City of Columbus Transportation Plan Update

A Companion Document to the Comprehensive Plan Update

Final Report

Prepared for

City of Columbus

Prepared by

Olsson Associates

August 2004

Columbus NEBRASKA

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CITY OF COLUMBUS

TRANSPORTATION PLAN UPDATE

COLUMBUS, NEBRASKA

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October 2003

OA Project No. 2003-0048

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1.0 INTRODUCTION

This report documents the results of a project conducted to update the Comprehensive Plan for the City of Columbus, Nebraska. In particular, this report addresses the transportation planning component of the project. The project was conducted by Olsson Associates (OA) under contract to the City of Columbus. Funding for the project was provided, in part, through the Nebraska Department of Roads (NDOR) Comprehensive Plan Assistance Program. Columbus is located in northeast Nebraska and is the county seat for Platte County. The current population of Columbus, based on the 2000 census data, is approximately 21,000. A location map is shown in Figure 1-1.

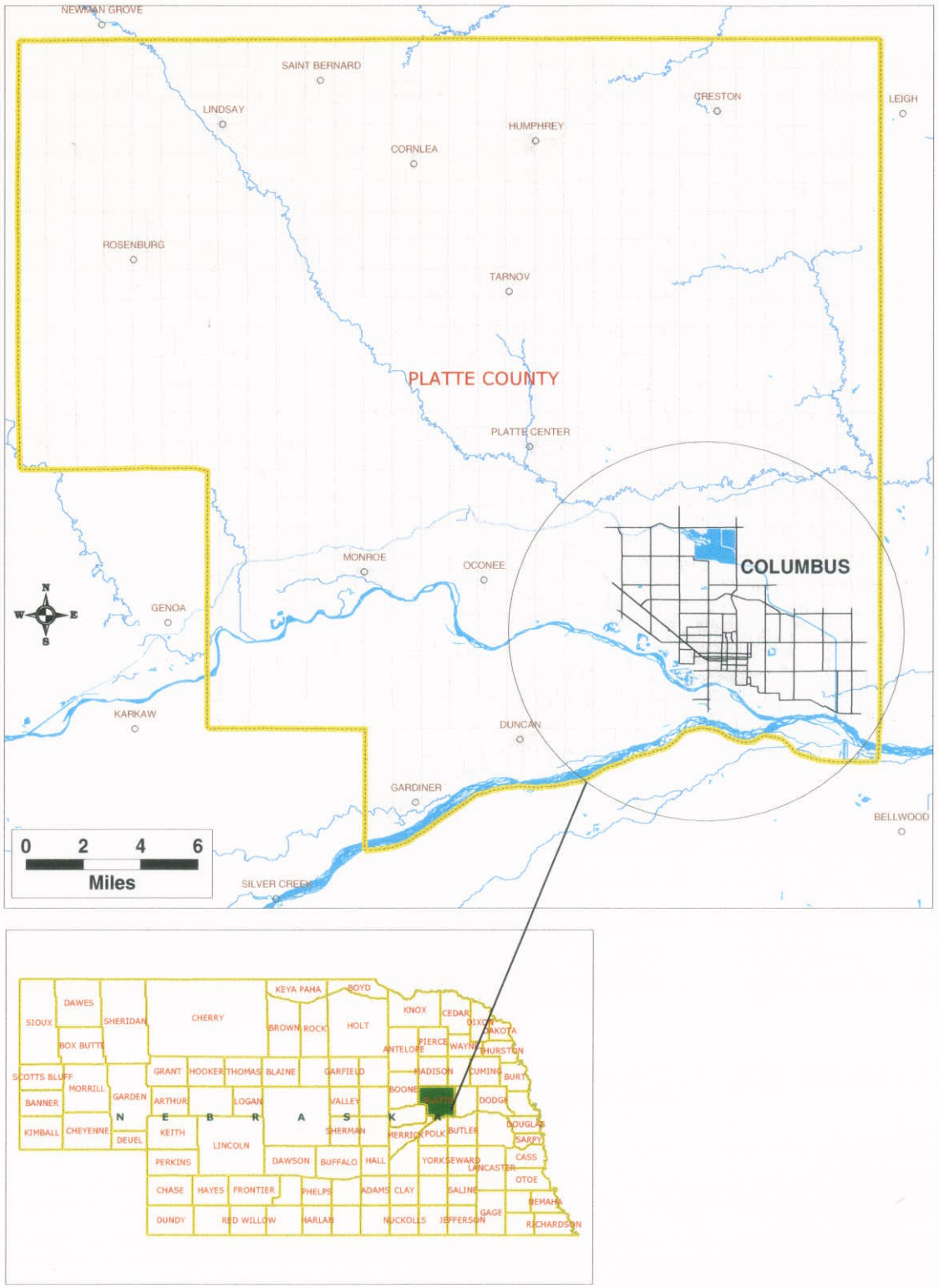
1.1 Study Objective

The primary study objective was to update the City's Comprehensive Plan. The current Comprehensive Plan was adopted in 1992. From the outset of the project, development of a concise, flexible, and useable Comprehensive Plan has been emphasized by City staff. In addition to updating the Comprehensive Plan, key study objectives included developing an updated land use and transportation plan to guide future growth in the community. Development of a computerized, citywide transportation model, in accordance with NDOR standards, was a focal point of the land use and transportation planning process. Key deliverables of this project include:

- A state-of-the-art computerized transportation model developed using TransCAD.
- A Long-Range Transportation Plan (LRTP) with recommended improvements prioritized for the short-, mid-, and long-range time frames.
- A transportation and land use plan that are compatible with City and NDOR geographic information systems (GIS).
- Final project report and updated Comprehensive Plan document.

The scope of work for this project was based primarily on planning level analysis. At the request of City staff, several intersections were studied in more detail including operational analyses and accident review. A citywide field review was also conducted as part of the model development process. Operational level recommendations, such as additional intersection turn lanes, were made for selected locations, as appropriate, based on the results of the analysis and field review. Most recommendations, however, are based on planning level analysis and are targeted at "big picture" improvements such as adding lanes to an existing roadway, replacing an at-grade railroad crossing with a viaduct, or providing a new roadway connection where no road exists today. This distinction is important, as most major roadway improvement projects must be identified and included in a long-range transportation plan for many years before funding is available.

The project also included a summary review of the current City Zoning and Subdivision Ordinances. This review was conducted specifically to evaluate consistency of the current ordinances and regulations with the adopted Comprehensive Plan. The results of this review are included in a separate technical memorandum.



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Study Area	
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1.2 Steering Committee

A project Steering Committee was organized at the beginning of the project to assist City staff and provide oversight for the work of the consultant project team. The Steering Committee was selected to represent a wide variety of community interests. City staff and Steering Committee members are listed in Table 1-1.

Table 1-1
City Staff and Steering Committee Members

Name	Affiliation
Joe Frei	City Administrator
Merlin Lindahl	City Engineer
Dan Curtis	Community Development Director
Joe Jarecke	City Council Member
Larry Marik	First National Bank & Trust
Larry Beiermann	Union Bank, Inc.
Marv Peterson	Century 21 Realty Team
Chuck Whitney	City Council Member
Harrison Cass	Superintendent, Columbus School System
Bruce Schneider	Columbus Planning Commission
Kris Winter	Nebraska Department of Roads, District 3

The Steering Committee met a number of times over the course of the project. They provided guidance to the project team on land use and transportation planning issues and reviewed interim project materials. Steering Committee meetings were held on the following dates:

- March 6, 2003
- April 17, 2003
- May 15, 2003
- July 24, 2003
- October 1, 2003
- January 22, 2004
- August 19, 2004

1.3 Technical Documentation

During the conduct of this project, interim material or technical documents were prepared for review by the Steering Committee. These items, which are listed below, were prepared in draft format to summarize technical progress and/or issues relevant to the project.

- Existing Transportation Conditions Technical Memorandum
- Issues and Opportunities Visioning Exercise

- Population Goals and Objectives
- Land Use Growth Scenarios
- Travel Demand Model Validation Summary
- Travel Demand Model Technical Documentation
- Travel Demand Model Assignment Plots
- Transportation Alternatives Summary

The above information, including comments received from the Steering Committee and revisions to address these comments, have been incorporated into this final project report.

1.4 Plan Adoption Process

This report documents the study process and presents land use and transportation plan recommendations for consideration in the updated Comprehensive Plan. Following review and approval of this document by City staff and the project Steering Committee, final recommendations will be incorporated into the updated Comprehensive Plan document. The draft final Comprehensive Plan document will then be presented for review and approval of the Planning Commission and City Council. Public hearings will be held with the Planning Commission and City Council meetings to provide opportunity for input from the public.

1.5 Report Organization

The remainder of this report is organized as outlined below:

- Chapter 2 – Land Use Plan
- Chapter 3 – Existing Transportation Conditions
- Chapter 4 – Transportation Model Development and Alternatives Analysis
- Chapter 5 – Alternative Transportation Elements Evaluation
- Chapter 6 – Recommended Transportation Plan

2.0 LAND USE PLAN

This chapter of the report documents the land use planning process including a summary of the land use planning process, existing land use, demographic analysis used to develop future land use trends, and the recommended future land use plan for the City.

2.1 Land Use Planning

The relationship between transportation systems and land use underlies all activities related to transportation planning. Any number of projects commonly thought of as transportation planning—a bypass roadway, transit service for persons with disabilities, the location of a highway interchange—have implications for land use. As a result, no transportation planning effort can be concerned with transportation services alone.

The complexity of the land use/transportation issue is influenced by two key factors. First, the relationship between land use and transportation is reciprocal: land use patterns affect travel decisions and travel decisions affect land use patterns. Second, the activity patterns of businesses and households change independently of land use and transportation in response to changing values, jobs, age, income and preferences. Great effort must be taken to try to better understand this relationship.

Therefore, the transportation demand and land development cycle was evaluated as part of this effort to ensure that transportation improvements can support growth and redevelopment in desired areas and, conversely, that in some areas only specific land uses are encouraged or allowed based on limited transportation capacity.

The following is a description of existing and future land uses for Columbus and existing demographics and projected future data that were used in the transportation modeling process.

2.2 Existing Land Use

Land use defines where people live, work and play. Land use patterns shape the nature of socioeconomic data by reflecting urban and non-urban activity through population, employment, dwelling units, school enrollment, and other related demographic data. Some locations represent areas with a greater density of urban activity such as residential, commercial, industrial, institutional or recreational land uses, while some locations represent less dense activity which may include agriculture and open space.

In general, Columbus' land use pattern is predominately suburban in nature, with a density of approximately 3.4 dwelling units per acre. However, the City is also the location of the largest manufacturing center in the region making Columbus the employment focal point of the region. The predominant use of land within the planning area is residential. The great majority of these residential uses are single-family residential, which make up 32.67% of the total land use. Mixed-density residential and high-density residential make up a much smaller portion of total land use accounting for

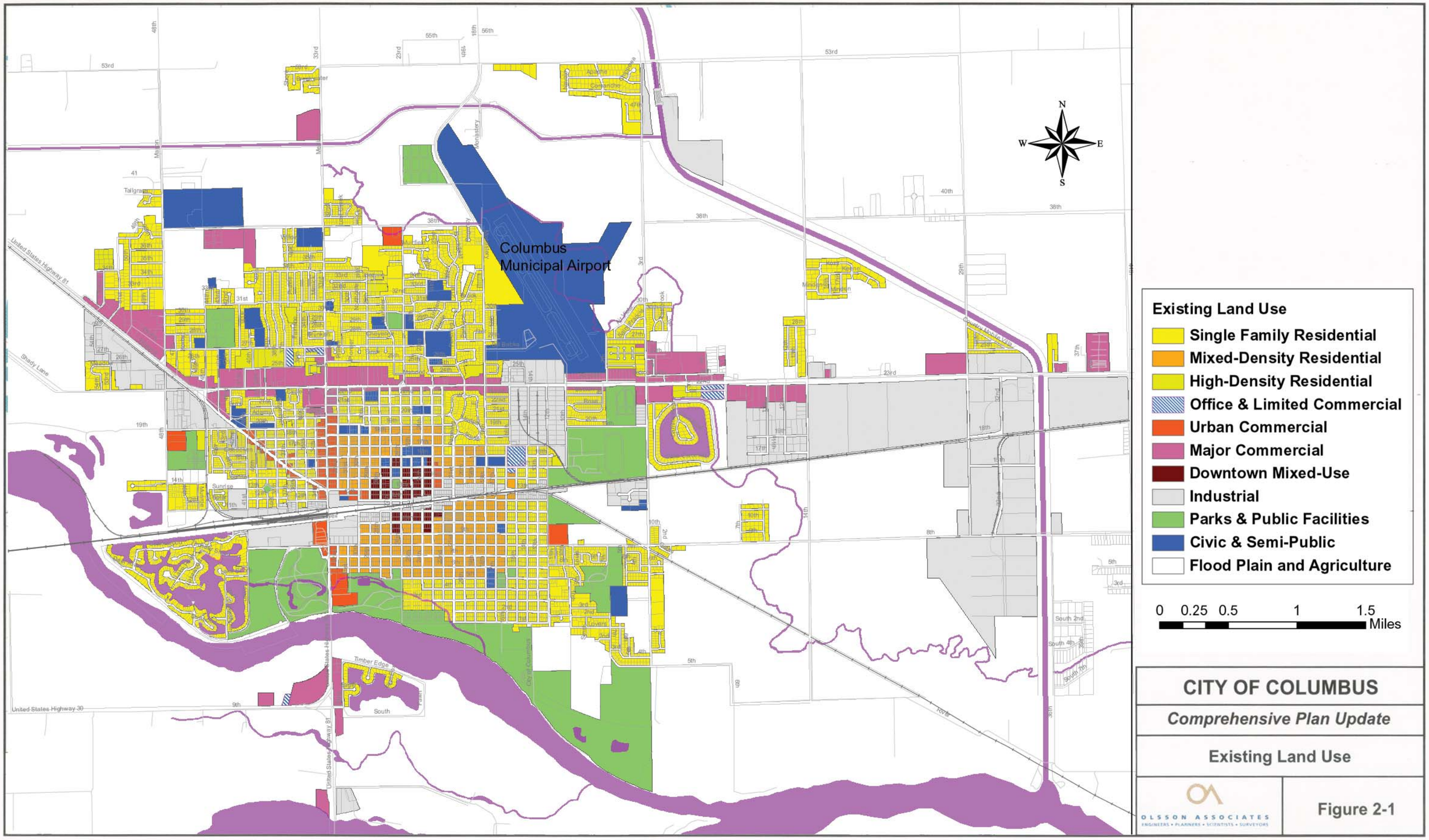
6.19% and 1.15%, respectively. Most of the residential development is located within the city limits of Columbus. Commercial and retail-oriented development is concentrated on both, 33rd Avenue and 23rd Street (the Highway 30-Highway 81 corridors). Commercial uses are also lightly mixed in the downtown and other transportation corridors such as Howard Boulevard and the UPRR line.

Historically, and today on a more limited basis, industrial activity is a significant element of land use in the downtown area. The bulk of industrial; land use, however, is located to the east of the city and outside of city limits. Remaining industrial uses are found within Columbus city limits and are located along the UPRR line that runs through the city as well as in the northwest section of the city. Public uses consist of parks, schools, churches, service clubs, fire stations, city water and sewer operations, post office and other similar public uses. The existing land use map is illustrated in Figure 2-1. Major natural resource related land uses in the planning area consist of agriculture and floodplain areas. These also are identified in Figure 2-1.

Table 2-1 provides a summary of existing land use of for the City of Columbus.

Table 2-1
Existing Land Use Summary

Land Use Type	Land Use Totals (in acres)	% of Total
Single-Family Residential District (R-1)	2,371	32.67%
Urban-Family Residential District (R-2)	449	6.19%
Multiple-Family Residential District (R-3)	84	1.15%
Office/Limited Commercial District(O/LC)	21	0.29%
Urban Commercial (UC)	19	0.27%
Major Commercial (MC)	628	8.65%
Central Business District (B-1)	45	0.62%
General Industrial District (MH)	1,929	26.58%
Civic	768	10.58%
Park and Public Facilities	943	12.99%
Total	7,257	100.00%


Columbus Municipal Airport
N
W
E
S
Existing Land Use
Single Family Residential
Mixed-Density Residential
High-Density Residential
Office & Limited Commercial
Urban Commercial
Major Commercial
Downtown Mixed-Use
Industrial
Parks & Public Facilities
Civic & Semi-Public
Flood Plain and Agriculture
0 0.25 0.5 1 1.5
Miles
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Existing Land Use
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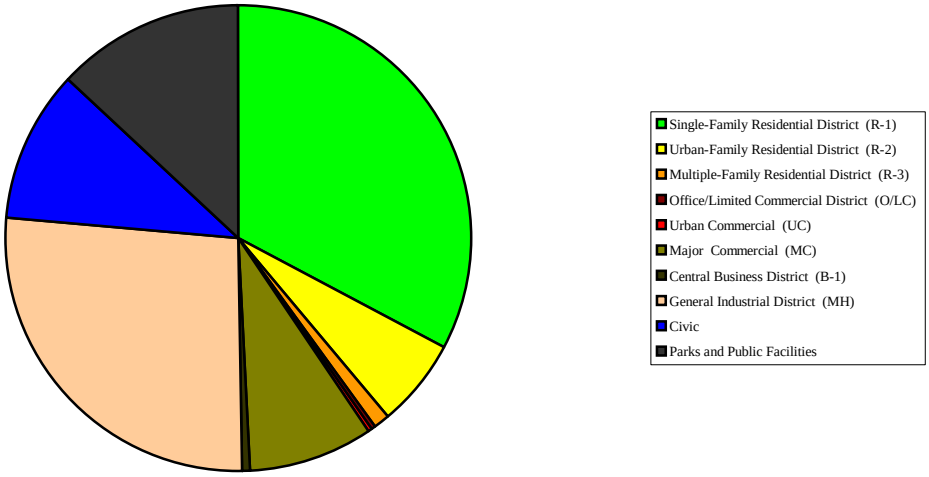
Figure 2-1

The following graph provides a summary of existing land use of for the City of Columbus.

Existing Land Use by Zones



2.3 Demographic Analysis

Coupled with land use, the demographics of a community—population and employment—defines the framework for many other sections of the plan. Information on current and future population is critical for planning future housing demand, land use patterns, economic develop and community facilities, like schools, roads and water service, for example. Population and employment projections should be carefully researched and grounded in realistic expectations.

Gradual population decline and increasing urbanization has been a persistent trend of Nebraska's population for over fifty years. As noted in *The Columbus Plan* from 1992, Columbus and Platte County strongly support this trend. The current population in Columbus is approximately 21,000, while the population of Platte County is nearly 32,000. The population of Columbus represents 66 percent of the total county population, while that figure was only 45 percent in 1950.

