intersection)		

Alternative Description	Positives	Negatives
Main Avenue Operations		
Provide 2nd Through Lane on Eastbound Approach	• This would help the approach and overall intersection operations. + There are already two receiving lanes to the east of the intersection.	– Widening Main Avenue will require replacement of a large culvert structure west of the intersection.
Dual Left-Turn Lane for Eastbound Approach	• This would help the approach and overall intersection operations. +	– Widening Main Avenue will require replacement of a large culvert structure west of the intersection.
Provide Right-Turn Lanes on the Southbound and Westbound Approaches	• This would help the approach and overall intersection operations. +	– May require some right-of-way in the northwest quadrant of this intersection.

BISMARCK EXPRESSWAY SECOND-LEVEL ALTERNATIVES SCREENING

From the universe of concepts available following the first-level screening process a group of improvement alternatives for Bismarck Expressway were 'packaged' and analyzed to determine their effectiveness in addressing projected corridor/intersection deficiencies. The list of improvement packages is provided below:

- Maintain the four-lane cross section and provide intersection improvements such as more turn lanes, replace stop conditions with signals when warranted, eliminate problematic movements, etc. The purpose of this generalized concept was to attempt to limit the right-of-way impacts in the corridor while addressing, to the extent possible, poor traffic operations in the corridor.
- Expand Bismarck Expressway to a six-lane cross section and maintain/add the appropriate turn lanes in the corridor from Washington Street through 26th Street. This alternative would include dual left turn lanes where warranted.
- Limit expansion of the corridor to six lanes to the highest volume portion of the corridor, project to be between Washington Street to 9th Street. This alternative is intended to balance the capacity needs in the corridor relative to the right-of-way impacts associated with widening the corridor. Currently, the right-of-way width in much of the corridor is approximately 83 feet wide. Expansion of the corridor to six-lanes requires at least an additional 22 feet of width (not including any associated sidewalk/trail facilities) in the roadway cross section.

Traffic Operations of Build Alternatives

The 2030 AM and PM peak period traffic operations analyses for Bismarck Expressway intersections under the range of Build conditions are documented in the Tables 26 and 27, respectively. These tables include the results for the TSM enhanced four-lane alternative and the six-lane alternatives.

A summary of the findings for the 2030 Build Conditions capacity analyses is provided below:

- In each of the Build alternatives a number of intersections are forecasted to operate at LOS D or worse. These intersections are listed below:
  - Bismarck Expressway / Washington Street
  - Bismarck Expressway / 9th Street
  - Bismarck Expressway / Main Avenue
- Initially, one would think widening the corridor to six-lanes and including additional turn lanes at selected intersections would provide the capacity needed in the corridor. By breaking down the operations results, reasons for not seeing larger overall improvements can be found, including:

- Based on review of the traffic model through traffic exclusively on Bismarck Expressway is relatively low percent of total traffic. For example, of the traffic observed in the corridor at Washington Street only 55 percent is still in the corridor east of 9th Street and less than 20 percent of the traffic travels the entire Bismarck portion of the corridor study area. Thus, there is a very high percentage of turning traffic that turns into and out of the corridor at the intermediate access points. The relative balance between turning traffic and through traffic reduces the effectiveness that another through lane has on improving traffic operations. This is due to a lower level of utilization of the center through lane (drivers turning left or right in a block or two are less likely to be in the center lane for much of their trip). With this in mind the greatest benefit from widening Bismarck Expressway to six lanes would be in the highest volume segment that is forecasted to be between Washington Street and 9th Street.
- With higher turning volumes and /or higher percentage turn volume, a greater benefit can be derived from adding turn lanes and all of the alternatives include adding turn lanes at similar locations.

• Most of the intersections, particularly those with lower overall traffic operation, have turn movements with high volumes, which results in lower than desired levels of service. Green time allocated to turning movements is generally lower than the green time allocated to through movements. As turning volume percentages of the total volume increase, the percentage of green time allocated to turning volume also needs to increase. However, only so much green time re-allocation to turning movements can be done before significant impacts to progression result. Widening Bismarck Expressway to six lanes provides more opportunities to re-allocate green time to turning volumes relative to the four-lane alternative. The shift in green time helps in the overall corridor flow, especially during the height of the peak. The impacts on pedestrian operations and pedestrian system improvement alternatives are documented in the non-motorized system alternatives assessment section of this appendix.

TABLE 26: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – MORNING (AM) PEAK HOUR FOR YEAR 2030 BUILD CONDITIONS

Intersection	Scenario (1)	Overall	Intersection Approach (2)			
			EB	WB	NB	SB
Bismarck Expressway / Washington St	4-lane	D	C	C	D	D
	6-lane to 9th	D	C	C	D	D
Bismarck Expressway / 2nd St (3)	4-lane					C
	6-lane to 9th					B
Bismarck Expressway / 3rd St	4-lane	C	C	B	D	C
	6-lane to 9th	C	B	C	D	C
	6-lane to 9th (5)	D	B	C	F	C
	6-lane to 9th (6)	C	B	C	D	C
Bismarck Expressway / Kirkwood Mall & Bozeman Dr (3)	4-lane				B	B
	6-lane to 9th				– –	B
Bismarck Expressway / 7th St	4-lane	B	A	A	A	C
	6-lane to 9th	B	A	A	A	C
	6-lane to 9th (5)	B	A	A	– –	C
	6-lane to 9th (6)	D	B	B	F	D
Bismarck Expressway / 9th St & University Dr	4-lane	D	C	D	D	– –
	6-lane to 9th	D	D	D	D	– –
	6-lane to 9th (5)	E	C	D	F	– –
	6-lane to 9th (6)	D	C	D	D	– –
	6-lane to 26th	D	C	D	D	– –
Bismarck Expressway / 12th St	4-lane	B	A	B	D	D
	6-lane to 26th	B	A	B	D	D
Bismarck Expressway / Airport Rd & 19th St	4-lane	C	C	C	C	D
	6-lane to 26th	C	C	C	C	D
Bismarck Expressway / 26th St	4-lane	C	B	D	D	C
	6-lane to 26th	C	B	D	D	C
Bismarck Expressway/ Burlington Drive	4-lane	A	A	A	C	D
Bismarck Expressway/ Yegen Rd (4)	4-lane	C	C	C	C	– –
Bismarck Expressway / Main Ave	4-lane	C	D	C	C	B
Bismarck Expressway / Rosser Ave	4-lane	B	C	– –	A	B

Notes:

(1) 4-lane = 4-lane Bismarck Expressway with intersection improvements; 6-lane to 9th = Widen Bismarck Expressway to 6-lanes between Washington Street and 9th Street along with other intersection improvements; 6-lane to 26th = Widen Bismarck Expressway to 6-lanes between Washington Street and 26th Street along with other intersection improvements

(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

(3) Unsignalized intersection

(4) Traffic signalization assumed for 2030 No Build conditions.

(5) The south leg of Bismarck Expressway and 7th Street would operate as one-way southbound. Diverted northbound traffic is rerouted to the 3rd and 9th Street intersections with Bismarck Expressway.

(6) The south leg of Bismarck Expressway and 7th Street would operate the same as under existing conditions with northbound left-turn and right-turn movements controlled by a separate northbound traffic signal phase.

TABLE 27: SUMMARY OF INTERSECTION TRAFFIC OPERATIONS – AFTERNOON (PM) PEAK HOUR FOR YEAR 2030 BUILD CONDITIONS

Intersection	Scenario (1)	Overall	Intersection Approach (2)			
			EB	WB	NB	SB
Bismarck Expressway / Washington St	4-lane	D	D	C	D	D
	6-lane to 9th	D	C	C	D	D
Bismarck Expressway / 2nd St (3)	4-lane					F
	6-lane to 9th					F
Bismarck Expressway / 3rd St	4-lane	D	C	C	E	E
	6-lane to 9th	C	C	B	D	D
	6-lane to 9th (5)	C	C	B	C	D
	6-lane to 9th (6)	C	C	B	D	D
Bismarck Expressway / Kirkwood Mall & Bozeman Dr (3)	4-lane				B	D
	6-lane to 9th				– –	D
Bismarck Expressway / 7th St	4-lane	D	B	D	A	D
	6-lane to 9th	C	B	B	A	D
	6-lane to 9th (5)	C	B	B	– –	D
	6-lane to 9th (6)	D	B	B	E	F
Bismarck Expressway / 9th St & University Dr	4-lane	C	C	C	D	– –
	6-lane to 9th	C	C	C	D	– –
	6-lane to 9th (5)	C	C	C	D	– –
	6-lane to 9th (6)	C	C	C	D	– –
	6-lane to 26th	C	C	C	C	– –
Bismarck Expressway / 12th St	4-lane	D	B	C	F	E
	6-lane to 26th	C	B	C	D	D
Bismarck Expressway / Airport Rd & 19th St	4-lane	D	C	D	E	D
	6-lane to 26th	C	C	C	C	C
Bismarck Expressway / 26th St	4-lane	C	B	B	E	D
	6-lane to 26th	C	B	B	E	D
Bismarck Expressway/ Burlington Drive	4-lane	B	A	B	C	D
Bismarck Expressway/ Yegen Rd (4)	4-lane	C	B	C	C	– –
Bismarck Expressway / Main Ave	4-lane	D	D	C	D	D
Bismarck Expressway / Rosser Ave	4-lane	B	D	– –	B	B

Notes:

(1) 4-lane = 4-lane Bismarck Expressway with intersection improvements; 6-lane to 9th = Widen Bismarck Expressway to 6-lanes between Washington Street and 9th Street along with other intersection improvements; 6-lane to 26th = Widen Bismarck Expressway to 6-lanes between Washington Street and 26th Street along with other intersection improvements

(2) EB = Eastbound; WB = Westbound; NB = Northbound; SB = Southbound

(3) Unsignalized intersection

(4) Traffic signalization assumed for 2030 No Build conditions.

(5) The south leg of Bismarck Expressway and 7th Street would operate as one-way southbound. Diverted northbound traffic is rerouted to the 3rd and 9th Street intersections with Bismarck Expressway.

(6) The south leg of Bismarck Expressway and 7th Street would operate the same as under existing conditions with northbound left-turn and right-turn movements controlled by a separate northbound traffic signal phase.

- The intersections of Bismarck Expressway with 12th Street and Airport Road/19th Street are projected to be at LOS D with a four-lane Bismarck Expressway. These segments are projected to experience more significant traffic volume increases leading to the new developments east of 26th Street.
- AM peak period turning volumes from northbound 7th Street to northbound 9th Street results in significant weaving on Bismarck Expressway between 7th Street and the eastbound left-turn at 9th Street. This weaving maneuver is a problem under current conditions and will become worse as traffic volumes increase. The six-lane alternatives would require weaving across an additional lane.
- Another alternative for the intersection of Bismarck Expressway and 7th Street is to make the south leg one-way southbound only. This would improve operations at the 7th Street because the signal phase for northbound traffic would be eliminated. However, this requires all northbound traffic destined for the 7th Street intersection be diverted to the 3rd Street and/or 9th Street intersections. This is projected to result in a drop in level of service of one level (i.e. from C to D) at each intersection. With right-turn lanes on the northbound and southbound approaches to the 3rd Street intersection the level of service would not degrade.
- If the current south leg and split phase signal control are maintained for the Bismarck Expressway and 7th Street intersection it is projected that the overall intersection LOS would be D with the northbound and southbound approaches projected to see significant levels of congestion. Providing an additional right-turn lane on each approach would be necessary to improve operations on those approaches.
- East of approximately 12th Street, the traffic operations benefits of widening Bismarck Expressway to six-lanes are relatively limited. In comparing operations results of the four-lane to the six-lane, a level of service improvement of one letter grade or more is not provided in either the AM or the PM periods.

Right-of-way Impact Assessment of Build Alternatives

Documented below are the right-of-way impacts associated with the range of alternatives evaluated.

Maintain Four-Lane and Add Turn Lanes Where Warranted

In this alternative, the turn lane modifications would be made:

- Kirkwood Drive/Bozeman Drive: Eliminate the left-turn and through movements from the side streets to Bismarck Expressway. There would be no direct right-of-way impacts with this alternative, but left turn and through traffic would need to be relocated to 3rd Street or 7th Street.

- 7th Street: Eliminate the westbound and northbound left-turn movements. Establish an eastbound lane add on Bismarck Expressway to better accommodate the 7th Street northbound right-turn volume. The lane add on Bismarck Expressway would be formed by extending the right turn lane from the Bismarck Expressway/9th Street intersection. This additional eastbound lane would then drop as a right-turn lane at the 9th Street/Bismarck Expressway intersection. Reconfiguration of the intersection movements (by eliminating the northbound left-turn movement) would allow the northbound traffic signal phase to be eliminated, because only right turns would be allowed.
- 9th Street: Include an additional eastbound left turn lane and an additional westbound left turn lane. To limit impacts to the fire station, the existing south curbline would be maintained and all of the widening would be to the north side of the road. In addition, to the turn lanes on Bismarck Expressway:
  - The eastbound right turn lane would be extended through the Bismarck Expressway/7th Street intersection to increase the available right turn storage.
  - Restripe the northbound approach to allow three through lanes since the right-turn volume is quite low. Also, extending the northbound third lane (the curb lane) further south (possibly all the way to Denver Avenue) would provide more storage capacity on this approach. 9th Street to the north could accept three lanes of traffic, which would be critical for this alternative to effectively provide more usable capacity.
- 12th Street: Provide left-turn arrow phases for the northbound/southbound approaches. Also provide an eastbound right-turn lane. These recommendations were originally developed as part of the *12th Street Corridor Study*.
- 19th Street/Airport Road: Provide an additional left-turn lane for the eastbound and westbound approaches. Provide right-turn lanes on all intersection approaches.
- 26th Street: In addition to the improvements that are underway for the Wal-Mart development, provide an additional northbound left turn lane on 26th Street.
- Yegen Road: No additional turn lanes other than those proposed as part of the Yegen Road relocation and as part of the Northern Plain Commerce Centre development were incorporated into the analysis.
- Main Avenue: Widen the eastbound approach to provide an additional through lane and an additional left-turn lane. Provide right-turn lanes on the westbound and southbound approaches.