The population of Columbus is expected to grow at a moderate rate, similar to past growth rates. Population in 2010 and 2025 is projected to be approximately 23,000 and 25,000 respectively.

The Columbus Plan of 1992 notes that Columbus made the transition from an agricultural service economy to an industry-based economy in the 1950s, building on the industrial infrastructure created by the large hydroelectric projects of the 1930s. Columbus has been building on that industry-based economy since that time. In 2000, the manufacturing sector employed approximately 35% of the work force in Columbus, Platte County and the Columbus labor market, the same percentage as in 1990.

The economy and employment in Columbus is best exemplified through employment data from all of Platte County. Several large industrial areas in the Columbus area are not located within the City limits but within the County. This factor and the primacy of Columbus in Platte County make employment and industry data for Columbus and Platte County nearly one and the same. Current employment in Platte County is approximately 16,800, a 15 percent increase from 1990.

Due to the heavy concentration of manufacturing employment in Columbus, future employment is anticipated to be slow over the planning period. Employment projections for Platte County in 2010 and 2025 are approximately 18,000 and 19,000 respectively.

2.4 Growth Centers—Future Land Use

Due to the current economic, political, environmental, and social climates that exist in Columbus the following areas of the community have been identified as the primary growth centers. These centers will provide the land needed for about 90 percent of the projected population growth for Columbus, over the next 20 years. The remaining 10 percent, if not more, should be accommodated in current built-up areas. Proper infrastructure, public facilities and other amenity systems should be included to make these areas both feasible and attractive.

The four growth centers include:

- ***Southeast Growth Center.*** This growth center is defined as the area east of 3rd Avenue, south of 8th Street, west of E 14th Avenue, and north of River Rd. This growth center is primarily residential with the potential for a commercial center southeast of 8th Street and River Rd. Southeast growth represents a redirection of residential development patterns and will help to distribute traffic loads equally around the city. A new elementary school; a bikeway between the city center and Tailrace Park; and recreational improvements along the Loup River will need to be completed as residential growth warrants.

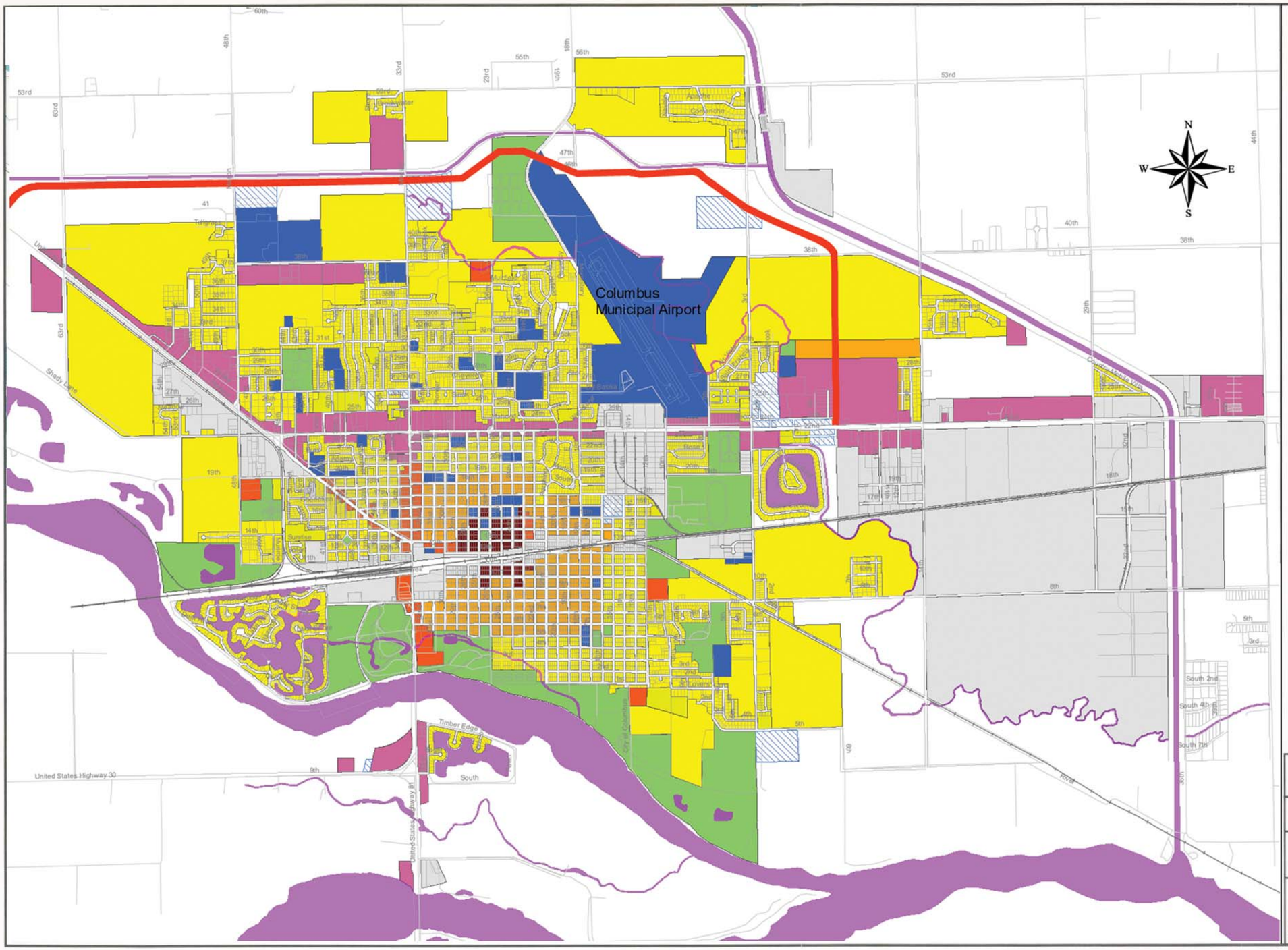
- ***Northeast Growth Center.*** This growth center is defined as the area east of 3rd Avenue, south of 38th Street, west of E 14th Avenue, and north of 23rd Street. This growth center can accommodate a regional commercial center, which is currently under development, as well as significant housing development. New development must be integrated with existing small subdivisions in the section of land between 23rd and 38th Streets, and 3rd Avenue and E 14th Avenue. The North Arterial should be incorporated into this area's transportation plan along

with a residential collector running parallel to 23rd Street. Also, new schools, parks and other public facilities will need to be built as the neighborhood grows. Access to the North Arterial as well as access management along this roadway will be key elements of this growth center.

- ***North Central Growth Center.*** This growth area continues development that has occurred between 18th and 48th Avenue and will be concentrated in areas north of 38th Street. Development in this area will primarily be residential with the possibility of commercial use along 33rd Avenue. Wilderness Park will need to be improved to better serve this growing neighborhood. Access to the North Arterial as well as access management along this roadway will be key elements of this growth center.

- ***Northwest Growth Center.*** Residential growth for this area will be concentrated north of 38th Street and West of 48th Avenue. Commercial nodes should be located along 48th Avenue and Hwy 81. Access to the North Arterial as well as access management along this roadway will be key elements of this growth center.

The future land use map illustrates the projected growth areas in Figure 2-2.



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Future Land Use

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Figure 2-2

3.0 EXISTING TRANSPORTATION CONDITIONS

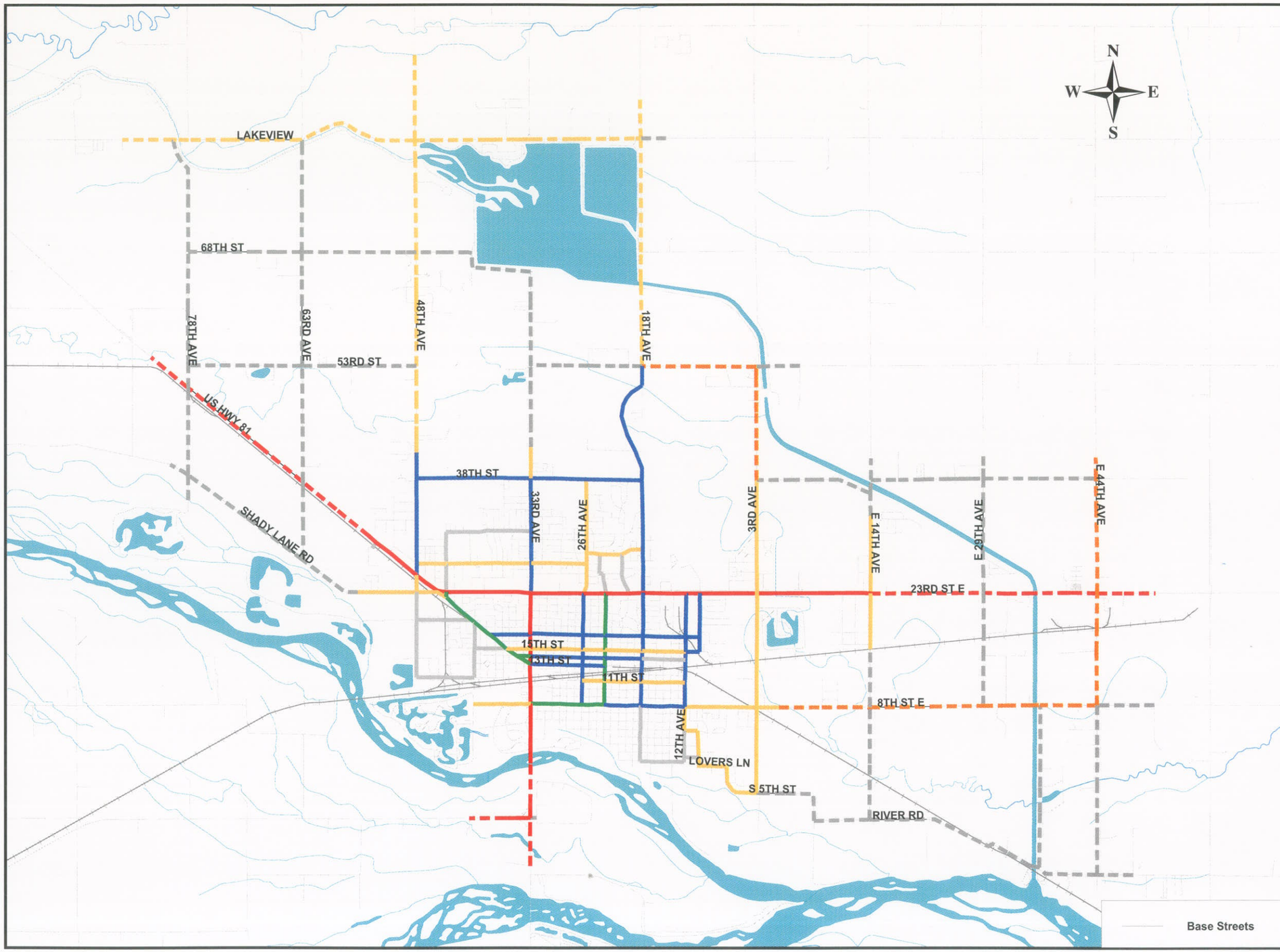
The purpose of this chapter is to document existing transportation conditions in the City of Columbus. The primary focus of this effort was to document the existing transportation system so that it could be accurately reflected in the transportation model developed for the project. This task included a comprehensive field review and data collection at selected locations to supplement existing traffic count data. Operational analyses were also conducted for selected intersection locations based on discussion with City staff. Accident data was also reviewed to identify safety deficiencies that could potentially be addressed through transportation improvements included in the transportation plan. Information from previous studies and reports was utilized to better understand existing transportation conditions in the City.

3.1 Existing Transportation System

The existing street network and functional classification system for Columbus is shown in Figure 3-1. The existing functional classification map for Columbus was developed from information provided by the City and NDOR. Roadway functional classification describes how a particular roadway is intended to function with respect to capacity, speed, mobility and level of access provided. Higher functional classifications provide greater capacity, higher speeds, and limited access. Lower functional classifications provide lower capacity, lower speeds, and high levels of access to adjacent properties.

Freeways and expressways represent the highest functional classification, capable of moving large volumes of traffic at high speeds with limited access from cross streets. Major arterials are also intended to move relatively large volumes of traffic at high speeds (typically 40-45 mph) with limited conflicts from side streets and adjacent properties. Minor arterials, while similar to major arterials, typically have lower speeds (less than 40 mph), less capacity, and more direct access to adjacent properties. In developed urban areas, major arterials are typically spaced at one-mile intervals. Minor arterials, in some instances, may be spaced at 0.5-mile intervals from other arterials. Collector and local streets round out the functional classification system. Collectors provide access from neighborhoods to the arterial street system. Even on collector streets, it is desirable to limit direct driveway access to the extent possible.

The Columbus transportation system can be characterized as a grid network with the exception of Howard Boulevard and Highway 81. These two roadways run diagonally on a northwesterly alignment from Columbus. The grid network is bisected by US Highway 30 (23rd Street) and US Highway 81 (33rd Avenue). Other primary north/south roadways include East 14th Avenue, 3rd Avenue, 10th/12th Avenue, 18th Avenue, 23rd Avenue, 26th Avenue, and 48th Avenue. Other primary east/west roadways include 8th Street, 13th Street, 14th Street, 15th Street, 17th Street, 27th Street and 38th Street.



Functional Classification

- Urban Principal Arterial
- Urban Major Arterial
- Urban Minor Arterial
- Urban Collector
- Urban Local
- Rural Principal Arterial
- Rural Major Collector
- Rural Minor Collector
- Rural Local

0 .5 1 1.5
Miles

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Existing Functional Classification

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Figure 3-1

3.2 Field Review and Data Collection Summary

It was necessary to document a number of key traffic and roadway characteristics to fully understand the existing transportation system and serve as inputs to the transportation model development process. These characteristics, most of which were collected through an extensive field review, include:

- Number of lanes
- Intersection geometrics
- Speed limits
- Parking characteristics
- Location and type of traffic control devices
- Urban vs. rural roadway cross section data (curbed vs. uncurbed)

All of these parameters are critical in developing the model roadway network and establishing appropriate roadway capacities. The number of lanes on each major roadway, existing speed limits, existing parking characteristics, existing traffic control device locations, and typical roadway section information are illustrated in Figures 3-2 through 3-6, respectively.

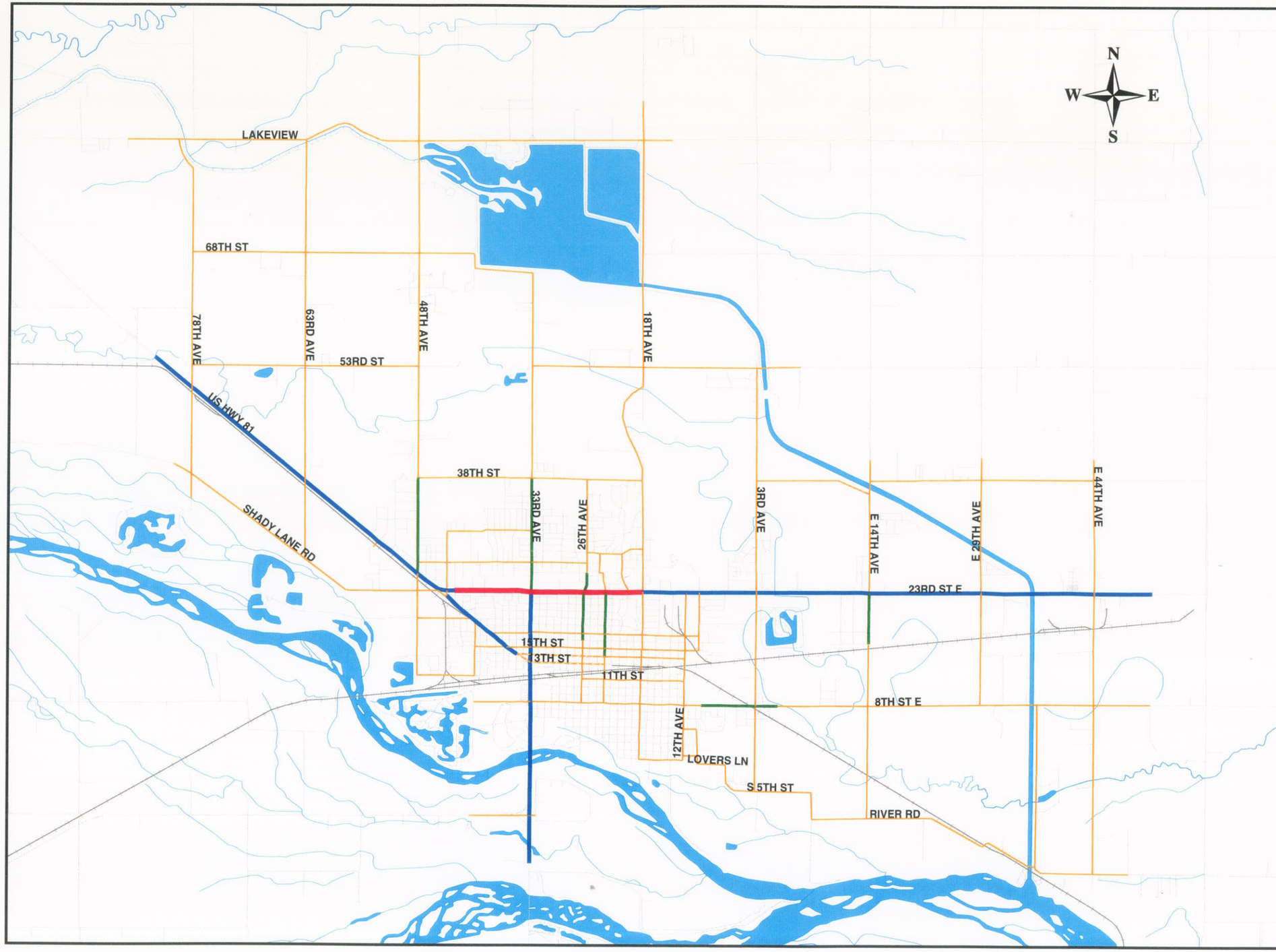
Existing traffic volumes (typically 2001 data) were also obtained from City, County, and NDOR sources to use in the model development and calibration process. These volumes were supplemented by traffic count data collected by OA staff at selected locations to provide good coverage of the existing street network. The existing daily traffic volumes used in the study are illustrated in Figure 3-7.

3.3 Traffic Operations and Safety Evaluation

Although this is primarily a planning study, detailed operational analyses were conducted as part of the existing conditions analysis for the intersections listed below:

- 23rd Street (US Highway 30) and East 14th Avenue
- 23rd Street (US Highway 30) and 18th Avenue
- 23rd Street (US Highway 30) and 23rd Avenue
- 23rd Street (US Highway 30) and 26th Avenue
- 33rd Avenue (US Highway 81) and 13th Street/Howard Boulevard
- 33rd Avenue (US Highway 81) and 14th Street
- 33rd Avenue (US Highway 81) and 21st Street/Menard's Driveway

Accident data was reviewed for intersections citywide to identify potential safety deficiencies that should be addressed as part of the transportation plan. Speed studies were also conducted along 38th Street between 18th Avenue and 48th Avenue. The results of these analyses are discussed briefly in this section. A more detailed summary of this information can be found in the *Existing Transportation Conditions Technical Memorandum* included in the Appendix.