Additional turn lanes were not evaluated at:

- Washington Street: An additional eastbound left turn lane was reviewed early as an alternative, but the forecasted left-turn volume of 50 vehicle and

110 vehicles in the AM and PM peak hours, respectively, does not warrant a second left-turn lane.

- 2nd Street: No new turn lanes were warranted.
- 3rd Street: No new turn lanes were warranted.
- Rosser Avenue: No new turn lanes were warranted.

RIGHT-OF-WAY IMPACTS BY INTERSECTION, MAINTAIN FOUR LANE CONCEPT

The right-of-way impacts associated with the concept that would maintain the four-lane cross-section and add turn lanes where warranted are documented by location below:

- Kirkwood Entrance/Bozeman Drive: No right-of-way impacts.
- 7th Street: Extension of the 9th Street right-turn bay on Bismarck Expressway through 7th Street requires relocation of the south side sidewalk further to the south. It is likely that the relocation would encroach slightly into the school property. Thus, the impacts would be minimal. The proposed modifications to the south approach movements would not result in a right-of-way impact.
- 9th Street: A key issue throughout the study has been the conflict between the location of the fire station and expansion of the Bismarck Expressway right-of-way to accommodate more lanes for the capacity needed in the current and future conditions. Expansion of the southern curbline of Bismarck Expressway is perceived to have a significant negative impact on fire station operations in emergency and non-emergency situations. Thus, in the alternative the south curbline was maintained and the widening to accommodate the additional left turn lane would be to the north. Widening to the north most likely could be accomplished with minimal impacts to the Eide Ford dealership located north of Bismarck Expressway between 7th Street and 9th Street. Much of the boulevard would be taken to accommodate the turn lane and for replacement of the sidewalk, however, little or no direct impact to the vehicle parking area would likely occur. There is also a slight grade difference between the street level and the parking lot that will likely require construction of a short retaining wall adjacent to the parking lot.

  If the corridor expansion west of the intersection is all to the north, then the east side expansion to accommodate the second westbound left turn lane would also need to be primarily to the north. As with the west side expansion, the east side of 9th Street expansion likely could be accomplished without a significant impact to the Wendy's restaurant or the auto service center in the northeast quadrant of the intersection.

- 12th Street: The proposed improvements could be accommodated within the current right-of-way.

- 19th Street: Expanding the intersection area to accommodate eastbound and westbound left turn lanes and right turn lanes on all approaches would result in the need to acquire additional right-of-way along both Bismarck Expressway and 19th Street. In addition to the turn lanes, sidewalks should be incorporated into the recommended concept, which would also require expanding the current right-of-way width. The areas directly adjacent to the intersection on both Bismarck Expressway and 19th Street do not contain constraints that would direct the widening exclusively or weighted it to any one side. It is recommended that widening on all approaches be centered on the current travelway, thus, minimizing the impacts to any one parcel. Expansion of the right-of-way would not impact buildings or customer parking at adjacent businesses.

  Sidewalks should be provided on both the north and south sides of the Bismarck Expressway corridor, which will require extension from the current north and south termini of 18th Street and east of Georgia Street, respectively. Extension of the sidewalk for segments outside the corridor area impacted by the recommended turn lanes would not require acquisition of additional right-of-way.

- 26th Street: The south side of the Bismarck Expressway corridor east of 23rd Street is landscaped with trees that also screen from view a parking lot. These trees represent some of the more extensive landscaping in the corridor, which is minimal. The setback between the road and the trees is less than 15 feet. Thus, any significant widening to the south would likely impact the trees. The setback to the north is more substantial at approximately 20 feet. Based on the potential for impacts to the south side trees and the greater setback to the north, it is recommended that the widening to accommodate the turn lanes be predominantly to the north.

  As with the segment of the corridor adjacent to 19th Street, adding a north side and a south side sidewalk/trail is included in the preliminary recommendations. Adding sidewalk to the corridor would result in the need to expand the corridor limits by approximately 11 feet on either side (5 feet for a setback from the travel way and a 6 foot sidewalk/path).

  While the widening would require acquisition of right-of-way, it would not result in impacts to buildings or substantially to any parking areas. Limited impacts to the north side business parking would likely occur due to the combination of adding a turn lane, sidewalk and placing more of the burden on the north to avoid impacting the trees on the south.

- Main Avenue: The proposed improvements would not result in substantial expansion of the right-of-way that would result in impacts to the adjacent areas. The most significant impact associated with the recommendation is the need to replace the box culvert along Hay Creek.

Six-Lane Bismarck Expressway – Washington Street to 9th Street and Add Turn Lanes Where Warranted

In this concept Bismarck Expressway would be expanded to three-lanes in the eastbound and westbound directions through the higher forecasted volume segments of the corridor from Washington Street through 9th Street. In addition to the six through lanes, left and right turn lanes at locations where they are currently provided would be replaced. The concept would also include adding additional left and/or right turn lanes at locations where they would be warranted. The Bismarck Expressway six-lane alternative between Washington Street and 9th Street is shown in the attached graphics at the end of this document. Turn lane improvements for the concept in the corridor are listed below:

- 2nd Street: The initial six-lane concept included maintaining the westbound right turn lane and the eastbound left turn lane at 2nd Street. In the 2030 horizon year forecasted left turning volume in the AM and PM peak periods are relatively light at 40 and 120 vehicles, respectively. The right turn volume is forecasted to be approximately 260 vehicles in both the AM and the PM periods. The 2nd Street intersection serves a fairly large area of businesses and residences, thus the short eastbound left-turn lane is retained. Maintaining this left-turn lane needs to be balanced against the right-of-way impacts to adjacent property owners on the north side of Bismarck Expressway.
- Kirkwood Drive/Bozeman Drive: Eliminate the left-turn and through movements from the north approach to/from Kirkwood Mall. Two concepts were reviewed for the south side access at Bozeman Drive:
  - Maintain the access point, but eliminate left turn and through movements from the south. This concept would require extension of the approach storage by establishing a larger "bulb-out" that would connect the existing frontage road to Bismarck Expressway. The concept would require property acquisition.
  - Eliminate the Bozeman Drive access to/from Bismarck Expressway.

Left turn traffic from the north and south side would need to be relocated to 3rd Street or 7th Street.

- 7th Street: In addition to adding the through lane, the alternative includes:
  - Eliminating the westbound and northbound left-turn movements.
  - Establishing a lane add on Bismarck Expressway to better accommodate the 7th Street northbound right-turn volume. The lane add on Bismarck Expressway would be formed by extending the right-turn lane from the Bismarck Expressway/9th Street intersection. This additional eastbound lane would then drop as a right-turn lane at the 9th Street/Bismarck Expressway intersection.
  - Eliminating the northbound traffic signal phase. Reconfiguration of the intersection movements (by eliminating the northbound left-turn

movement) would allow the northbound traffic signal phase to be eliminated, because only right turns would be allowed.

- 9th Street: In this alternative the additional through lane in each direction would be accompanied by:
  - An additional eastbound and westbound left-turn lane. To limit impacts to the fire station, the existing south curbline would be maintained and all of the widening would be to the north side of the road.
  - Extending the eastbound right-turn lane through the Bismarck Expressway/7th Street intersection to increase the available right turn storage.
  - Restripe the northbound approach to allow three through lanes since the right-turn volume is quite low. Also, extending the northbound third lane (the curb lane) further south (possibly all the way to Denver Avenue) is a possibility to providing more storage capacity on this approach. 9th Street to the north could accept three lanes of traffic, which would be critical in resulting in this alternative providing more usable capacity.
- 12th Street: Provide left-turn arrow phases for the northbound/southbound approaches. Also provide an eastbound right-turn lane. These recommendations were originally developed as part of the *12th Street Corridor Study*. No additional through lanes were included.
- 19th Street/Airport Road: Provide an additional left-turn lane for the eastbound and westbound approaches. Provide right-turn lanes on all intersection approaches. No additional through lanes were included.
- 26th Street: In addition to the improvements that are underway for the Wal-Mart development provide an additional northbound left-turn lane on 26th Street. No additional through lanes were included.
- Yegen Road: No additional turn lanes other than those proposed as part of the Yegen Road relocation and as part of the Northern Plain Commerce Centre development were incorporated into the analysis. No additional through lanes were included.
- Main Avenue: Widen the eastbound approach to provide an additional through lane and an additional left-turn lane. Provide right-turn lanes on the westbound and southbound approaches. No additional through lanes on Bismarck Expressway were included.

Right-Of-Way Impacts by Intersection, Widen to Six-Lane Concept

The right-of-way impacts associated with the concept that would widen the Bismarck Expressway to six-lanes from Washington Street to 9th Street are documented by location below:

- Washington Street: Immediately adjacent to Washington Street, the impacts to the adjacent properties would be minimal, because three eastbound through lanes currently exist for a short distance east of Washington Street

and in the westbound direction no improvements would be provided. No westbound improvements were assumed because Washington Street would be the terminus of the six-lane corridor and the transition back to the four-lane section.

- 2nd Street: If the existing westbound right-turn lane and the eastbound left-turn lane are maintained, there would be impacts to the north side parking areas for the McDonalds and the Perkins restaurants and on the south side to the frontage road. The current setback between the frontage road and Bismarck Expressway is as little as 10 to 12 feet. The concept would add over 22 feet in width to Bismarck Expressway. To reduce the impacts, the following modifications could be made:
  - It may be possible to eliminate the eastbound left-turn lane from Bismarck Expressway to 2nd Street. The left turn volume is forecasted to be fairly light (40 vehicles in the AM and 130 vehicles in the PM in 2030). In addition, the combination of the unsignalized intersection and the high peak hour Bismarck Expressway volume, will make it increasingly more difficult to find an acceptable gap to make the left turn. Thus, eliminating the left turn movement will improve the safety of the intersection and reduce the overall Bismarck Expressway footprint.
  - Eliminate the westbound exclusive right-turn lane from Bismarck Expressway to 2nd Street. Right turning volume is forecasted to be approximately 260 vehicles in both the AM and PM peak periods in 2030. While the volume is fairly substantial, it could be reasonably accommodated in the third through lane, especially in the AM peak period. In the AM peak through volume is forecasted to be approximately 600 vehicles, which when spread over three lanes leaves substantial reserve capacity. In the PM peak period through volumes in 2030 are forecasted to increase to 1,700 vehicles, which will not provide a similar level of reserve capacity. There would likely, however be enough capacity in the outside lane to reasonably accommodate the right-turning traffic. When balanced with the potential for impacts to the Perkins restaurant parking, the traffic impacts associated with removal of the turn lane are minimal.
- 3rd Street: On the east side of the intersection the south side frontage road creates a fairly hard edge. The frontage road is set back 10 to 12 feet from the current curbline. Widening around the centerline allows for preservation of much of the parking areas for the Expressway Inn. Between 3rd Street and 7th Street the alignment would shift to the north and would impact the parking area for Kirkwood Mall to some degree.
- Kirkwood Entrance/Bozeman Drive: Expanding the corridor by one through lane in each direction and maintaining the turn lanes results in impacts to both the north and south side of the corridor. Maintaining the Bozeman Drive access may require reconstructing a larger bulb-out for vehicle stacking. A reconstructed bulb-out would require additional right-of-way to the south and would result in impacts to the commercial buildings

on either side of the Bozeman Drive access to/from Bismarck Expressway. Eliminating the Bozeman Drive access to/from Bismarck Expressway would reduce the adjacent property impacts on the south side and the current southern curbline could be used as the limits of the corridor, thus, not impacting the frontage road. Pushing the majority of the corridor widening to the north would result in a greater impact on Mall parking, but would not result in building impacts.

- 7th Street: Widening the Bismarck Expressway corridor to accommodate the third through lane at 7th Street will be influenced by the action plan for the 9th Street intersection. At 9th Street expansion of the corridor to the south is very limited due to substantial negative impacts to the fire station in the southwest quadrant. At 9th Street the concept would be to provide most or all of the widening to the north, which would require that most of the widening at 7th Street also be to the north. Widening the corridor to include the two additional through lanes (one in each direction) would require acquisition of parking at the Kirkwood Mall, but would not impact buildings. On the east side of 7th Street the widening would require acquisition a portion of the Eide Ford vehicle display area, but would not impact buildings.
- The concept also includes the proposals described as part of the Add Turn Lanes Only alternative. Outlined in the following bullet points are the adjacent impacts associated with the turn lane additions:
  - Extension of the 9th Street right-turn bay on Bismarck Expressway through 7th Street to better provide for the 7th Street northbound right-turn volume requires relocation of the south side sidewalk further to the south. It is likely that the relocation would encroach slightly into the school property. Thus, the impacts would be minimal.
  - The proposed modifications to the south approach movements would not result in a right-of-way impact.
- 9th Street: Expansion of the south curbline of Bismarck Expressway is perceived to have a significant negative impact on fire station operations in emergency and non-emergency situations. Thus, in the alternative the south curbline was maintained and the widening to accommodate the additional through and turn lanes would be to the north. Widening to the north would result in impacts to the Eide Ford dealership located north of Bismarck Expressway between 7th Street and 9th Street. All of the boulevard would be taken to accommodate the additional lanes (through lanes and eastbound left turn lane) and the southern row of vehicle display parking would be taken. Widening the corridor would not result in the need to take buildings, but the impacts to the vehicle display area would impact over 50 vehicle parking stalls. The level of impact should not be discounted when viewed from the auto dealer's perspective.