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Existing Number of Lanes

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Figure 3-2

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Existing Speed Limits

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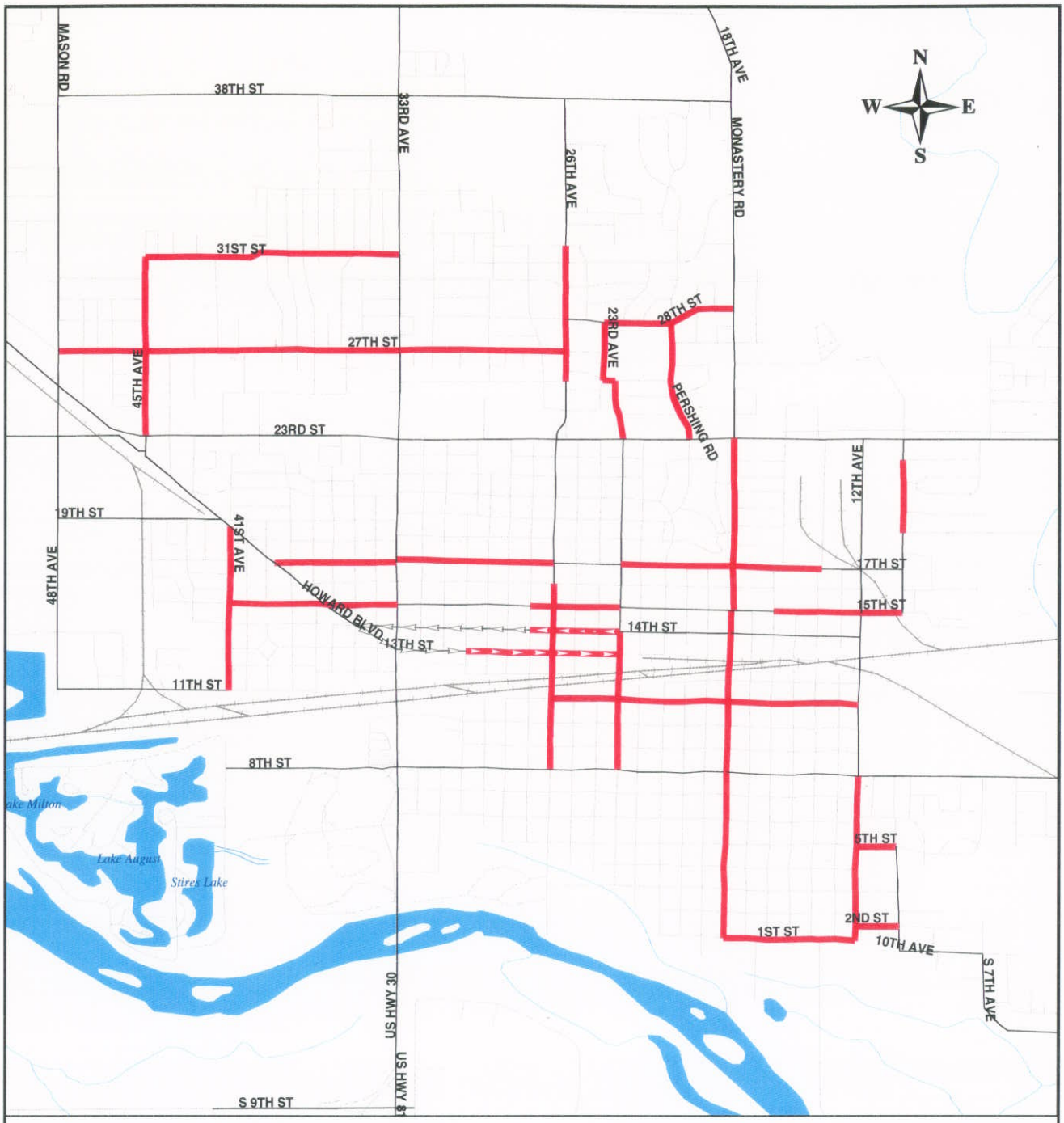
Figure 3-3



On_Street Parking

One-Way Streets

0 .2 .4 .6
Miles

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Existing On-Street Parking Locations and One-Way Roadways	
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Traffic Control Devices

- Traffic Control
- 4 - Way Stop Control
- Ped Crosswalk (Flashing Yellow on side of Street)
- Ped Signal (Overhead Signal)
- Future Traffic Signal

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Existing Traffic Control Device Locations	
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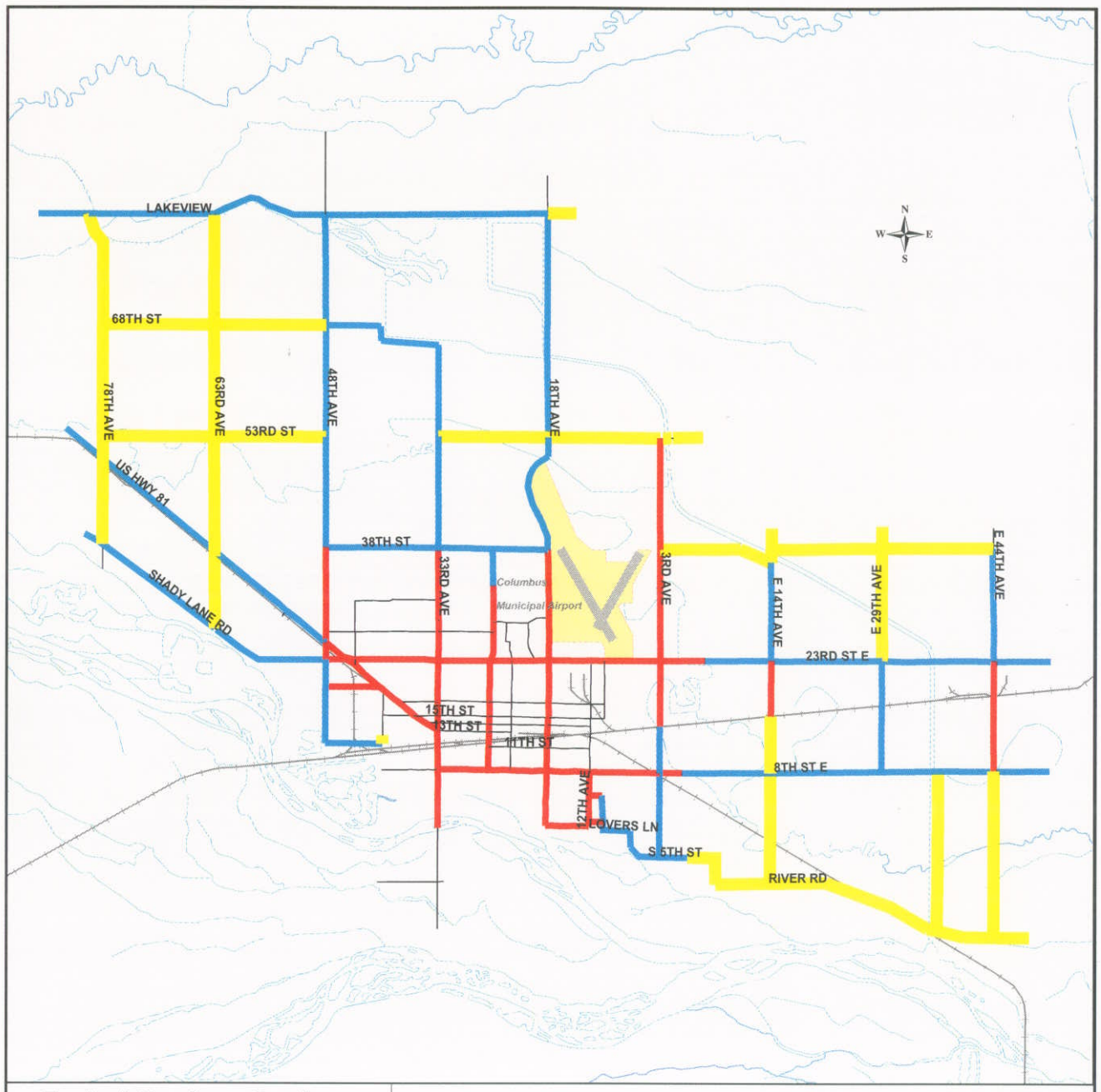

Typical Roadway Sections

- Curb & Gutter
- Rural Section (without curb)
- Gravel Roads

0 .7 1.4 2.1

Miles

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Existing Typical Roadway Sections	
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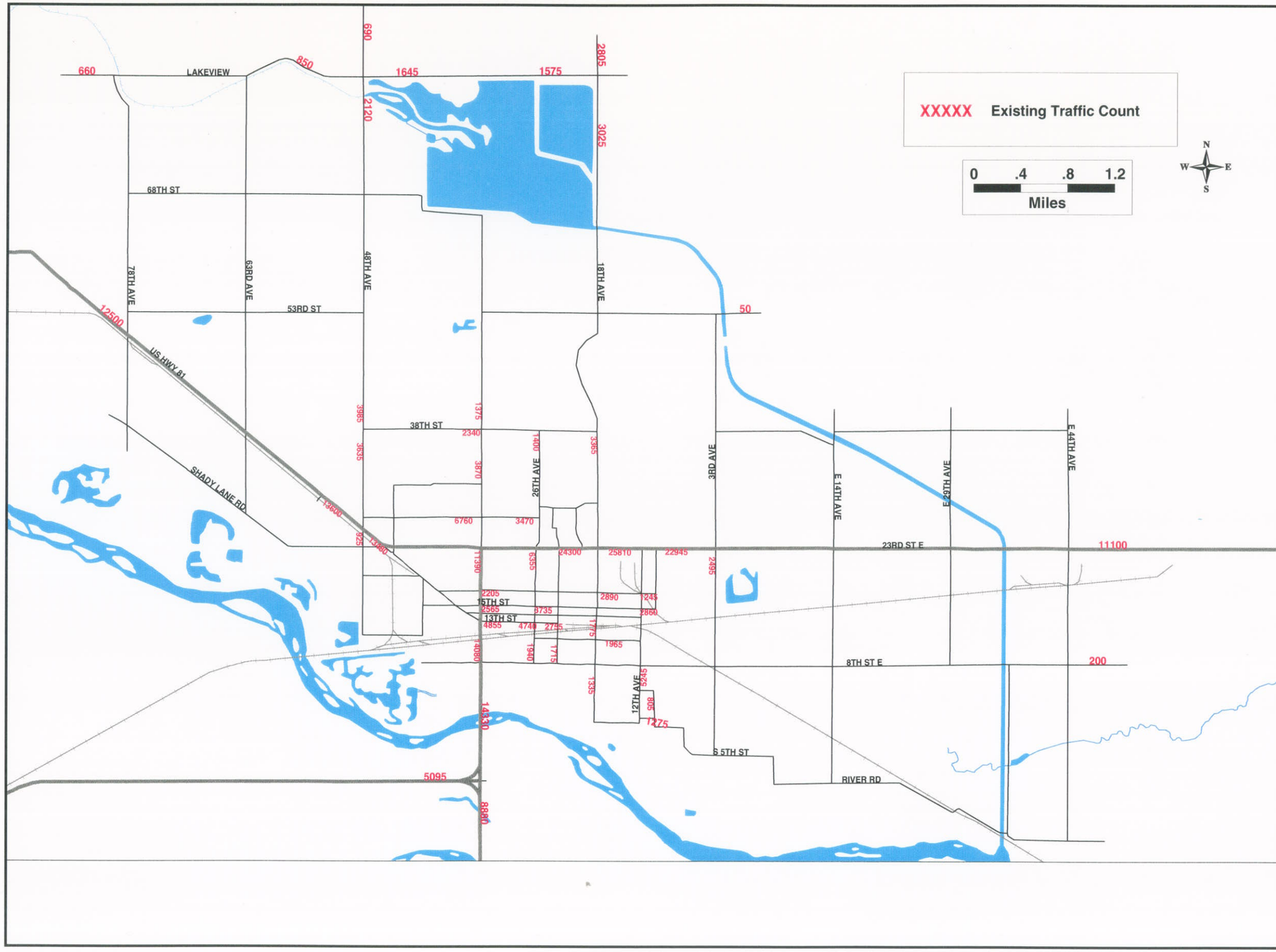

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Existing Daily Traffic Volumes

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Figure 3-7

The results of the operational analyses indicate that the intersections evaluated operate at acceptable levels of service (LOS C or better) with the exception of the intersection of 33rd Avenue and the Menard's Drive. The minor street (east/west) movements at this unsignalized intersection operate at LOS F during the PM peak hour. Although moderate delay is experienced by the minor street movements at this intersection, current volumes do not satisfy warrants for signalization at this time. The results of previous studies indicate that all signalized intersections in Columbus operate at LOS C or better. The signalized intersection of 33rd Avenue with both 13th Street/Howard Boulevard and 23rd Street, were previously identified as having one or more individual turning movements that operate at LOS D or worse. These deficiencies are both expected to be addressed by planned NDOR improvements to these intersections.

The review of accident data as part of this project and the results of previous studies indicate that accident rates for sections of US Highway 30 and 81 in Columbus are higher than statewide average accident rates for similar roadway facilities. A number of intersections along these two roadways also have higher than average accident rates. This trend can be attributed to the relatively high traffic volumes on these roadways coupled with frequent driveways, closely spaced signalized intersections, and turn lane storage deficiencies at some intersections. Many of the primary commercial/retail areas in Columbus are located along these roadways, likely contributing to the accident history. The NDOR improvements discussed above as well as a recently completed NDOR improvement at the intersection of 33rd Avenue and 8th Street will help to improve the accident history along these roadways.

Spot speed studies were conducted along 38th Street between 18th Avenue and 48th Avenue. The segment of 38th Street in question currently has a posted speed limit of 35 mph in between two segments with posted speed limits of 50 mph. The results of the speed studies indicate that 85th percentile speeds on this segment of 38th Street range from 42 to 52 mph. These results suggest that motorist compliance with the 35 mph speed limit is poor and that a higher speed limit may be justified for this roadway segment. Although the higher speed limit may be justified based on traffic studies, such a change could introduce safety/land use conflicts in this primarily residential area.

3.4 Summary and Recommended Improvements

Existing roadways in Columbus currently operate at acceptable levels of service (LOS C or better). Most intersections also operate at LOS C or better, although there are a few intersection movements that currently operate at LOS D or worse. Most intersections or roadway segments noted in previous studies as having LOS deficiencies have been improved through recent City projects or will be improved through planned NDOR projects along US Highways 30 and 81. All transportation needs, however, are not quantified based simply on capacity calculations. Three major issues were apparent based on the existing conditions analysis that should be considered in developing a transportation plan for the community:

- **Capacity improvements are needed along US Highways 30 and 81** - Although existing volumes are less than the theoretical capacity of these roadways, current operations are not acceptable to most City staff, elected officials, and residents of the community. A number of factors, including intersection and traffic signal spacing, quality of signal timing and progression, inadequate intersection geometrics, and poor access management practices have substantially reduced the capacity of these major roadways.
- **Additional railroad viaducts are a critical missing element of the transportation system** – This issue has been studied extensively in recent years. Unfortunately, City staff, elected officials, and the community have not been able to reach consensus on the locations of proposed viaducts and closure of existing at-grade railroad crossing locations. Resolution of this issue is critical to a successful, future transportation system.
- **East/West and North/South Roadway Continuity must be improved** – The existing street system lacks continuous arterial roadways to complement Highways 30 and 81. Most other arterial roadways lack continuity or don't really function as arterial roadways due to frequent residential driveways.

A number of potential transportation system improvements were identified based on the results of the existing conditions analyses. These improvements are outlined below:

23rd Street (US Highway 30) and 26th Avenue:

- Improve the lane alignment on the northbound and southbound approaches of this intersection.
- Provide additional storage length for the southbound left-turn movement.
- Improve the signing and pavement marking for the northbound right-turn lane.

23rd Street (US Highway 30) and 23rd Avenue:

- Improve the lane alignment on the northbound and southbound approaches of this intersection.
- Eliminate the free right-turn island on the south leg of the intersection.

23rd Street (US Highway 30) and 18th Avenue:

- Remove the medians on the northbound and southbound approaches and re-stripe to improve vehicle alignment and stacking distance.
- Improve signing and pavement marking for northbound and southbound right-turn lanes.
- Addition of eastbound and westbound right-turn lanes.

23rd Street (US Highway 30) and East 14th Avenue:

- Provide a southbound left-turn lane to improve alignment and match the 3-lane roadway section on the northbound approach of this intersection.
- Increase the storage length that is provided for the southbound movement between US Highway 30 and the east/west frontage road.

33rd Avenue (US Highway 81) and Howard Boulevard/13th Street/14th Street:

- Increase the left-turn storage length provided for the back-to-back left-turn lanes along US Highway 81 between the 13th Street and 14th Street intersections.
- Major geometric modifications should be investigated at this location as part of the planned NDOR US Highway Viaduct Study. Alternatives evaluated should include side-by-side left-turn lanes; dual left-turn lanes; conversion of the existing, closely-spaced one-way pair intersections to a conventional four-legged intersection; and potentially even a grade-separated northbound to westbound movement from US Highway 81 to Howard Boulevard.
- Improve the intersection geometrics by eliminating the existing free right-turn lanes.

US Highway 81 and Menard's Drive/21st Street:

- Improve the lane alignment on the east and west approaches of Menard's Drive and 21st Street.
- Construct a raised median on the west leg of the intersection (Menard's Drive) to channelize traffic, improve operations and safety, and delineate appropriate circulation paths into and out of the parking lot area.
- If signalization is ever considered for this intersection, internal circulation modifications should be made so that the signalized intersection could be located at 20th Street (instead of 21st Street) to improve spacing between this intersection and 23rd Street.

38th Street Corridor from 48th Avenue to 18th Avenue:

- Increase the speed limit on 38th Street between 30th Avenue and 36th Avenue to 40 mph.

It is interesting to note that minor geometric improvements were identified at a number of existing intersections along US Highway 30 and 81. Individually, these deficiencies may not seem like an important issue. Collectively, however, these deficiencies have a cumulative impact on overall corridor operations. For example, minor north/south alignment deficiencies at intersections along 23rd Street as outlined above can require the minor street traffic to use several more seconds of green time each traffic signal cycle. This reduces the green time (and capacity) from the main street where it is needed most. When this condition exists at several intersections, the impact on traffic operations throughout the corridor is compounded.