If the corridor expansion west of 9th Street is all, or almost exclusively, to the north, the east side expansion to accommodate the second westbound left

turn lane would also need to be primarily to the north. With the distance of the northerly widening project, the alignment of Bismarck Expressway east of 9th Street/University Drive will need to be shifted to the north to allow the through lanes to line up across the intersection. The northerly shift of the alignment will result in taking approximately 12 parking spaces from the Wendy's restaurant in the northeast quadrant. The site contains approximately 30 stalls. Thus, removing 12 spaces (approximately 40 percent) with a widening project would have a significant impact on the viability of the use in the current configuration.

The auto service operation located east of the Wendy's would also be impacted by the corridor widening. The building would not be impacted, but approximately nine to 10 parking spaces would be, and even more importantly, circulation in and out of the building would negatively impacted. The building circulation would not likely be impacted to the level that would result in a taking of the property, but the south side of the building parking results in a loss of approximately 25 percent of the reasonably available parking.

- 12th Street: The proposed improvements could be accommodated within the current right-of-way.
- 19th Street: Expanding the intersection area to accommodate eastbound and westbound left-turn lanes and right-turn lanes on all approaches would result in the need to acquire additional right-of-way along both Bismarck Expressway and 19th Street. In addition to the turn lanes, sidewalk should be incorporated into the recommended concept, which would also require expanding the current right-of-way width. The areas directly adjacent to the intersection on either Bismarck Expressway or 19th Street do not contain constraints that would direct the widening exclusively or weighted it to any one side. It is recommended that widening on all approaches be centered on the current travelway, thus, minimizing the impacts to any one parcel. Expansion of the right-of-way would not impact buildings or customer parking at adjacent businesses.

  Sidewalks should be provided on both the north and south sides of the Bismarck Expressway corridor, which will require extension from the current north and south termini of 18th Street and east of Georgia Street, respectively. Extension of the sidewalk for segments outside the corridor area impacted by the recommended turn lanes would not require acquisition of additional right-of-way.
- 26th Street: The south side of the Bismarck Expressway corridor east of 23rd Street is landscaped with trees that also screen from view a parking lot. These trees represent the some the more extensive landscaping in the corridor, which is minimal. The setback between the road and the trees is less than 15 feet. Thus, widening much, if any, to the south would likely impact the trees. The setback to the north is more substantial at

approximately 20 or so feet. Based on the potential for impacts to the south side trees and the greater setback to the north, it is recommended that the widening to accommodate the turn lanes be predominantly to the north.

As with the segment of the corridor adjacent to 19th Street, adding a north side and a south side sidewalk/trail is included in the preliminary recommendations. Adding sidewalk to the corridor would result in the need to expand the corridor limits by approximately 11 feet on either side (5 feet for a setback from the travel way and a 6 foot sidewalk/path).

While the widening would require acquisition of right-of-way, it would not result in impacts to buildings or substantially to any parking areas. Limited impacts to the north side business parking would likely occur due to the combination of adding a turn lane, sidewalk and placing more of the burden on the north to avoid impacting the trees on the south.

Bismarck Expressway Pedestrian Crossing Alternatives Assessment

Background

Ensuring the safety of pedestrians and bicyclists traveling along and across the Bismarck Expressway corridor is an important goal of the Interstate/Bismarck Expressway Corridor Study. As such, a process of identifying a broad range of concepts that would support the non-motorized traveler safety goal and screening the concepts to the more reasonable was employed. The purpose of this summary is to provide documentation of the alternatives reviewed throughout the study and to provide documentation of the recommended actions.

Currently, the Bismarck Expressway has sidewalks/multi-use trails located on the north and south sides of the street from east of Washington Street to approximately 18th Street. Each signalized intersection within the corridor from Washington Street through 19th Street currently has marked crosswalks. Pedestrian activated push button and walk signals are provided at all of the signalized intersections. In some cases the pedestrian must use the pedestrian button in order to get a "walk" signal, while in others the "walk" signal is automatically illuminated with the complementary vehicle indicators.

NON-MOTORIZED ALTERNATIVES

The safety of pedestrians crossing Bismarck Expressway has been identified as an issue by the public. The potential conflicts between pedestrians and automobiles and the amount of time required for a pedestrian to safely cross the roadway are the two primary concerns. A wide range of safety improvements for pedestrians crossing the Bismarck Expressway has been conducted. A brief description of each alternative along with the positives and negatives for each alternative is provided in the attached table.

ANALYSIS FINDINGS/RECOMMENDATIONS

The proposed roadway improvement plan for Bismarck Expressway recommends a six-lane facility between Washington Street and 9th Street. A wider street requires more time for pedestrians to cross safely. It is recommended that the required time for pedestrian WALK indication only be provided when the pedestrian push button is activated. If a pedestrian push button is not activated the WALK signal is not displayed and signage should be added to the pedestrian push button to inform the pedestrian they must use the pedestrian push button. The pedestrian crossing time will be adequate to cross all of the travel lanes. Additional regulatory signage should also be installed informing motorists they must yield to pedestrians in the crosswalks. The use of adult crossing guards at the 12th Street intersection should be continued for this school crossing.

SUMMARY OF BISMARCK EXPRESSWAY PEDESTRIAN IMPROVEMENT ALTERNATIVES

Alternative Description	Positives	Negatives
Maintain existing Bismarck Expressway cross section (four through lanes plus turn lanes)	+ Shorter crossing distance for pedestrians + Less pedestrian signal time is required + No right of way impacts	- Increased congestion leads to impatient drivers who may be less likely to yield to pedestrians
Install regulatory signing that require motorists to yield to pedestrians/ Additional cross walk signing	+ Reinforces the 'rules of the road' to motorists	- Signs can provide a false sense of security for pedestrians
Textured pavement or different color pavement in the crosswalk area	+ Clearly defines the crosswalk to both motorists and pedestrians	- Treatment can be relatively expensive - Textured pavements can cause problems with snow removal - Increase maintenance costs
Provide crossing guards at school crossings	+ Crossing guards are more visible to traffic then children + Warrants are likely met at J. Myhre School + Crossing guards provide positive guidance to children	- Generally volunteers, requires dedication
Leading pedestrian signal phase (i.e., the WALK indication is provided prior to the conflicting GREEN indication)	+ Pedestrians occupy the crosswalk before conflicting vehicles are released and this increases their visibility	- Requires conflicting right-turn movement to be controlled by right-turn arrows and no right-turn on reds are allowed. - Reduces capacity of conflicting right-turn movement
Exclusive pedestrian signal phase (i.e., only pedestrians are served during this signal phase)	+ Pedestrian/Motorist conflicts are removed	- Pedestrian phase requires a considerable amount of cycle time - Can significantly reduce intersection capacity for motor vehicles - An exclusive pedestrian phase should only be used where large pedestrian volumes exist (not the case along Bismarck Expressway)

SUMMARY OF BISMARCK EXPRESSWAY PEDESTRIAN IMPROVEMENT ALTERNATIVES

Alternative Description	Positives	Negatives
Require pedestrians to use pedestrian push button in order to receive WALK indication	+ Can provide more green time for the higher volume traffic movements	- Can be confusing for pedestrians and proper signage must be used in association with the pedestrian push button
Provide intersection pedestrian refuge islands and supplemental pedestrian push button - with proposed Bismarck Expressway expansion	+ Provides pedestrians with a resting place when crossing wide roads + Reduced/Staged exposure to vehicle traffic (only one direction conflicts at a time)	- Requires a raised median island that is at least six feet wide – additional right of way - Some pedestrians will not feel safe standing on an island in the middle of traffic
Provide mid-block pedestrian refuge islands - with proposed Bismarck Expressway expansion (No pedestrian signal)	+ Provides pedestrians with a resting place when crossing wide roads	- Requires a raised median island that is at least six feet wide – additional right of way - Some pedestrians will not feel safe standing on an island in the middle of moving traffic - False sense of security - Snow removal – If short median - Obstacle for motor vehicles (mid-block) - Cost
Provide a pedestrian overpass/ underpass with a wider Bismarck Expressway cross section	+ Removes the potential pedestrian-vehicle conflicts + Removal of pedestrian signal phase may increase intersection capacity for vehicles at adjacent intersections	- Cost of structure can be significant - Right of way impacts (ADA requirements) - Pedestrians may continue to cross at intersections (Effort vs. Time Savings) - No locations meet warrants - Few complementary activity areas (Mall/J. Myhre)

NON-MOTORIZED FACILITIES ALONG BISMARCK EXPRESSWAY

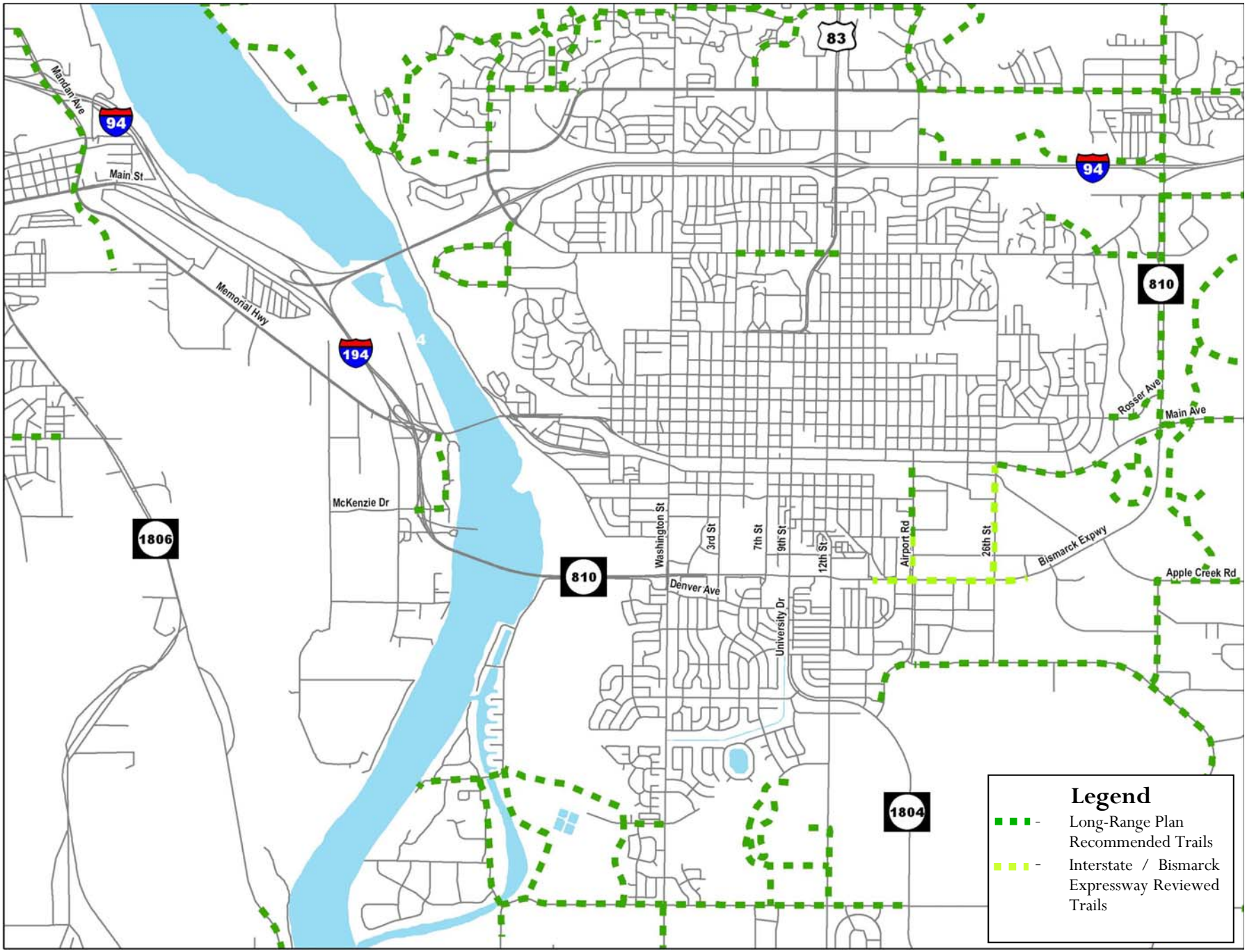
The *Bismarck-Mandan Metropolitan Area Long Range Transportation Plan* and the Bismarck Parks and Recreation – *The Path to 2005* plan both note gaps in the current sidewalk and trails systems. These documents recommend new trail segments or wider sidewalks along the following streets:

- 19th Street between Main Avenue and Michigan Avenue
- Main Avenue between 19th Street and Bismarck Expressway
- A connection between Bismarck Expressway and 19th Street utilizing 17th Street and Michigan Avenue
- 26th Street between Rosser Avenue and Main Avenue
- Bismarck Expressway north of Main Avenue
- Highway 1806 trail that would go through the I-94 / Mandan Avenue interchange

The implementation of the above projects does not address pedestrian flow along the Bismarck Expressway east of 18th Street. With the new retail centers at 26th Street it is important to provide pedestrian access to these properties. To address these gaps along the Bismarck Expressway the following trail segments were considered:

- 19th Street – continue the trail south from Michigan Avenue to Bismarck Expressway. There is currently a 30-36' boulevard separating the frontage road from 19th Street where a trail could be built. This trail connection would also provide a traffic signal to cross Bismarck Expressway.
- Bismarck Expressway – continue the trail and sidewalks from 18th Street to a minimum of 26th Street and preferably to Burlington Drive. This would provide pedestrian access to a critical new retail area in Bismarck.
- 26th Street – At a minimum a sidewalk should be provided along this street from Main Avenue to Bismarck Expressway.