A number of other potential improvement alternatives, as outlined below, were also identified during the field review conducted for the project:

- Consideration should be given to a southbound right-turn lane at the intersection of 48th Avenue and 38th Street.
- The recently completed improvement to the intersection of 33rd Avenue and 8th Street appears to have split signal phasing in the east/west direction. It is recommended that traditional left-turn signal phasing (i.e., concurrent east/west left-turn movements) be implemented at this intersection.

- Left-turn lanes should be considered on all approaches at the intersection of 33rd Avenue and 27th Street. All approaches currently do not have left-turn lanes which creates lane alignment issues.
- The roadway alignment and intersection geometry should be improved at the intersection of 23rd Avenue and 26th Street to improve traffic operations and pedestrian movements.
- Consideration should be given to a continuous three-lane section (with a center, two-way left-turn lane) on 8th Street between 33rd Avenue and the three-lane section just east of 12th Avenue.
- The north/south alignment should be improved at the intersection of 18th Avenue and 15th Street.
- The gravel section of 1st Street between 16th and 18th Avenue should be paved.
- Signal warrants should be evaluated to determine if the signal at 23rd Avenue and 17th Street is warranted.
- 3rd Avenue south of the railroad tracks should be resurfaced as soon as possible.

The merits of the potential improvements identified in this chapter were discussed with City staff and the Steering Committee to determine if they should be included in the final transportation plan recommended in Chapter 6 of this report.

4.0 TRANSPORTATION MODEL DEVELOPMENT AND ALTERNATIVES ANALYSIS

This chapter of the report provides an overview of the transportation model development and calibration process. Development of future year traffic volume assignments and evaluation of transportation alternatives is also discussed in this chapter. Recommended roadway improvements based on the transportation modeling and analysis effort are presented in Chapter 6.0 of this report. The complete *Travel Demand Model Documentation Report*, which was previously submitted to City staff and the Steering Committee for review and comment, is included in the Appendix.

4.1 Transportation Modeling Process Overview

The transportation model for the City of Columbus was developed using the TransCAD modeling software, version 4.5. The model was developed using the 2001 transportation network and estimated 2001 socioeconomic data (residential dwelling units, number of employees, square feet of office or retail development, number of students, etc.). The transportation model is a representation of the Columbus area's transportation facilities and the travel patterns using these facilities. The traffic model contains inventories (location, posted speed limit, number of lanes, parking characteristics, etc.) of the existing roadway facilities and residential and non-residential land use data by traffic analysis zones (TAZs).

The transportation modeling process consists of several steps including estimation of daily vehicle trips by TAZ based on the land use data, distribution of vehicle trips by TAZ, and then assignment of vehicle trips to the street network. The transportation model assignments are then compared to current traffic counts. When the traffic assignments match the existing traffic counts within acceptable ranges of error the model can be used to test future year scenarios. These scenarios may be either land use or transportation network modifications. Future traffic volumes can then be estimated using the model to aid in making planning or programming decisions.

The Columbus transportation modeling process included the following steps:

- Development of 2001 transportation roadway network
- Determination of 2001 land use data
- Trip generation – generation of vehicle trips for each land use
- Trip distribution – geographical distribution of vehicle trips between origin and destination TAZ
- Trip assignment – assignment of traffic volumes to specific roadways

4.2 Model Calibration

The transportation model was calibrated and validated using the transportation network, socioeconomic estimates, and traffic counts for the year 2001. Model calibration involves running the model using existing data and comparing model results to actual

traffic counts. Between each calibration run, different parameters are evaluated and necessary adjustments made so that model calibration can be achieved. The model calibration and validation included review of several statistical performance measures such as percent assignment error, root mean square error (RMSE), and coefficient of determination.

The percent assignment error and percent root mean square error by facility type are summarized in Tables 4-1 and 4-2, respectively. As shown in Table 4-1, the percent error of the traffic assignment for each functional classification and the network as a whole are well within the recommended error ranges. Engineering practice suggests that a RMSE of 35% or lower is representative of a well-calibrated model. The 15% RMSE for the Columbus model is considerably lower than this target value. Another tool to measure the overall model accuracy is the coefficient of determination or R^2 value. A desirable R^2 value is 0.88, thus the R^2 value of 0.98 achieved in Columbus is very good.

Table 4-1
Percent Assignment Error

Functional Class	Percent Error	
	Computed	**Suggested Range***
Urban Principal Arterial	1.8%	<10%
Urban Major Arterial	8.4%	<15%
Urban Minor Arterial	2.3%	<15%
Urban Collector	4.3%	<25%
Urban Local	2.4%	N/A
Rural Principal Arterial	N/A	<10%
Rural Minor Arterial	0%	<15%
Rural Major Collector	0.5%	<25%
Rural Minor Collector	N/A	<25%
Rural Local	N/A	N/A
Total Network	**1.5%**	**<5%**

*Source: *Calibration and Adjustment of System Planning Models*, Federal Highway Administration, December 1990.

Table 4-2
Percent Root Mean Square Error

Functional Class	Percent RMSE
Urban Principal Arterial	7.25%
Urban Major Arterials	19.24%
Urban Minor Arterials	17.65%
Urban Collector	24.55%
Urban Rural	N/A*
Rural Principal Arterial	0%
Rural Minor Arterial	13.38%
Rural Major Collector	N/A*
Rural Minor Collector	0%
Total Network	**15.34%**

*Only one count available for comparison

4.3 Year 2001 Traffic Assignment

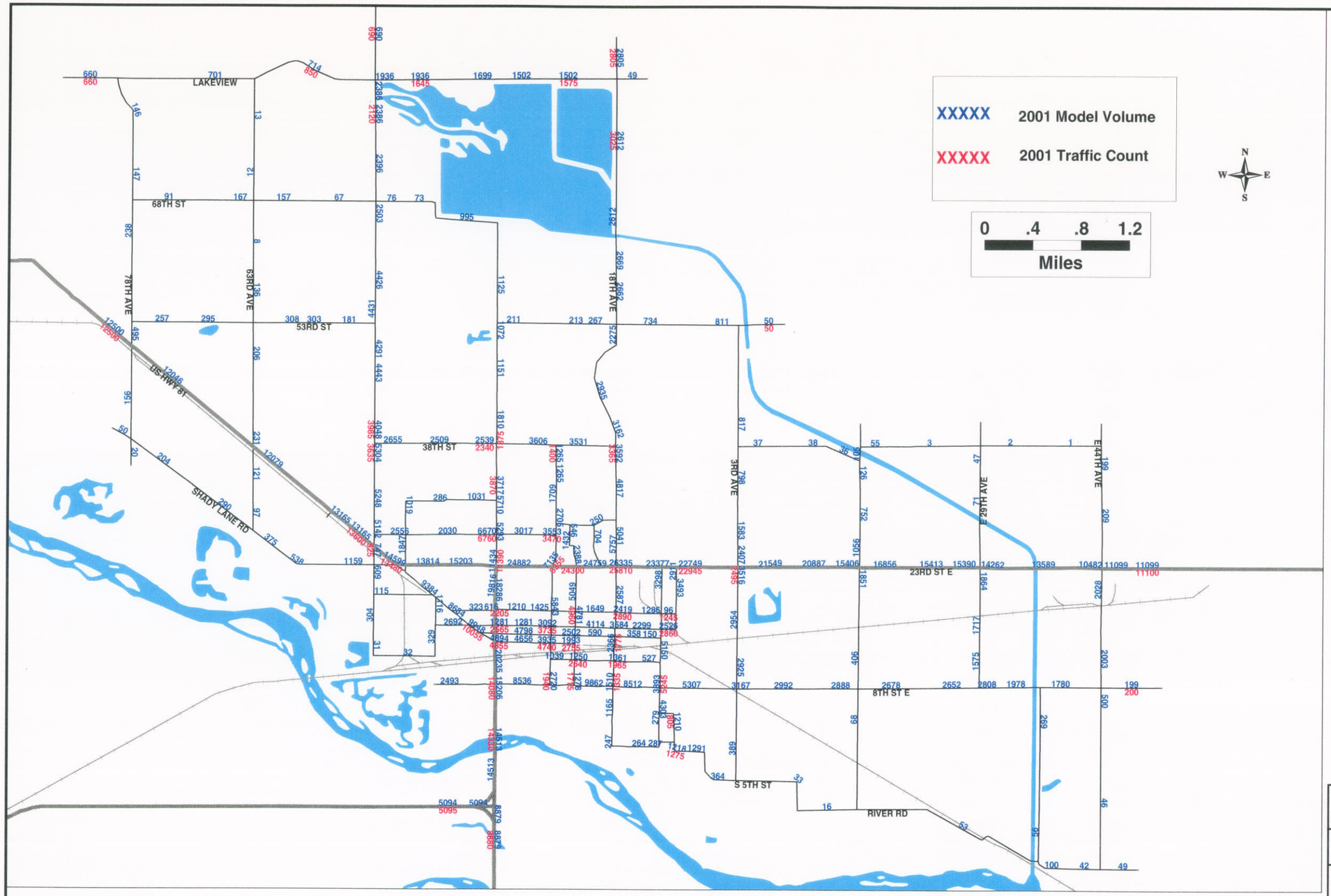
The traffic assignments for the year 2001 based on the model development and calibration process described above are illustrated in Figure 4-1. The existing year 2001 traffic counts are also shown on selected roadway links where they were available. As shown in Figure 4-1, there is typically very good correlation between assigned volumes and existing volumes on specific roadway links. Based on the 2001 traffic assignments, all roadways in Columbus currently operate at level of service (LOS) C or better. LOS C, stable flow, should be the goal of a community the size of Columbus. This typically represents a condition in which more than 70-80 percent of a roadway's capacity, on a daily basis, is utilized. It must be kept in mind that the model is intended to represent average daily traffic conditions. As such, it is possible for there to be isolated roadway segments or intersections with some peak hour operational deficiencies. This is consistent with the existing peak hour operational issues, primarily along 33rd Avenue and 23rd Street, identified in the existing conditions analysis.

4.4 Future Year Traffic Forecasts

The next step in the transportation planning process was the estimation of base future year traffic volumes using projected land use information. For purposes of this study, land use and traffic volume projections were prepared for an approximate 20-year horizon year (Year 2025). The future year traffic assignments were developed using the future land use plan presented in Chapter 2.0. Based on this plan, detailed land use characteristics (population, employment, number of dwelling units, square footage of commercial or retail development, etc.) were defined for each TAZ in the model. Future year traffic assignments were then developed for each roadway through the trip generation, distribution, and assignment process.

Only major roadway improvements included in the City's current Capital Improvement Program (CIP) or identified by City staff were assumed to exist in the base future roadway network. The base future roadway network, also commonly referred to as the "Existing Plus Committed Roadway Network" included the following improvements to the existing roadway network:

- North Arterial Roadway (US Highway 81 to 23rd Street) – Construction of 4-lane divided roadway for the first 800 feet north of 23rd Street. The remainder to initially be a 2-lane roadway, with ultimate 4-lane divided cross-section. Initial construction to begin in 2004.
- 33rd Avenue/8th Street Intersection Improvement – Geometric improvement to improve east/west alignment and intersection geometrics. Construction complete in 2003.



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Year 2001 Traffic Assignment

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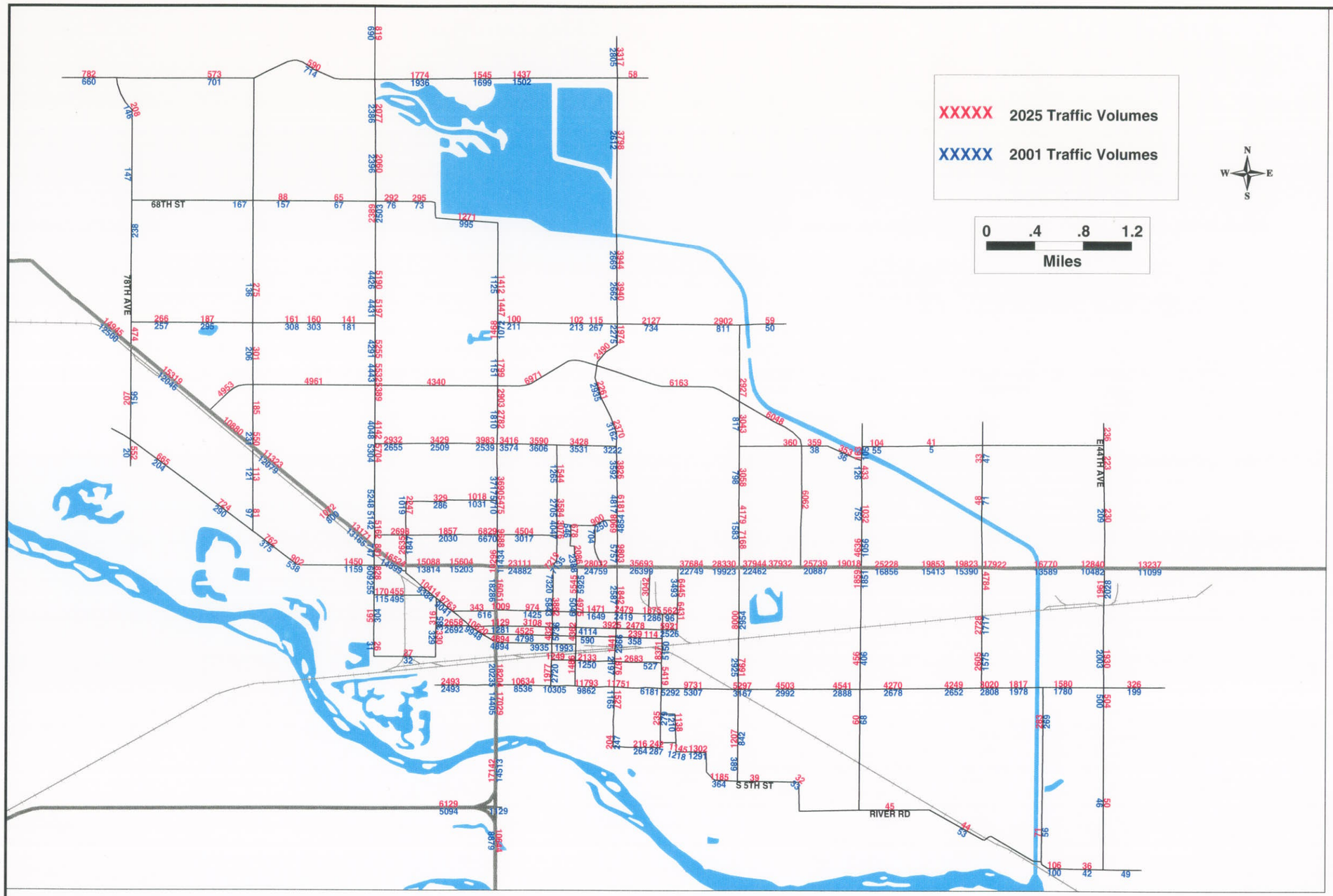
Figure 4-1

- 3rd Avenue/23rd Street Intersection Improvement – Intersection geometric improvements and traffic signalization. Construction complete in 2003.
- 3rd Avenue Widening Improvement (UP railroad tracks south to Lover's Lane) – Construction of 3-lane roadway section (41' concrete roadway). Construction estimated to be complete in 2010.
- 38th Street Widening Improvement (18th Avenue to 48th Avenue) – Construction of 3-lane roadway section (41' concrete roadway). Construction estimated to be complete in 2005/2006.
- 48th Avenue Widening Improvement (38th Street to ½ mile north) – Construction of 3-lane roadway section (41' concrete roadway). Construction estimated to be complete in 2010.
- 18th Avenue/23rd Street Intersection Improvement – Intersection geometric improvements to improve north/south roadway alignment. Construction estimated to be complete 2010.
- 33rd Avenue/23rd Street Intersection Improvement – Construction of major intersection geometric improvements including dual left-turn lanes and removal of free right-turn lanes. Construction estimated to be complete in 2005/2006.
- 33rd Avenue Widening Improvement (23rd to 27th Street) – Construction of 5-lane roadway section to be constructed in conjunction with improvements to the 33rd Avenue/23rd Street intersection. Construction estimated to be complete in 2005/2006.
- East 6th Avenue/23rd Street Intersection Improvement – Construction of eastbound dual left-turn lanes. Construction estimated to be complete in 2004.

Note that several of these improvements actually exist today. For example, the improvement to the intersection of 33rd Avenue and 8th Street was completed in 2003. However, the model was calibrated for the year 2001. Therefore, this improvement, for modeling purposes, is considered a future improvement and not part of the existing transportation network.

The base future year (Year 2025) traffic assignments on the existing plus committed roadway network are shown in Figure 4-2. For reference, the 2001 calibration year traffic assignments are also shown in Figure 4-2. The future year traffic volumes indicate substantial traffic volume growth (12,000 - 17,000 vpd) on 23 Street between 18th Avenue and the North Arterial. Traffic volume increases on 23rd Street east of the North Arterial generally range from 5,000 - 8,000 vpd over existing volumes. Relatively substantial traffic volume increases in the range of 4,000 - 5,000 vpd are also projected for portions of 8th Street and 3rd Avenue. Volume increases on most other collector and arterial roadways are typically in the range of 1,000 - 3,000 vpd.

Projected volumes on the North Arterial range from approximately 5,000 vpd east of US Highway 81 to 7,000 vpd west of 18th Avenue. Volume decreases, typically in the range 1,000 - 2,000 vpd, are projected along portions of 33rd Avenue and 23rd Street. This trend



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Year 2025 Traffic Assignment

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Figure 4-2

can likely be attributed to some traffic diversion from these roadways to the North Arterial as well as some land use changes shifting high traffic generators (such as Wal-Mart) further east on 23rd Street.

To better evaluate potential future roadway deficiencies, roadway segments projected to operate at LOS D or worse (volume to capacity ratio greater than 0.70) were identified. Only two roadways, 8th Street between 33rd Avenue and 3rd Avenue and 23rd Street between 33rd Avenue and the North Arterial, are expected to operate over this threshold based on the future volume assignments. Thus, a majority of the major roadways in Columbus are expected to operate at LOS C or better based on the 2025 traffic volume projections. This does not mean that there will not be isolated intersection problems at some locations. However, the overall street network, with the noted exceptions, is expected to operate at an acceptable level of service.

As discussed below, the capacity of 8th Street can be improved with a continuous three-lane roadway section. Ideally, 23rd Street would also be widened to add capacity and improve traffic operations. Unfortunately, widening of this roadway is unlikely and would have significant impacts – both financially (to the City and NDOR) and to adjacent properties. As a result, other alternatives to improve the operations along 33rd Avenue must be identified.

4.5 Transportation Alternatives Evaluation

A number of potential transportation alternatives were evaluated for the Columbus area. Alternatives were developed based on the existing conditions analysis, existing or projected transportation model results, and discussion and input from City staff and Steering Committee members. Transportation alternatives were generally identified to accomplish one of the following goals:

- Improve roadway segments with unacceptable operations (i.e., level of service D operation)
- Widen existing roadways to provide additional through lane or turn lane capacity
- Improve a roadway to provide better compliance with the desired roadway functional classification
- Provide logical extensions to existing roadways
- Provide roadway connections that do not exist today to improve overall circulation and network continuity
- Provide major transportation improvements such as bypass roadways or railroad viaducts that are needed to ensure an effective transportation system in the future

Based strictly on projected future year traffic volumes, major transportation improvements were not required to address existing capacity deficiencies. However, a number of these alternatives may have merit to improve traffic flow in specific locations throughout the City and to ensure long-term success of the City's transportation system.

The transportation alternatives evaluated as part of the modeling effort are outlined below and illustrated in Figure 4-3. The discussion below includes a description of the improvement as well as a brief discussion regarding the expected traffic and land use impacts associated with each alternative. Traffic volume assignment plots for each alternative are included in the Appendix.

Alternative 1 - Widen 8th Street to a 3-Lane Section

Description: This alternative tested a continuous three-lane roadway section on 8th Street between 33rd Avenue and 3rd Avenue. Currently, this roadway section is a combination of 2-lane roadway with on-street parking, two-lane roadway with dedicated left-turn lanes at some intersections with restricted parking, and a three-lane section (with a center, two-way left-turn lane) between 12th Avenue and 3rd Avenue.

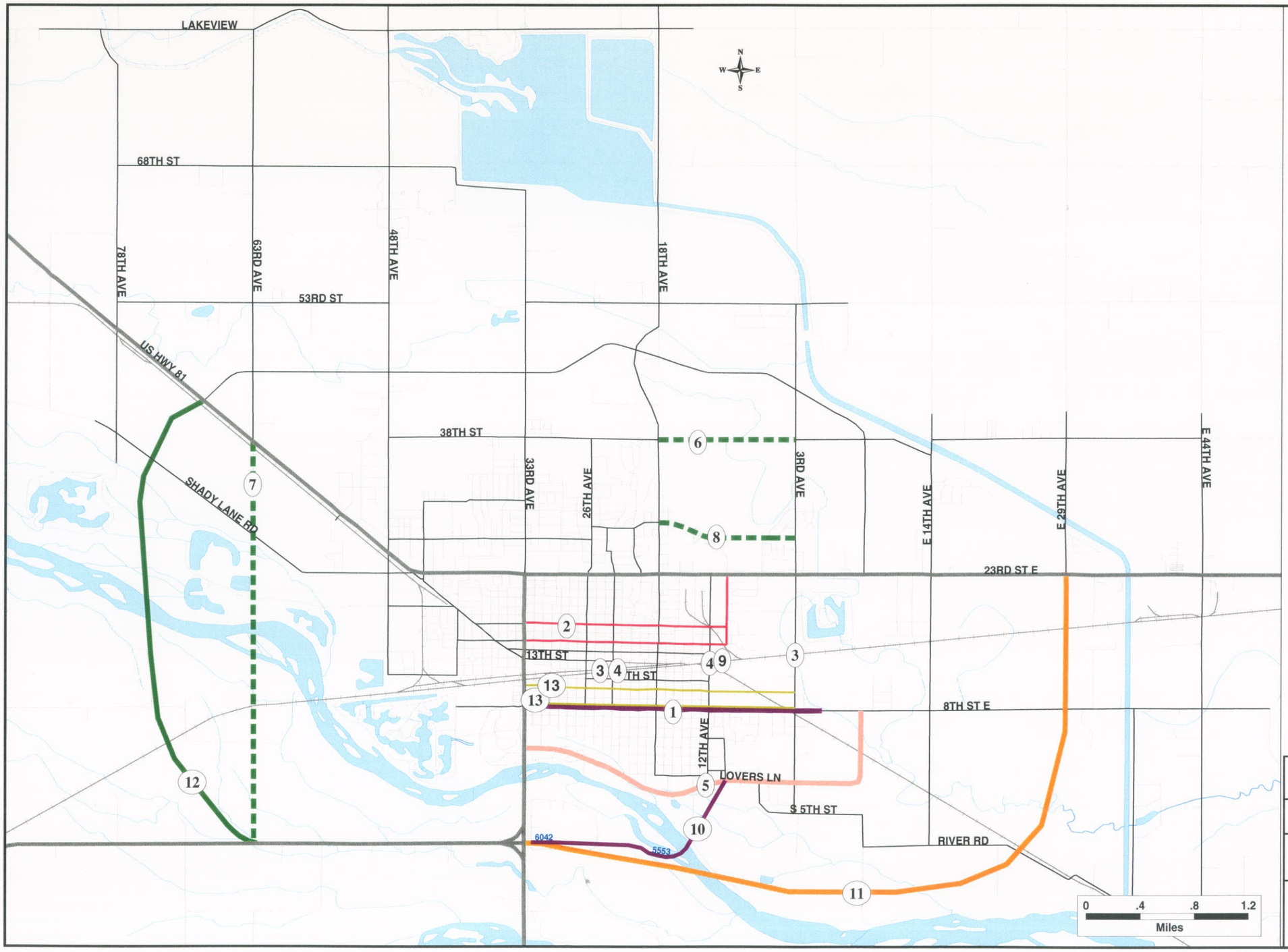
Traffic Impacts: Volumes on 8th Street currently range between 3,100 vehicles per day (vpd) east of 3rd Avenue to nearly 9,000 vpd near 33rd Avenue. Projected volumes ranges from 5,200 vpd east of 3rd Avenue to approximately 11,100 vpd near 33rd Avenue. These projected volumes exceed the capacity of a two-lane roadway and are greater than the existing volumes on several roadways with 3-lane roadways sections. A three-lane roadway section is recommended to accommodate projected traffic volumes.

Land Use Impacts: The primary land use adjacent to 8th Street from 33rd Avenue to 3rd Avenue is single family and mixed-density residential, with frontage on 8th Street. However, the projected traffic volumes won't significantly increase enough to negatively impact the existing land use patterns.

Alternative 2 - 15th Street and 17th Street as a One-Way Pair

Description: This alternative tested 15th Street and 17th Street as one-way pairs between 33rd Avenue and 10th Avenue. The alternative also included an improved connection on 10th Avenue between 15th/17th Street and 23rd Street.

Traffic Impacts: This alternative was tested primarily as an option to (1) reduce volumes on 13th/14th Streets and improve traffic operations at the intersection of 13th and 14th Street with 33rd Avenue or (2) provide an east/west alternative to congested portions of 23rd Street. This alternative demonstrated that 13th and 14th Streets are, in fact, the best east/west roadways to serve the downtown area. It also demonstrated that additional east/west roadway capacity south of 23rd Street did not divert traffic from 23rd Street and, therefore, did little to improve existing operations along this roadway.



Year 2025 Model Test Alternatives

1. Widen 8th Street to a 3-Lane Section
2. 15th Street and 17th Street as a One-Way Pair
3. Railroad Viaduct on 3rd Avenue and 23rd Avenue
4. Railroad Viaduct on 12th Avenue and 23rd Avenue
5. Arterial Roadway North of the River
6. 38th Street Extension between 18th Avenue and 3rd Avenue
7. 63rd Avenue Extension between US Highway 81 and US Highway 30
8. 27th Street Extension between 18th Avenue and 3rd Avenue
9. Railroad Viaduct on 10th Avenue
10. South Arterial Roadway
11. Southeast Bypass Roadway
12. West Bypass Roadway
13. 8th Street and 10th Street as a One-Way Pair

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Transportation Modeling Alternatives

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Figure 4-3

Land Use Impacts: The primary land uses along 15th Street and 17th Street between 33rd Avenue and 10th Avenue are residential, except in the Central Business District and near the Scotus Schools. The one-way pairs concept will not significantly impact land uses, despite the changes in traffic patterns.

Alternative 3 - Railroad Viaduct on 3rd Avenue and 23rd Avenue

Description: This alternative tested a two-lane railroad viaduct on 3rd Avenue and 23rd Avenue with all other existing at-grade railroad crossings closed. It should be noted that all existing roadways were not included in the transportation model, only those functionally classified as collector or arterial roadways. Therefore, minor existing at-grade crossings such as 21st or 25th Avenue are not discussed.

Traffic Impacts: As would be expected, this alternative results in traffic volume increases along 3rd Avenue and 23rd Avenue with corresponding volume reductions on 12th, 18th, and 26th Avenues due to the closure of these at-grade crossings. Volume increases on 3rd and 23rd Avenue are in the range of 2,500 - 4,000 vpd. Smaller increases in the range of 1,500 - 2,500 are expected on the 33rd Avenue viaduct. This is not necessarily a positive effect, however, some minor increase to traffic volumes on this viaduct should be expected if other at-grade crossings are closed. There is also some localized redistribution of traffic on east/west roadways including 8th, 15th, and 17th Streets as vehicles are rerouted to the available viaduct locations.

Land Use Impacts: The most apparent impact on land use may be to provide better opportunities for retail development on 23rd Avenue due to increasing traffic volumes. Another impact is the disposition of land in locations where at-grade railroad crossings are closed. The sale of land to adjacent property owners may provide redevelopment or expansion opportunities in the CBD.

Alternative 4 - Railroad Viaduct on 12th Avenue and 23rd Avenue

Description: This alternative tested a two-lane railroad viaduct on 12th Avenue and 23rd Avenue with all other existing at-grade railroad crossings closed.

Traffic Impacts: Similar to Alternative 3, this alternative results in traffic volume increases on 12th Avenue, 23rd Avenue, and 33rd Avenue. However, in this alternative the volume increases are typically no more than 1,500 vpd. This alternative also results in less redistribution of east/west traffic than Alternative 3.

Land Use Impacts: The most apparent impact on land use may be to provide better opportunities for retail development on 12th Avenue and 23rd Avenue due to increasing traffic volumes. Another impact is the disposition of land in locations where at-grade railroad crossings are closed. The sale of land to adjacent property owners may provide redevelopment or expansion opportunities in the CBD.

Alternative 5 - Arterial Roadway North of the River

Description: This alternative tested a relatively high-speed (45 mph) arterial roadway north of the Loup River on the approximate alignment of 1st Street, which then turned north, to tie into the North Arterial roadway.

Traffic Impacts: This alternative appears to be fairly attractive as projected traffic volumes range from approximately 5,000 vpd on the east/west portion of the roadway to nearly 12,500 vpd on the north/south portion of the roadway near east 23rd Street. Volumes on 23rd Street east of the North Arterial increase by as much as 1,500 vpd. This alternative results in volume reductions on 8th Street, 3rd Avenue, 10th/12th Avenue, and 23rd Street east of 3rd Avenue in the range of 2,500 – 5,700 vpd. It also appears to have resulted in a slight shift in traffic from the North Arterial roadway to 23rd Street of less than 1,000 vpd.

Land Use Impacts: The potential alignment of this proposed roadway will cross through East Pawnee Park, immediately east of 33rd Avenue and skirt the existing levee on the north side of the Loup River. The potential loss of parkland is a significant impact as is the potential location of the roadway in the floodplain. Another land use impact is the potentially negative effect of the high-speed roadway on existing residential uses on the north side of 1st Street in regard to noise, air quality, and aesthetics.

Alternative 6 - 38th Street Extension between 18th Avenue and 3rd Avenue

Description: This alternative tested the extension of 38th Street from 18th Avenue to 3rd Avenue. Although this improvement would require a roadway through the north end of the airport, it was felt that this was an important alternative to test due to the lack of east/west roadway continuity north of 23rd Street. Due to the airport location a roadway underpass or northerly realignment are likely required to make this a viable alternative.

Traffic Impacts: This alternative essentially duplicates the purpose of the North Arterial roadway, however, it is located much closer to existing and proposed future land uses. Therefore, it appears to be a more attractive roadway corridor purely from a traffic volume standpoint. Portions of 38th Street have projected volumes approaching 10,000 vpd, which is significantly higher than projected volumes on 38th Street without this connection. As expected, this alternative results in volume reductions on the North Arterial roadway of nearly 5,000 vpd except the segment between 23rd and 38th Street, which is projected to have a volume increase of approximately 2,000 vpd. This alternative is also the only alternative that results in consistent volume reduction along 23rd Street (US Highway 81), which range from slightly less than 1,000 vpd on the west end of town to over 3,000 vpd east of 18th Avenue.

Land Use Impacts: The obvious impact is that this alternative alignment crosses the Columbus Municipal Airport. Airport experts note that the airport may be relocated but only to a similar suitable location. The estimated cost of the relocation is prohibitive at

over $50 million. However, the roadway may be constructed under the runway facilities in the airport. The feasibility of this course of action is uncertain.

Alternative 7 - 63rd Avenue Extension from US Highway 81 to US Highway 30

Description: This alternative tested a high-speed west bypass roadway (63rd Street) between Shady Lane Road and US Highway 30. This alternative would require crossing the Loup River and UP railroad tracks west of Columbus.

Traffic Impacts: This proposed roadway extension attracts approximately 2,100 vpd and results in a corresponding volume reduction on portions of 33rd Avenue, 23rd Street, and Howard Boulevard ranging from 700 – 2,200 vpd. This alternative is the only alternative that showed consistent volume reductions along the US 30/81 corridor on the south and west sides of Columbus.

Land Use Impacts: While the traffic impacts are positive, the potential land use impacts are problematic. The river crossing and associated environmental impacts may prove to be prohibitively expensive. Furthermore, the river crossing may impact environmentally sensitive areas that would be a fatal flaw for the project.

However, the proposed roadway may create new development opportunities on the west side of Columbus that do not currently exist. In particular, many development opportunities would be created at the intersection of the proposed roadway and US 81. Finally, land uses along Howard Boulevard and US 30/81 in Columbus, particularly the retail land uses, may be negatively affected because of the projected traffic reductions.

Alternative 8 - 27th Street Extension between 18th Avenue and 3rd Avenue

Description: This alternative tested the extension of 27th Street from 18th Avenue to 3rd Avenue. Similar to Alternative 6, this improvement would require a roadway through the airport. Again, it was felt that this was an important alternative to test due to the lack of east/west roadway continuity north of 23rd Street.

Traffic Impacts: This alternative had mixed results. With this extension, portions of 27th Street attracted nearly 9,000 vpd and resulted in traffic volume reductions on both the North Arterial roadway and 23rd Street in the range of 1,500 – 2,500 vpd. It appears that 27th Street is too close to 23rd Street and is too residential in character to function as a parallel arterial carrying relatively high traffic volumes.

Land Use Impacts: The obvious impact is that this alternative alignment crosses the Columbus Municipal Airport. Airport experts note that the airport may be relocated but only to a similar suitable location. The estimated cost of the relocation is prohibitive at over $50 million. However, the roadway may be constructed under the runway facilities in the airport. The feasibility of this course of action is uncertain.

Alternative 9 - Railroad Viaduct on 10th Avenue

Description: This alternative tested a two-lane railroad viaduct on 10th Avenue with closure of 12th and 18th Avenues. The existing at-grade crossings at other locations remained open in this alternative. It should be noted that up to three existing at-grade crossings may require closure to implement a new railroad overpass in accordance with NDOR Standards.

Traffic Impacts: This alternative resulted in relative small volume increases (less than 1,000 vpd) on 26th and 33rd Avenues. Volumes on 23rd Avenue increased by approximately 2,500 vpd while volumes on portions of 11th Street and 12th Avenue were reduced by 1,500 – 2,000 vpd. Volumes on most other roadways remained the same except for some localized redistribution of east/west traffic volumes between 3rd Avenue and 23rd Avenue. This alternative demonstrates that even with a viaduct on 10th Avenue, traffic still tends to utilize the add-grade crossings on 23rd and 26th Avenues.

Land Use Impacts: The land use impacts of this alternative are negligible except the south terminus of the proposed viaduct lands in undeveloped land. The potential exists for new development in this area due to the new roadway and viaduct.

Alternative 10 - South Arterial Roadway

Description: This alternative tested an arterial roadway extending east from the south junction of US Highway 30 and 81 continuing east on an alignment near S. 9th Street and eventually going north to connect to the North Arterial on an alignment similar to Alternative 5. The primary difference between this alternative and Alternative 5 is the location of the bypass roadway intersection with Highway 81 (33rd Avenue).

Traffic Impacts: This alternative is quite similar to Alternative 5. It appears to be fairly attractive as projected traffic volumes range from 6,000 vpd on the east/west portion of the roadway to nearly 10,000 vpd on the north/south portion of the roadway near east 23rd Street. This alternative results in volume reductions on 8th Street, 3rd Avenue, 10th/12th Avenue, and 23rd Street east of 3rd Avenue in the range of 2,000 – 4,000 vpd. Volumes on 23rd Street east of the North Arterial increased by as much as 1,500 vpd. Similar to Alternative 5, this alternative also resulted in a shift in traffic from the North Arterial roadway to portions of 23rd Street/US Highway 81 west of 33rd Avenue of 1,500 – 3,500 vpd.

Land Use Impacts: The potential Loup River alignment of this proposed roadway would cross through significant portions of the Loup River floodplain, creating numerous environmental impacts. The implementation at this high speed roadway could have a negative impact of the existing residential uses north of 1st Street and west of 12th Avenue in regard to noise, air quality, and aesthetics.

Alternative 11 – Southeast Bypass Roadway

Description: This alternative tested a high-speed (60 mph) southeast bypass roadway extending east from the south junction of Highways 30 and 81 and connecting with East 29th Avenue. The east/west segment of this roadway could utilize a portion of the River Road alignment. This alternative also had a connection with 3rd Avenue. This primary difference with this alternative and the other two similar south roadway alternatives (Alternatives 5 and 10) are that the alignment of this alternative stays south and east well away from the existing urban area of the City.

Traffic Impacts: Volumes for this alternative range from less than 1,000 vpd just south of East 23rd Street to nearly 5,000 vpd just east of US Highway 81 (33rd Avenue). The connection to 3rd Avenue attracted over 2,500 vpd, which illustrates the importance of convenient connections from the bypass roadway back to other urban area roadways. This alternative resulted in volume reductions in the range of 1,000 – 3,500 vpd on portions of parallel arterials including 8th Street and 23rd Street.

Land Use Impacts: This alternative will have a positive impact on industrial land uses in the east part of Columbus due to the ease of vehicular access. Conversely, it will have a negative impact on the area's environment with the crossing of the Loup River and long stretches of floodplain. In addition, this potential alternative crosses the Quail Run Golf Course, a city-owned course north of the Loup River and South of 3rd Avenue.

Alternative 12 – West Bypass Roadway

Description: This alternative tested a high-speed; far west bypass roadway connected US Highway 81 with US Highway 30 west of Columbus. This alternative is similar to Alternative 7 except the bypass roadway is approximately one mile further west. This alternative would also require a crossing of the Loup River.