The proposed trail/sidewalk upgrades from both this study and previous studies are shown graphically in Figure A20. The segment of Bismarck Expressway between Burlington Drive and Main Avenue is relatively undeveloped. In this segment there is also a major bridge structure that traverses the railroad that currently does not have adequate width to accommodate sidewalks or a trail. It is not recommended that pedestrian facilities be provided along this segment of Bismarck Expressway since pedestrian improvements are already proposed along both Main Avenue and Rosser Avenue.



Bismarck-Mandan
Metropolitan Planning Organization

Figure A20. Alternative Multi-Use Trails

APPENDIX B

COST ESTIMATES

Project Number: 16169897 **Project Name: MANDAN**

Subaccount: **Location of Project: MANDAN, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)	**Alternative:**	**B**
	Prepared By:	**ACB**
	Date Prepared:	**6/27/2006**

Item	Unit Cost	Quantity	Extended Cost	*Shaded Fields are for INPUT*
FROM PAGE 1, BID ITEM TABULATION			**$10,364,777.50**	
			$10,364,777.50	

	% Range	% Used	Cost	
Project Construction Bid Items	Project Dependent	**N / A**	$10,364,777.50	**(A)**
Contingencies	(15 - 30%) of **A**	30.0%	$3,109,433.25	**(B)**
ITS	(6 - 10%) of (**A+B**)	0.0%	$0.00	**(C)**
Drainage / Utilities	(3 - 10%) of (**A+B**)	10.0%	$1,036,477.75	**(D)**
Signing and Striping	(1 - 5%) of (**A+B+C+D**)	2.5%	$259,119.44	**(E)**
Construction Signing & Traffic Control	(5 - 25%) of (**A+B+C+D+E**)	15.0%	$1,554,716.63	**(F)**
Mobilization	(4 - 7%) of (**A+B+C+D+E+F**)	5.0%	$518,238.88	**(G)**
Total of Construction Bid Items	(**A+B+C+D+E+F+G**)		$16,842,763.45	**(H)**
Force Account - Utilities	(1 - 2%) of **H**	0.0%	$0.00	**(I)**
Force Account - Misc.	(5 - 15%) of **H**	0.0%	$0.00	**(K)**
Subtotal of Construction Cost	(**H+I+J+K**)		$16,842,763.45	**(L)**
Total Construction Engineering	(17%) of **L**	0.0%	$0.00	**(M)**
Total Preliminary Engineering	(15%) of **L**	0.0%	$0.00	**(N)**
Utilities	Project Dependent	N / A	$0.00	**(O)**
Right-of-Way (Acre)	Project Dependent	$7000/AC		**(P)**
		Total Project Cost	$16,843,000.00	**(Q)**

NOTES:

Project Number: 16169897 **Project Name: MANDAN**

Subaccount: **Location of Project: MANDAN, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)		
	Alternative:	**B**
	Prepared By:	**ACB**
	Date Prepared:	**6/27/2006**

	Item		Unit Cost	Quantity	Extended Cost
1	Item 201-Clearing and Grubbing	LS	$101,300.00	1	$101,300.00
2	Item 202-Rem of Bituminous Surfacing	SY	$2.50	70,909	$177,272.50
3	Item 202-Rem of Structure	EA	$100,000.00	4	$400,000.00
4	Item 203-Unclassified Excavation	CY	$5.00	52,820	$264,100.00
5	Item 302-Aggregate Base Course	CY	$13.00	13,205	$171,665.00
6	Item 550-Concrete Pavement (9 inch)	SY	$40.00	3,052	$122,080.00
7	Item 550-Concrete Pavement (11 inch)	SY	$50.00	76,178	$3,808,900.00
8	Item 602-Concrete Structures (Bridges)	SF	$120.00	45,173	$5,420,760.00
9					$0.00
	Sub Total				**$10,364,777.50**

PROJECT CONSTRUCTION BID ITEMS **$10,364,777.50**

NOTES:
1. Assumed typical section of 11" of concrete over 6" of ABC on interstate.
1. Assumed typical section of 9" of concrete over 6" of ABC on side streets.

Project Number: 16169897 **Project Name: MANDAN**

Subaccount: **Location of Project: MANDAM, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)		
	Alternative:	**E**
	Prepared By:	**MSP**
	Date Prepared:	**6/27/2006**

Item		Unit Cost	Quantity	Extended Cost	*Shaded Fields are for INPUT*
FROM PAGE 1, BID ITEM TABULATION				**$5,623,996.00**	
				$5,623,996.00	

	% Range	% Used	Cost	
Project Construction Bid Items	Project Dependent	**N / A**	$5,623,996.00	**(A)**
Contingencies	(15 - 30%) of **A**	30.0%	$1,687,198.80	**(B)**
ITS	(6 - 10%) of (**A+B**)	0.0%	$0.00	**(C)**
Drainage / Utilities	(3 - 10%) of (**A+B**)	10.0%	$562,399.60	**(D)**
Signing and Striping	(1 - 5%) of (**A+B+C+D**)	2.5%	$140,599.90	**(E)**
Construction Signing & Traffic Control	(5 - 25%) of (**A+B+C+D+E**)	15.0%	$843,599.40	**(F)**
Mobilization	(4 - 7%) of (**A+B+C+D+E+F**)	5.0%	$281,199.80	**(G)**
Total of Construction Bid Items	(**A+B+C+D+E+F+G**)		$9,138,993.50	**(H)**
Force Account - Utilities	(1 - 2%) of **H**	0.0%	$0.00	**(I)**
Force Account - Misc.	(5 - 15%) of **H**	0.0%	$0.00	**(K)**
Subtotal of Construction Cost	(**H+I+J+K**)		$9,138,993.50	**(L)**
Total Construction Engineering	(17%) of **L**	0.0%	$0.00	**(M)**
Total Preliminary Engineering	(15%) of **L**	0.0%	$0.00	**(N)**
Utilities	Project Dependent	N / A	$0.00	**(O)**
Right-of-Way (Acre)	Project Dependent	$7000/AC		**(P)**
		Total Project Cost	$9,139,000.00	**(Q)**

NOTES:

Project Number: 16169897 **Project Name: MANDAN**

Subaccount: **Location of Project: MANDAM, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)	**Alternative:**	**E**
	Prepared By:	**ACB**
	Date Prepared:	**6/27/2006**

	Item		Unit Cost	Quantity	Extended Cost
1	Item 201-Clearing and Grubbing	LS	$55,000.00	1	$55,000.00
2	Item 202-Rem of Bituminous Surfacing	SY	$2.50	10,514	$26,285.00
3	Item 202-Rem of Structure	EA	$100,000.00	3	$300,000.00
4	Item 203-Unclassified Excavation	CY	$5.00	23,287	$116,435.00
5	Item 302-Aggregate Base Course	CY	$13.00	5,822	$75,686.00
6	Item 550-Concrete Pavement (11 inch)	SY	$50.00	34,931	$1,746,550.00
7	Item 602-Concrete Structures (Bridges)	SF	$120.00	27,992	$3,359,040.00
	Sub Total				**$5,623,996.00**