Traffic Impacts: This alternative results in a volume on the bypass roadway ranging from 900 - 1,500 vpd with a corresponding volume reduction along portions of US Highways 30 and 81 of approximately 1,000 vpd. Traffic patterns associated with this alternative are similar to that of Alternative 7 except the volumes attracted to the bypass roadway or diverted from other parallel roadways is on average about 50 percent less. This illustrates the relative attractiveness of placing the bypass roadway just one mile closer to the urban area.

Land Use Impacts: While the traffic impacts are positive, the potential land use impacts are problematic. The river crossing and associated environmental impacts may prove to be prohibitively expensive. Furthermore, the river crossing may impact environmentally sensitive areas that would be a fatal flaw for the project.

However, the proposed roadway may create new development opportunities on the west side of Columbus that do not currently exist. In particular, many development opportunities would be created at the intersection of the proposed roadway and US 81.

Finally, land uses along Howard Boulevard and US 30/81 in Columbus, particularly the retail land uses, may be negatively affected because of the projected traffic reductions.

Alternative 13 - 8th Street and 10th Street as a One-Way Pair

Description: This alternative tested 8th Street and 10th Street as one-way pairs between 33rd Avenue and 3rd Avenue. This alternative will be difficult to implement since 10th Street does not currently connect with 33rd Avenue due to the existing viaduct.

Traffic Impacts: Similar to Alternative 2, this alternative was tested primarily as an option to (1) reduce volumes on 13th/14th Streets and improve traffic operations at the intersection of 13th and 14th Street with 33rd Avenue or (2) provide an east/west alternative to congested portions of 23rd Street. As with Alternative 2, it was demonstrated that 13th and 14th Streets are, in fact, the best east/west roadways to serve the downtown area. It also demonstrated that additional east/west roadway capacity south of 23rd Street did not divert traffic from 23rd Street and, therefore, did little to improve existing operations along this roadway.

Land Use Impacts: Single-Family and Urban-Family Residential Districts are the primary uses for land adjacent to both 8th and 10th Streets. A small part of the Central Business District, the city's Wastewater Treatment Facility and an Industrial area adjacent of 10th Street are the only exceptions. Currently 10th Street does not connect with 33rd Avenue. In order to make this connection a large portion of Industrial area will need to be displaced. The remainder of the adjacent land use is not significantly impacted by the change in traffic patterns.

5.0 ALTERNATIVE TRANSPORTATION ELEMENTS EVALUATION

This chapter provides a summary of the evaluation of alternative transportation elements including transit, trails, aviation, rail, and intelligent transportation systems (ITS).

5.1 Transit

Columbus is served by demand-responsive transit. The Columbus Area Transit System or HandiBus has two vehicles. One vehicle is operated full-time and the other part-time. Columbus HandiBus provided 17,000 passenger trips in 2002. Fares are subsidized for seniors and handicapped individuals. Published fares are currently $1.00 per trip.

Inter-city transit is provided through Black Hills Stage Lines, Inc. Black Hills Stage Lines provides daily round-trip service between Columbus and Omaha with an intermediate stop in Fremont. Arrow Stage Lines also provides daily round trip service between Columbus and Norfolk. Travelers wishing to access Interstate transit systems such as Greyhound and Amtrak can do so by traveling to Omaha on Black Hills Stage Lines.

Columbus was not a destination within the three alternative commuter transit scenarios that were part of the recent Nebraska Transit Options Feasibility Study. Should commuter transit between Omaha and Fremont be established, it might be feasible to extend this service to Columbus in the future.

Buffalo County has developed the Nebraska model for use of Intelligent Transportation Systems (ITS) to improve rural transit cost effectiveness and efficiency. Omaha Metro Area Transit implemented a backbone vehicle tracking system that could be implemented throughout rural Nebraska. These systems and technologies should be considered in Columbus.

In 2003, Columbus HandiBus was not able to serve about 50 rides per month due to insufficient system capacity or scheduling difficulties. As “Baby-Boomers” enter retirement years, additional demand for service will result.

Potential transit improvements for the Columbus area are outlined below:

- Additional Transit Service:
  - Increase service from one full-time and one part-time vehicle to two full-time vehicles.
  - Increase service to three full-time vehicles

- Efficiency Improvements: In order to make meeting transit demand more cost effective and efficient, join a coalition of rural transit providers to:
  - Provide regionally-based computer-aided dispatching
  - Provide regionally-based vehicle tracking and real-time service

- Provide transit vehicle priority at traffic signals to reduce transit vehicle delays

5.2 Trails

Columbus has been systematically developing a trail system since 1997 to meet recreational needs. Existing and proposed trails included in the City's current trails master plan are illustrated in Figure 5-1. Two Lakes Trail has been completed for three years. Wilderness Trail was dedicated and opened in September 2003. The Loup Canal and Lost Creek Canal trails are open. The Loup Canal Trails extends for about 35 miles along the Loup Canal system. The Pawnee Park East Trail is being constructed while the Pawnee Park West Trail is seeking funding.

Trail connectivity and continuity are lacking in various areas of the City. For example, there are no signed bike routes within the populated areas of the City connecting to existing trails to the north and east. City trail supporters desire to develop and implement an interconnected system of well-constructed and well-maintained trails within the City and connecting to other trails in the region.

5.3 Aviation

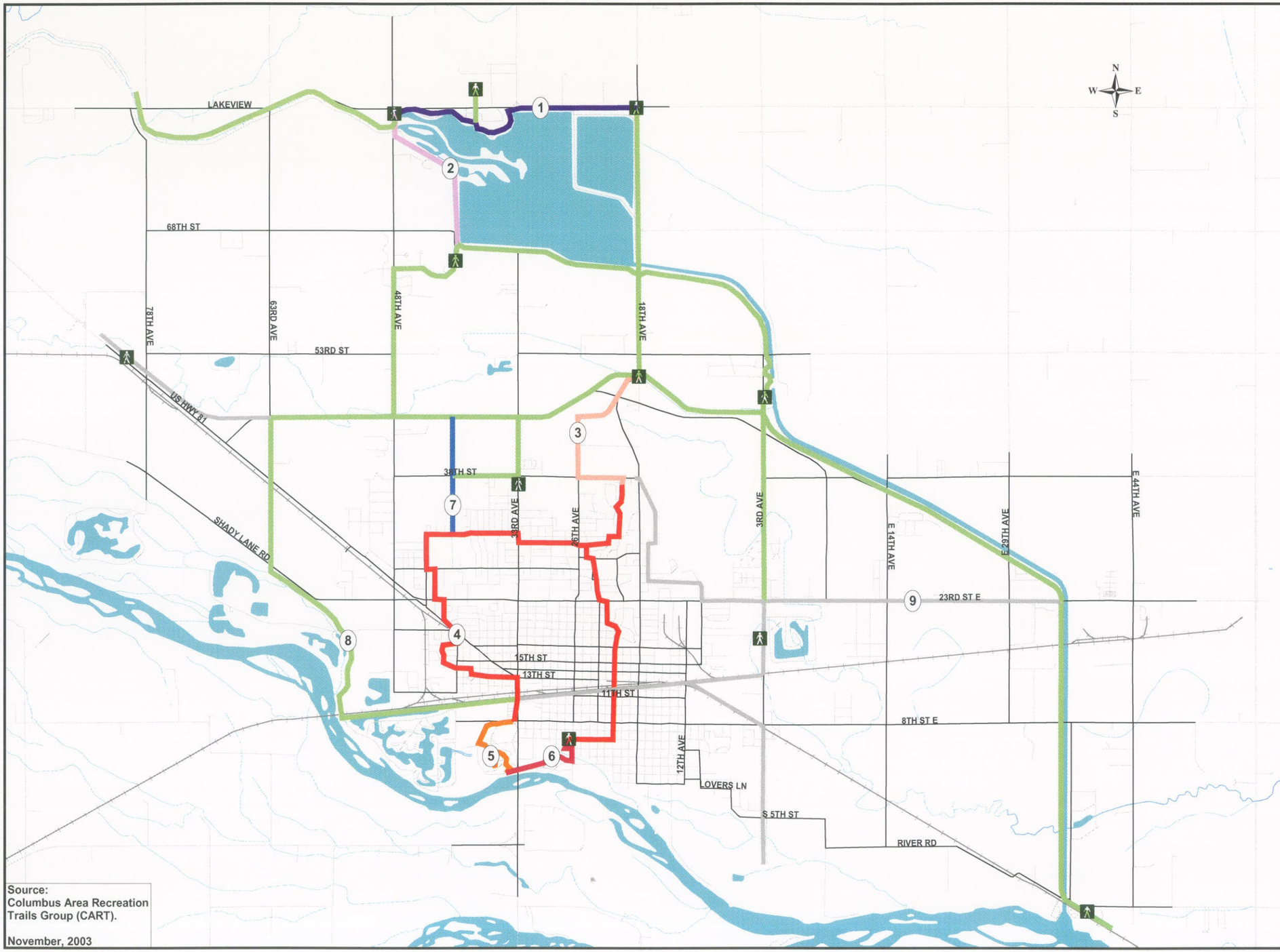
The Columbus Municipal Airport serves air transport needs for Columbus and the surrounding area. There is currently no scheduled passenger air service serving Columbus. The City has a Capital Improvement Program to systematically maintain and upgrade the airport facilities. The City plans to develop the North Arterial Roadway between 23rd Street (US 30) east of Columbus to US 81 northwest of Columbus. The North Arterial does not alter existing airport access from 23rd Street and 18th Avenue.

Only two major infrastructure improvements are planned for the Columbus Municipal Airport over the next 20-year period. These include (1) adding a second runway and (2) improving the approach to Runway 14.

5.4 Railroad

The Union Pacific Railroad crosses the City of Columbus east and west bisecting the City. Only one grade-separated railroad crossing currently exists. This viaduct is located on 33rd Avenue (US Highway 81). At-grade railroad crossings currently exist at 27th Avenue, 26th Avenue, 25th Avenue, 23rd Avenue, 21st Avenue, 18th Avenue, 12th Avenue, 3rd Avenue, and East 14th Avenue. The existing viaduct and at-grade railroad crossing locations in Columbus are illustrated in Figure 5-2.

Recent studies show there is a need to facilitate north-south traffic flow and reduce delay caused by UP trains passing through the city. The UP forecasts the number of trains will continue to increase due to higher demand for environmentally friendly Wyoming coal in the eastern parts of the United States. In fact, an estimated 80 trains per day physically close at-grade crossings for 30 to 40% of the day according to the *Columbus Grade*



Source:
Columbus Area Recreation Trails Group (CART).

November, 2003

Trail Heads

Types of Trails

(1) Two Lakes Trail
(2) Columbus Campus Trail
(3) Wilderness Trail
(4) In Town Street Trail
(5) Pawnee Park West Trail
(6) Pawnee Park East Trail
(7) Hospital Trail
(8) Other Trails
(9) Trails by City

0 .4 .8 1.2
Miles

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Columbus Trails Master Plan

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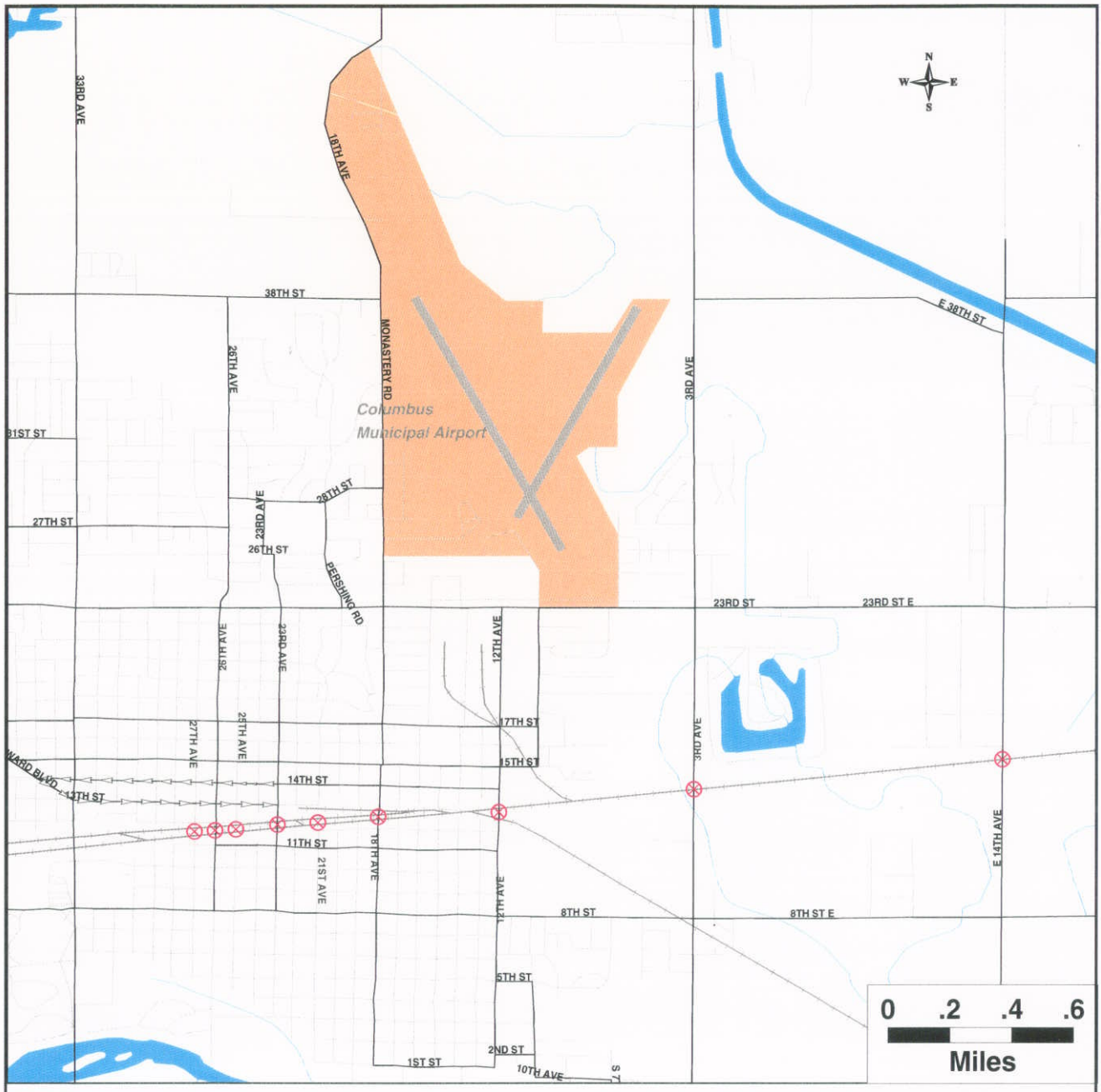
Figure 5-1



⊗ **Existing At-Grade Railroad Crossing Locations**

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Comprehensive Plan Update	
Railroad Crossing Locations	
OLSSON ASSOCIATES ENGINEERS • PLANNERS • SCIENTISTS • SURVEYORS	Figure 5-2

Separation Feasibility Study which was completed in February 2001. Frequent and long trains also hinder delivery of police, fire and ambulance services.

The emergency hospital is located near 38th Street and 48th Avenue north of the tracks. Should the existing railroad overpass be closed for any reason, emergency service access to many populated areas of the city will be seriously hindered. Other Nebraska cities of comparable size and geography to Columbus have moved forward with developing plans for and implementing multiple railroad grade-separation structures. A primary NDOR and Union Pacific requirement, however, for funding of new railroad viaducts is closure of existing at-grade crossings.

City residents seem to be in general agreement about the need for additional railroad viaducts, but cannot agree on viaduct locations or potential locations of at-grade crossing closures. The main objections appear to be potential traffic volume increases on roadways being considered for a future viaduct. The best potential viaduct locations appear to be 23rd Avenue, 12th Avenue, and 3rd Avenue. This issue has previously been studied in depth with 23rd Avenue and 12th Avenue identified as the recommended viaduct locations.

It is imperative that City staff, elected officials, and other community leaders develop consensus for additional railroad viaduct locations in Columbus to ensure safe and efficient traffic flow in the future. At some point, this will become a liability issue for the community from a traffic safety or emergency service response time standpoint. Ultimately, this issue could also be a detriment to economic development or community growth initiatives. It must be demonstrated to the public that such improvements are necessary to ensure the future success of the transportation network and that they can be planned, designed, and implemented while maintaining livable neighborhoods.

5.5 Traffic Operations and Intelligent Transportation Systems

The Nebraska Department of Roads (NDOR) has installed and maintains approximately 15 traffic signals along the state highway system in Columbus (23rd Street and 33rd Avenue). All NDOR signals utilize Type 170 controllers. NDOR rates the controllers as being in good condition. However, the Type 170 controller is a relatively old technology. Recently developed 2070 controllers have substantial improvements in functionality. These controllers, which are currently being evaluated by NDOR, have been implemented throughout the U.S. With the importance of maintaining, and ideally improving, traffic operations along these two main thoroughfares, improvements to the traffic signal system may be warranted. In addition, these traffic signals currently utilize time-based coordination with no physical, hardwire communications between signals. This method of signal coordination is not reliable and should also be improved. Both of these potential system upgrades (traffic signal controller and communication system upgrades) can be categorized as intelligent transportation system (ITS) improvements.

Intelligent transportation systems encompass a broad range of advanced communications, control, and electronics technologies to improve the efficiency, reliability, and safety of

our transportation system. ITS strategies will continue to become more important transportation solutions as it becomes more difficult and cost-prohibitive to build new roadways to improve traffic congestion.

A number of traffic operations and intelligent transportation system (ITS) projects, as outlined below, should be considered to improve the transportation system in Columbus. These projects, which focus primarily on the traffic signals along the state highway system, will require significant coordination with the NDOR.

- Traffic signal timing plans for peak and off-peak traffic periods along 23rd Street and 33rd Avenue should be updated at least every three years.
- To provide optimal traffic signal coordination based on updated timing plans, reliable communications must be provided between the traffic signal controllers along 23rd Street and 33rd Avenue. Potential communications media including fiber optic and wireless solutions should be investigated.
- Ideally, a comprehensive feasibility study should be conducted to evaluate traffic signal controller and communication upgrade options for the US Highway 30 and 81 corridors through the City. This study should evaluate the potential for other ITS strategies such as closed circuit television (CCTV) monitoring cameras that could be implemented at major intersections such as the 23rd Street/33rd Avenue junction to assist with traffic incident management.
- An advanced traffic management system (ATMS) should be implemented based on the results of the feasibility study. The ATMS system should be capable of closed-loop (minimum) or central system traffic control (recommended).
- If numerous at-grade railroad crossings exist in the future, ITS strategies should be used to notify, and when appropriate, route emergency service vehicles around at-grade crossings blocked by trains to reduce response times.
- Coordination should be maintained with NDOR statewide ITS planning activities. For example, communications should be provided between the City's ATMS and the planned NDOR District 3 Traffic Operations Center in Norfolk to provide for potential shared control and operation of the signal system by NDOR staff.