PROJECT CONSTRUCTION BID ITEMS **$5,623,996.00**

NOTES:
1. Assumed typical section of 11" of concrete over 6" of ABC

Project Number: 16169897 **Project Name: MANDAN**

Subaccount: **Location of Project: MANDAN, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)		
	Alternative:	**I**
	Prepared By:	**MSP**
	Date Prepared:	**6/27/2006**

Item		Unit Cost	Quantity	Extended Cost	*Shaded Fields are for INPUT*
FROM PAGE 1, BID ITEM TABULATION				**$2,542,374.00**	
				$2,542,374.00	

	% Range	% Used	Cost	
Project Construction Bid Items	Project Dependent	**N / A**	$2,542,374.00	**(A)**
Contingencies	(15 - 30%) of **A**	30.0%	$762,712.20	**(B)**
ITS	(6 - 10%) of (**A+B**)	0.0%	$0.00	**(C)**
Drainage / Utilities	(3 - 10%) of (**A+B**)	10.0%	$254,237.40	**(D)**
Signing and Striping	(1 - 5%) of (**A+B+C+D**)	2.5%	$63,559.35	**(E)**
Construction Signing & Traffic Control	(5 - 25%) of (**A+B+C+D+E**)	15.0%	$381,356.10	**(F)**
Mobilization	(4 - 7%) of (**A+B+C+D+E+F**)	5.0%	$127,118.70	**(G)**
Total of Construction Bid Items	(**A+B+C+D+E+F+G**)		$4,131,357.75	**(H)**
Force Account - Utilities	(1 - 2%) of **H**	0.0%	$0.00	**(I)**
Force Account - Misc.	(5 - 15%) of **H**	0.0%	$0.00	**(K)**
Subtotal of Construction Cost	(**H+I+J+K**)		$4,131,357.75	**(L)**
Total Construction Engineering	(17%) of **L**	0.0%	$0.00	**(M)**
Total Preliminary Engineering	(15%) of **L**	0.0%	$0.00	**(N)**
Utilities	Project Dependent	N / A	$0.00	**(O)**
Right-of-Way (Acre)	Project Dependent	$7000/AC		**(P)**
		Total Project Cost	$4,131,000.00	**(Q)**

NOTES:

Project Number: 16169897 **Project Name: MANDAN**

Subaccount: **Location of Project: MANDAN, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)	**Alternative:**	**I**
	Prepared By:	**MSP**
	Date Prepared:	**6/27/2006**

	Item		Unit Cost	Quantity	Extended Cost
1	Item 201-Clearing and Grubbing	LS	$26,000.00	1	$26,000.00
2	Item 202-Rem of Bituminous Surfacing	SY	$2.50	3,516	$8,790.00
3	Item 202-Rem of Structure	EA	$100,000.00	2	$200,000.00
4	Item 203-Unclassified Excavation	CY	$5.00	4,634	$23,170.00
5	Item 302-Aggregate Base Course	CY	$13.00	1,158	$15,054.00
6	Item 550-Concrete Pavement (9 inch)	SY	$40.00	6,951	$278,040.00
7	Item 602-Concrete Structures (Bridges)	SF	$120.00	16,811	$2,017,320.00
	Sub Total				**$2,542,374.00**

PROJECT CONSTRUCTION BID ITEMS **$2,542,374.00**

NOTES:
1. Assumed typical section of 9" of PCCP over 6" of ABC

Project Number: 16169897 **Project Name: BISMARCK**

Subaccount: **Location of Project: BISMARCK, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)	**Alternative:**	
	Prepared By:	**MSP**
	Date Prepared:	**6/27/2006**

Item	Unit Cost	Quantity	Extended Cost	*Shaded Fields are for INPUT*
FROM PAGE 1, BID ITEM TABULATION			**$11,997,237.50**	
			$11,997,237.50	

	% Range	% Used	Cost	
Project Construction Bid Items	Project Dependent	**N / A**	$11,997,237.50	**(A)**
Contingencies	(15 - 30%) of **A**	30.0%	$3,599,171.25	**(B)**
ITS	(6 - 10%) of (**A+B**)	0.0%	$0.00	**(C)**
Drainage / Utilities	(3 - 10%) of (**A+B**)	10.0%	$1,199,723.75	**(D)**
Signing and Striping	(1 - 5%) of (**A+B+C+D**)	2.5%	$299,930.94	**(E)**
Construction Signing & Traffic Control	(5 - 25%) of (**A+B+C+D+E**)	15.0%	$1,799,585.63	**(F)**
Mobilization	(4 - 7%) of (**A+B+C+D+E+F**)	5.0%	$599,861.88	**(G)**
Total of Construction Bid Items	(**A+B+C+D+E+F+G**)		$19,495,510.95	**(H)**
Force Account - Utilities	(1 - 2%) of **H**	0.0%	$0.00	**(I)**
Force Account - Misc.	(5 - 15%) of **H**	0.0%	$0.00	**(K)**
Subtotal of Construction Cost	(**H+I+J+K**)		$19,495,510.95	**(L)**
Total Construction Engineering	(17%) of **L**	0.0%	$0.00	**(M)**
Total Preliminary Engineering	(15%) of **L**	0.0%	$0.00	**(N)**
Utilities	Project Dependent	N / A	$0.00	**(O)**
Right-of-Way (Acre)	Project Dependent	$7000/AC		**(P)**
		Total Project Cost	$19,496,000.00	**(Q)**

NOTES:

Project Number: 16169897 **Project Name: BISMARCK**

Subaccount: **Location of Project: BISMARCK, ND**

Engineers (Semi) Detailed Estimate (FY 05 Cost Index)	**Alternative:**	
	Prepared By:	**MSP**
	Date Prepared:	**6/27/2006**

	Item		Unit Cost	Quantity	Extended Cost
1	Item 201-Clearing and Grubbing	LS	$55,000.00	1	$55,000.00
2	Item 202-Rem of Bituminous Surfacing	SY	$2.50	167,377	$418,442.50
3	Item 202-Rem of Curb & Gutter	LF	$4.00	38,348	$153,392.00
4	Item 202-Rem of Sidewalk	SY	$7.00	64,953	$454,671.00
	Item 202-Rem of Structure	EA	$100,000.00	1	$100,000.00
5	Item 203-Unclassified Excavation	CY	$5.00	30,000	$150,000.00
6	Item 302-Aggregate Base Course	CY	$13.00	28,871	$375,323.00
7	Item 550-Concrete Pavement (9 inch)	SY	$40.00	173,225	$6,929,000.00
8	Item 602-Concrete Structures (Bridges)	SF	$120.00	15,384	$1,846,080.00
9	Item 748-Curb & Gutter-Type 1	LF	$15.00	39,282	$589,230.00
10	Item 750-Sidewalk Concrete 4IN	SY	$29.00	33,831	$981,099.00
11					$0.00
	Sub Total				**$11,997,237.50**

PROJECT CONSTRUCTION BID ITEMS **$11,997,237.50**

NOTES:
1. Assumed typical section of 9" of concrete over 6" of ABC