6.0 RECOMMENDED TRANSPORTATION PLAN

This chapter includes the recommended long-range transportation plan for the City of Columbus. The plan focuses on roadway, transit, and ITS improvements. Recommended trails and aviation improvements were summarized in Chapter 5.0 based on information obtained from the City's trails and airport master plans, respectively.

The recommended future functional classification map for the City is illustrated in Figure 6-1. The functional classification of several roadways has been upgraded based on projected traffic volume growth and the intended future function of the roadway. The roadway classification types used by the NDOR in the existing functional classification map have been maintained in the future map.

6.1 Long-Range Transportation Plan (LRTP)

Recommended transportation improvements have been identified and divided into short-term (0 – 5 years), mid-term (6 – 15), and long-term (16 – 25 years) time frames. These improvements are summarized in Tables 6-1, 6-2, and 6-3 and illustrated in Figures 6-2, 6-3 and 6-4. Note that there are numerous recommendations regarding implementation of 3-lane roadway sections, while traffic volumes may not warrant such an improvement for many years, if ever, it is important that these corridors be included in the Transportation Plan for right-of-way preservation and to provide important planning information to the community.

In addition to the specific transportation recommendations, the following general transportation system recommendations are provided:

- Corridor preservation should be a priority for all future roadways classified as collector or above to ensure adequate right-of-way is reserved for future roadway construction and/or widening. Typically, at least 100 feet of right-of-way should be preserved for arterial roadways and 80 feet of right-of-way for collector roadways. This will provide adequate width for the roadway, sidewalks/trails, utilities, and green space. It is also a good practice to provide 120 feet of right-of-way within approximately 700 – 1000 feet on each approach of major arterial intersections to allow for dual left-turn lanes and exclusive right-turn lanes.
- Direct driveway access should not be allowed on any future arterial roadways. It should be limited to the extent possible on collector roadways. In particular, strict access management should be implemented on the North Arterial including frontage roads to eliminate or reduce direct driveway access.
- Future traffic signals, particularly along US Highway 30, 81, and the North Arterial, as well as other major arterial roadways should ideally be spaced at ½-mile intervals and, at a minimum, no closer than ¼-mile apart.
- Unsignalized median openings on divided highways such as US Highways 30, 81, and the North Arterial should ideally be spaced at ¼-mile intervals and, at a minimum, 1/8-mile intervals.

Table 6-1
Recommended Short-Term (0 - 5 years) Transportation Improvements

Project Number	Location	Project Description
1.	23rd Street/33rd Avenue (U.S. Highway 30 and 81)	Access management study to determine potential capacity improvements and develop corridor access management plan. This document should include intersection and driveway spacing guidelines so that new development plans can be handled in an equitable fashion based on published standards.
2.	23rd Street/18th Avenue Intersection	Geometric modification to improve north/south lane alignment and stacking distance and add east/west right-turn lanes.
3.	23rd Street/23rd Avenue Intersection	Geometric modification to improve north/south lane alignment and eliminate free right-turn island on south leg.
4.	23rd Street/26th Avenue Intersection	Geometric modification to improve north/south lane alignment and southbound left-turn stacking distance.
5.	33rd Avenue/21st Street/Menard's Intersection	Geometric modification to improve alignment of the east/west legs of the intersection.
6.	33rd Avenue/8th Street Intersection	Eliminate split east/west signal phasing and implement standard left-turn phasing. We believe the lane geometry will support this improvement.
7.	8th Street – 33rd Avenue to 10th Avenue	Implement three-lane roadway section with a center, two-way left-turn lane.
8.	33rd Avenue/23rd Street Intersection	Major geometric improvement to add dual left-turn lanes.
9.	23rd Avenue at UPRR Tracks	Construct two-lane viaduct and close at least two adjacent at-grade railroad crossings.
10.	33rd Avenue/13th Street/14th Street/Howard Boulevard Intersection	Major geometric improvement to increase capacity and left-turn storage length on U.S. Highway 81 between 13th and 14th Streets.
11.	33rd Avenue – 23rd Street to 27th Street	Construct five-lane roadway section. This improvement should include left-turn lanes in all four directions.
12.	38th Street – 48th Avenue to 18th Avenue	Construct three-lane roadway section with center, two-way left-turn lane. This improvement should include a southbound left-turn lane at the intersection of 38th Street and 48th Avenue.

Table 6-1 - Continued
Recommended Short-Term (0 - 5 years) Transportation Improvements

Project Number	Location	Project Description
13.	18th Avenue – 23rd Street to 38th Street	Restripe roadway to provide a three-lane roadway section with center, two-way left-turn lane.
14.	26th Avenue – 32nd Street to 38th Street	Construct three-lane roadway section with center, two-way left-turn lane.
15.	North Arterial	Construct the North Arterial from 23rd Street to 33rd Avenue.
16.	39th/40th/41st Avenue Area – 23rd Street to 38th Street	Implement north/south collector roadway system between 23rd Street and 38th Street.
17.	Transit System	Increase service to two full-time vehicles.
18.	Transit System	To improve efficiency, join a coalition of rural transit providers to (1) provide regionally-based computer-aided dispatching, vehicle tracking, and real-time service, and (2) provide transit vehicle priority at traffic signals to reduce transit vehicle delays.
19.	Traffic Signal Coordination	Update timing plans along 33rd Avenue, 23rd Street, and other key arterial roadways at least every three years.
20.	Traffic Signal Communications Upgrade	Implement a wire line or wireless communications system along 33rd Avenue and 23rd Street to provide reliable traffic signal progression.
21.	Traffic Signal System Feasibility Study	Conduct a comprehensive traffic signal and communications feasibility study to determine long-term options to upgrade the signal and communications system. This study should evaluate the potential for other ITS strategies such as CCTV.
22.	Traffic Monitoring Cameras	Implement closed circuit television (CCTV) monitoring cameras at the intersection of 23rd Street and 33rd Avenue to assist with traffic incident management. This improvement could be implemented as part of the geometric improvements planned for this intersection in the next several years.
23.	Roundabout Project	Identify an intersection to be improved to a roundabout to improve capacity or reduce accidents. Such a project would likely qualify for STP funding through NDOR. Potential roundabout locations include the intersections of 8th Street/26th Avenue, 8th Street/18th Avenue, 8th Street/12th Avenue, and 33rd Avenue/38th Street.

Table 6-2
Recommended Mid-Term (6 – 15 years) Transportation Improvements

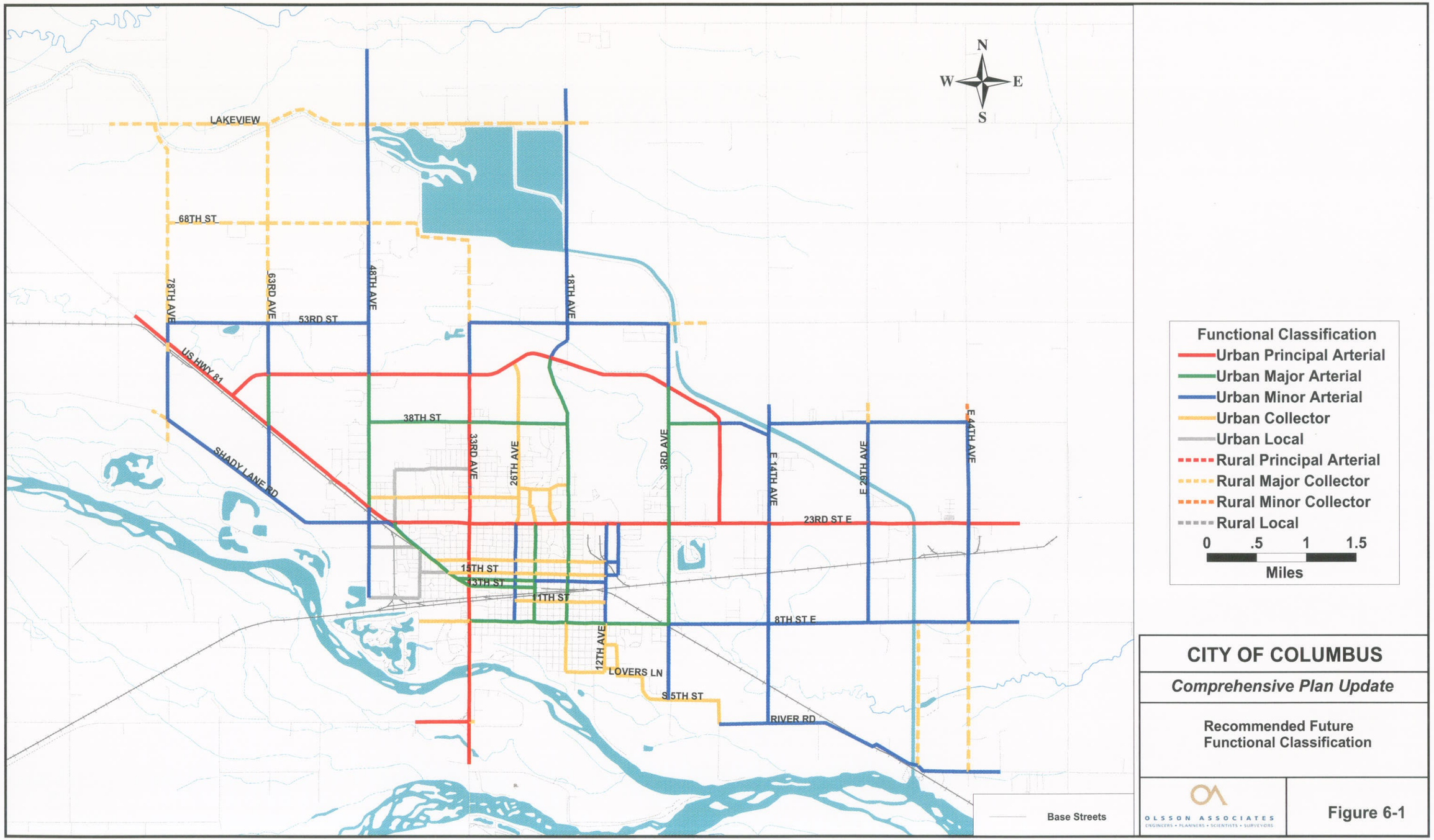
Project Number	Location	Project Description
1.	North Arterial	Construct the North Arterial from 33rd Avenue to U.S. Highway 81
2.	1st Street – 16th Avenue to 17th Avenue	Pave roadway.
3.	48th Avenue – 38th Street to North Arterial	Construct three-lane roadway section with center, two-way left-turn lane.
4.	12th Avenue – 8th Street to 23rd Street	Construct three-lane roadway section with center, two-way left-turn lane. If 12th Avenue is closed between 17th and 23rd Streets, the north portion of this improvement should be constructed on 10th Avenue with a smooth transition constructed to connect 10th and 12th Avenues in the vicinity of 15th Street.
5.	23rd Avenue – 8th Street to 14th Street	Restripe roadway to provide a three-lane roadway section with center, two-way left-turn lane. This improvement would require removal of existing on-street parking.
6.	26th Avenue – 8th Street to 15th Street	Construct three-lane roadway section with center, two-way left-turn lane. Note that this improvement is in the CBD area and would require removal of existing parallel parking.
7.	23rd Street/East 14th Avenue Intersection	Construct southbound left-turn lane and increase stacking distance between U.S. Highway 30 and the frontage road.
8.	15th Street/18th Avenue Intersection	Intersection improvement to align the north/south legs of the intersection. A roundabout could be considered in this location.
9.	23rd Avenue/26th Street Intersection	Geometric modification to improve the north/south alignment and reduce pedestrian crossing distance.
10.	12th Avenue at UPRR Tracks	Construct two-lane viaduct and close at least two adjacent at-grade railroad crossings.
11.	23rd Street/33rd Avenue (U.S. Highway 30 and 81)	Implement appropriate elements of the corridor access management plan to improve capacity and safety.
12.	South Collector Roadway	Construct a South Collector Roadway between 33rd Avenue and 3rd Avenue on an alignment between 1st Street and 5th Street.

Table 6-2 - Continued
Recommended Mid-Term (6 – 15 years) Transportation Improvements

Project Number	Location	Project Description
13.	3rd Avenue –UPRR Tracks to S. 5th Street	Construct three-land roadway section with center, two-way left-turn lane.
14.	3rd Avenue –30th Street to North Arterial	Construct three-lane roadway section with center, two-way left-turn lane.
15	33rd Avenue – 38th Street to the North Arterial	Construct three-lane roadway section with center, two-way left-turn lane.
16.	South Bypass Roadway	Conduct corridor study to determine preferred alignment and environmental impacts.
17.	West Bypass Roadway	Conduct corridor study to determine preferred alignment and environmental impacts.
18.	Transit System	Increase service to three full-time vehicles.
19.	Highway-Rail Intersections	Evaluate the benefits and costs of using ITS to support emergency service providers and direct traffic around at-grade railroad crossings impacted by trains to avoid delay and reduce trip times.
20.	Traffic Signal Coordination	Update timing plans along 33rd Avenue, 23rd Street, and other key arterial roadways at least every three years.
21.	Traffic Signal System	Implement an advanced transportation management system (ATMS) based on the results of the traffic signal system feasibility study.
22.	Traffic Signal System	Provide communications connectivity between the City's ATMS and either the planned NDOR District 3 Traffic Operations Center (TOC) or the planned Statewide NDOR TOC to provide for shared control and operations of the system.

Table 6-3
Recommended Long-Term (16 – 25 years) Transportation Improvements

Project Number	Location	Project Description
1.	3rd Avenue at UPRR Tracks	Construct two-lane viaduct and close at least two adjacent at-grade railroad crossings.
2.	South Bypass Roadway	Construct a South Bypass Roadway between 33rd Avenue and East 6th Avenue (North Arterial) extending east from the south junction of US Highway 30 and 81.
3.	West Bypass Roadway	Construct West Bypass Roadway between US Highway 81 and US Highway 30 on the alignment of 63rd or 78th Avenue.
4.	48th Avenue – US Highway 81 to 11th Street	Construct three-lane roadway section with center, two-way left-turn lane.
5.	23rd Street – 45th Avenue to 63rd Avenue	Construct three-lane roadway section with center, two-way left-turn lane.
6.	53rd Street – 33rd Avenue to 48th Avenue	Construct two-lane rural roadway section.
7.	38th Street – 3rd Avenue to East 14th Avenue	Construct three-lane roadway section with center, two-way left-turn lane. This improvement should realign 38th Street to remove the jog in the roadway on the north and south sides of the Loup Canal.
8.	East 14th Avenue – 17th Street to 8th Street	Construct three-lane roadway section with center, two-way left-turn lane.
9.	East 14th Avenue – 23rd Street to 38th Street	Construct three-lane roadway section with center, two-way left-turn lane.
10.	East 29th Avenue – 23rd Street to 8th Street	Construct three-lane roadway section with center, two-way left-turn lane.
11.	East 29th Avenue – 23rd Street to 38th Street	Construct three-lane roadway section with center, two-way left-turn lane.
12.	26th Avenue – 25th Street to 32nd Street, 38th Street to the North Arterial	Construct three-lane roadway section with center, two-way left-turn lane.
13.	18th Avenue – 38th Street to North Arterial	Construct three-lane roadway section with center, two-way left-turn lane.
14.	Highway-Rail Intersections	Implement cost-effective ITS to notify emergency service providers and direct traffic around at-grade railroad crossings impacted by trains to avoid delay and reduce trip times.
15.	Traffic Signal Coordination	Update timing plans along 33rd Avenue, 23rd Street, and other key arterial roadways at least every three years.



CITY OF COLUMBUS

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Recommended Future Functional Classification

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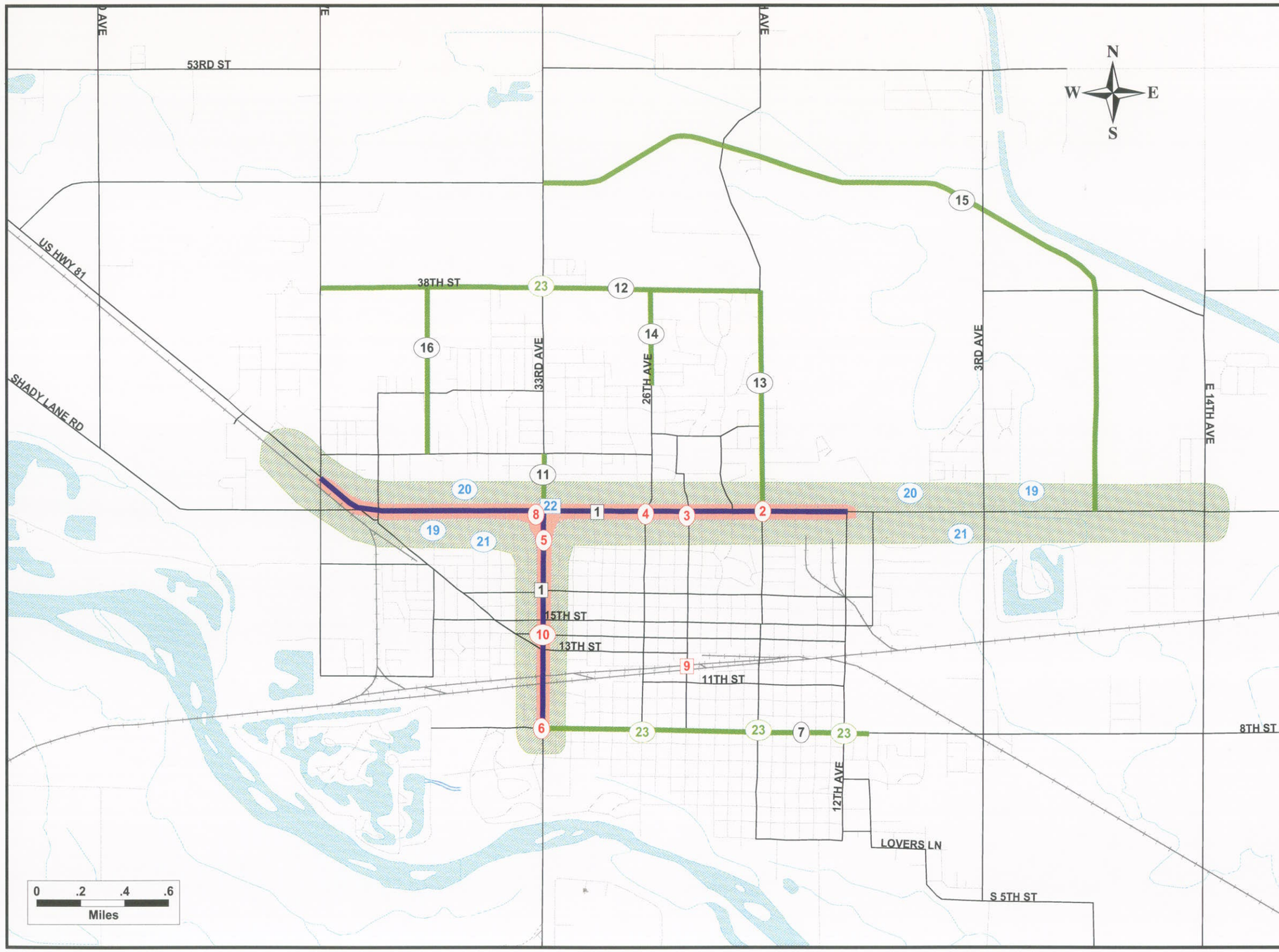
Figure 6-1



Legend:

- 1 Access Management Study
- 2 Intersection Improvements
- 11 Roadway Improvements
- 9 Railroad Viaduct
- 21 Traffic Signal Coordination/ Communications Upgrade/ Feasibility Study
- 22 Traffic Monitoring Cameras
- 23 Potential Roundabout Improvement

Note:
Improvement numbers in this figure correspond to the detailed descriptions in Table 6-1.

CITY OF COLUMBUS

Comprehensive Plan Update

Recommended Short-term Transportation Improvements

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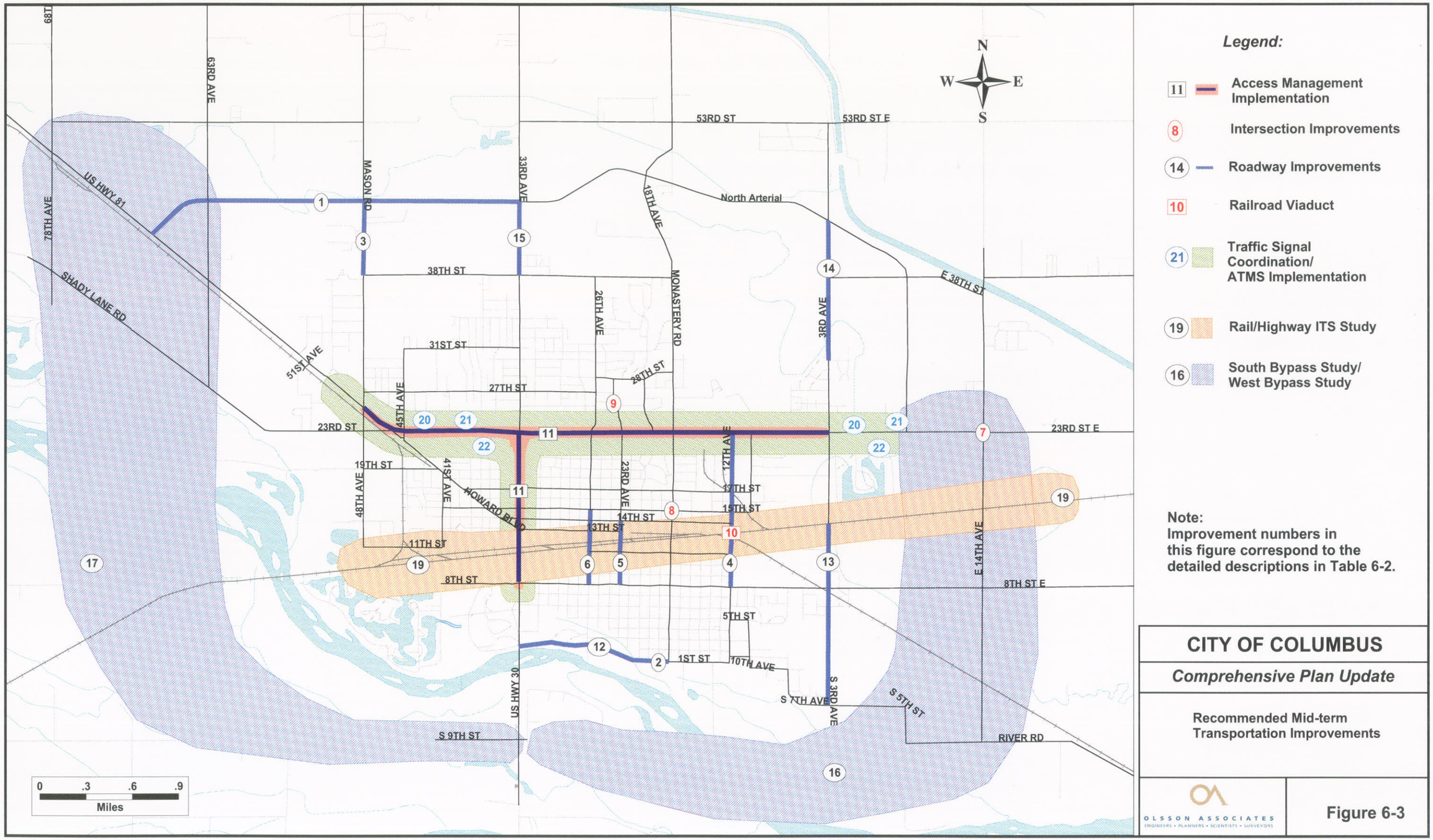
Figure 6-2



CITY OF COLUMBUS

Comprehensive Plan Update

Recommended Mid-term Transportation Improvements

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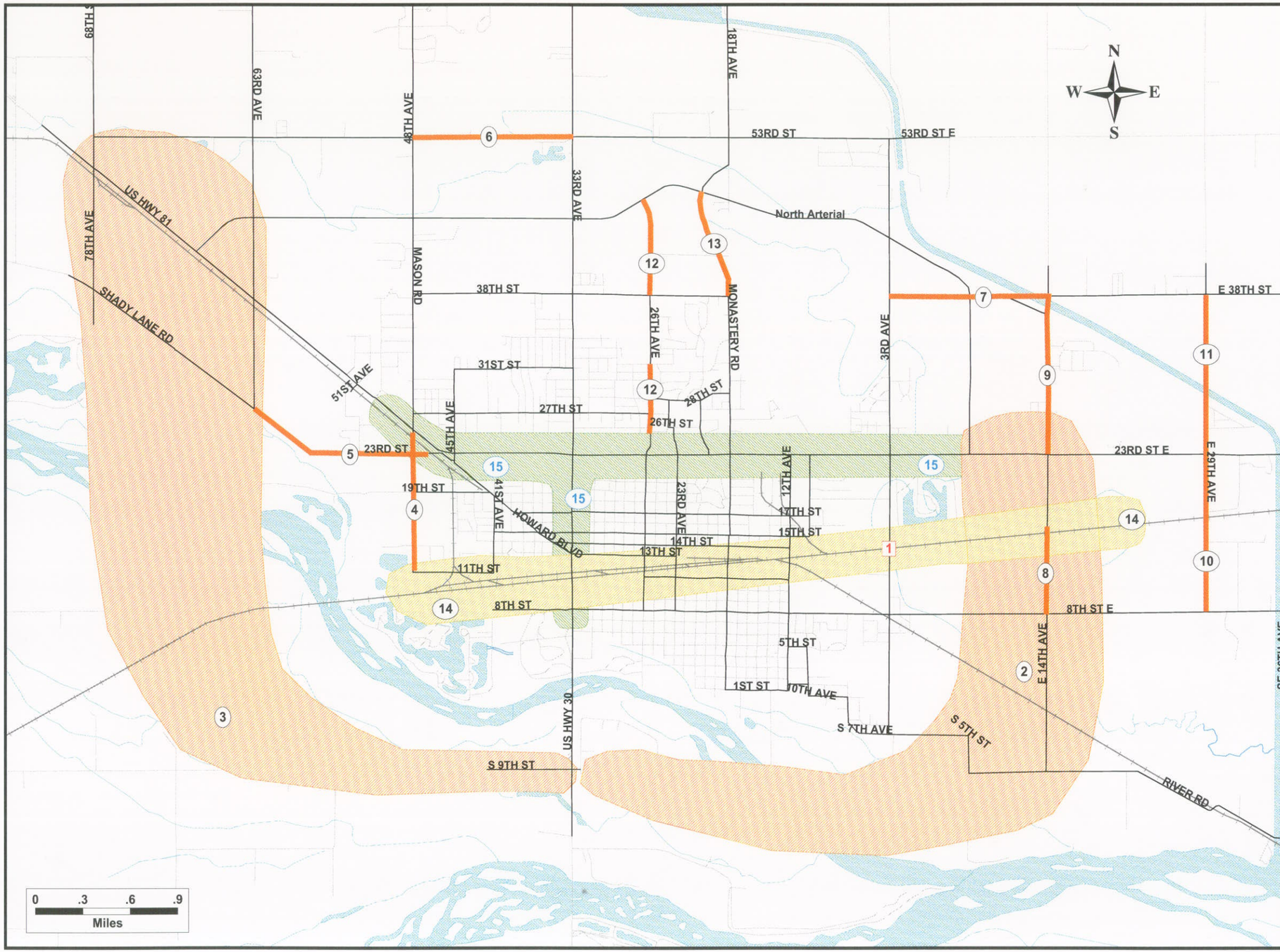
Figure 6-3



Legend:

- 9 — Roadway Improvements
- 1 — Railroad Viaduct
- 15 — Traffic Signal Timing
- 14 — Rail/Highway ITS Implementation
- 2 — South Bypass Roadway/ West Bypass Roadway

Note:
Improvement numbers in this figure correspond to the detailed descriptions in Table 6-3.

CITY OF COLUMBUS

Comprehensive Plan Update

Recommended Long-term Transportation Improvements

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Figure 6-4

- Access management should be a priority along all major arterial roadways. Every effort should be taken to improve existing access management deficiencies. For new development along divided roadways, driveways should not be allowed within 300 feet of major, signalized intersections.
- Continuous collector roadway networks should be developed to supplement the arterial roadway system. In undeveloped areas, a collector roadway master plan should be developed to ensure dedication of right-of-way when development occurs and the ability to maintain continuity throughout the community.
- Roundabouts are an excellent alternative to traffic signals for many intersections in Columbus. For similar traffic conditions, roundabouts typically offer greater capacity and substantially fewer accidents. It is recommended that roundabouts be considered, as appropriate, for future intersections where 4-way stop control or signalization are being considered. Roundabouts would likely work well for most intersections off the state highway system. In particular, they would be good alternatives at existing four-way stop intersections such as 8th Street/26th Avenue, 8th Street/18th Avenue, 8th Street/12th Avenue, or 33rd Avenue/38th Street.

6.2 Funding Evaluation

Various federal, state, and local funding sources could be considered for implementation of Columbus transportation improvements. Possible funding sources are discussed below:

- Federal Surface Transportation Program (STP) dollars. This program returns federal gas tax dollars to states on an annual basis. These funds can be used for improvements to any public roadway. The Nebraska Department of Roads allocates these funds to cities and counties and retains some for state use. It is expected this program will continue with the next federal transportation reauthorization legislation. Since Congress is debating Federal transportation funding, it is impossible to be sure of the outcome. All of the bills being considered by Congress include about 50% to 100% increase in most federal transportation funding categories.
- State Highway Dollars. The Nebraska Department of Roads collects state gas taxes for funding of improvements to the state highway system. These funds could be used for improvements to state highways in Columbus such as US Highways 30 and 81.
- Grade-Separation Dollars. The Nebraska Department of Roads collects a train-mile tax from railroads in the state. These funds are used to fund new grade-separation structures.
- Union Pacific Dollars. Union Pacific Railroad provides funding to communities closing at-grade highway-rail intersections. These funds could be used to construct a new railroad grade-separation structure.
- State and Federal Airport Dollars: Funding generated from airport use taxes is available for airport maintenance and improvements.

- State and Federal Highway Safety Dollars: Funding is available for improvements at hazardous locations.
- Intelligent Transportation System (ITS) Dollars. Federal and state funds are frequently set aside for ITS projects to improve traffic and transit operations. These funds are administered by both FHWA and FTA. Some state and local areas have obtained Congressional "earmarks" for specific ITS projects or programs.
- Transportation Enhancement Dollars: Federal programs exist for transportation enhancements such as trails.
- City Sales or Other Tax Dollars. The City has traditionally used some of its city taxes for transportation maintenance and operational improvements.
- Bonding Dollars. Many communities have used bonding to fund transportation improvements. A source of funding to repay the bonds is required.

Obviously, the number of potential improvement projects far exceeds the funding that may be available for these improvements. Thus, it is critical that a recommended transportation plan be adopted so that available funding sources can be explored and appropriate projects included in the State's Transportation Improvement Program (TIP).

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APPENDICES

Appendix A Existing Transportation Condition Report

Appendix B Travel Demand Model Documentation

Appendix C Alternative Traffic Volumes Assignment Plots

APPENDIX A

Existing Transportation Conditions Report

COMPREHENSIVE PLAN

EXISTING TRANSPORTATION CONDITIONS

COLUMBUS, NE

Technical Memorandum

Prepared for

City of Columbus

Prepared by

Olsson Associates

October 2003

OA Project No. 2003-0048

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The purpose of this report is to document the results of analyses conducted for existing traffic conditions as part of the City of Columbus Comprehensive Plan. The existing conditions evaluation included various data collection efforts and operational and safety analyses for the current transportation network. A summary of the tasks completed for analysis of the existing traffic conditions is included in the following sections of this report.

1.0 DATA COLLECTION SUMMARY

A comprehensive field review of existing traffic control devices, speed zones, roadway cross-sections and intersection lane geometrics was conducted as part of the data collection effort. This data would later be used in developing the traffic model. In addition, traffic volume counts and field data were collected during the peak hour periods of operation. The following intersections were included as part of this in depth review.

- US Highway 30 and E. 14th Avenue
- US Highway 30 & 18th Avenue
- US Highway 30 & 23rd Avenue
- US Highway 30 & 26th Avenue
- US Highway 81 & 14th Street
- US Highway 81 & 13th Street/Howard Boulevard
- US Highway 81 & 21st Street/Menards East Driveway (PM only)

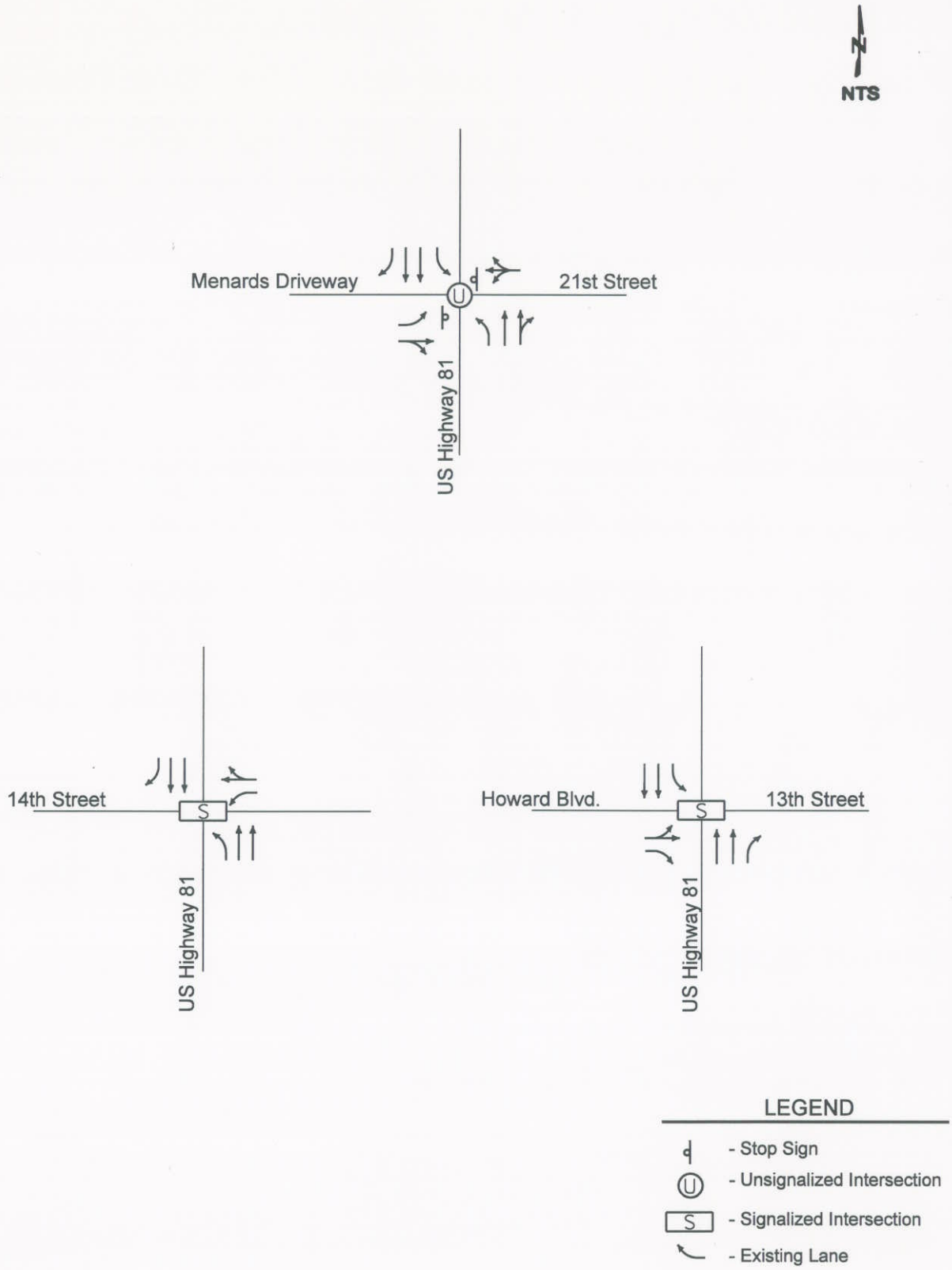
Spot speed studies were also conducted along the 38th Street corridor from 18th Avenue to 48th Avenue, to monitor speeds of traffic approaching the hospital just west of 48th Avenue.

1.1 Field Review of Traffic Signals / Street Geometrics

Field observations/measurements were taken at selected intersections within the City of Columbus. This fieldwork consisted of recording intersection lane geometrics, speed limits, and traffic signal and other traffic control device data for use in operational analyses. Observation of general traffic conflicts, turning movements and queue lengths was also conducted. Several deficiencies were noted, including unsatisfactory alignment of left-turn lanes and opposing approaches, need for channelization, inadequate storage lengths and lack of proper signing and striping. Based on the field review, existing intersection lane configurations and traffic control at these select intersections are illustrated in Figures 1A and 1B.

1.2 Traffic Counts

Peak hour turning movement counts (including pedestrian and heavy vehicle counts) were conducted at specific intersection locations determined by City of Columbus and Olsson Associates staff. The counts were collected during June 2003 under normal traffic conditions. These counts were conducted during the peak periods of traffic flow (7:00am – 9:00am and 4:00pm – 6:00pm) at the locations listed above.



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Existing Lane Configurations and Traffic Control

FIGURE 1A

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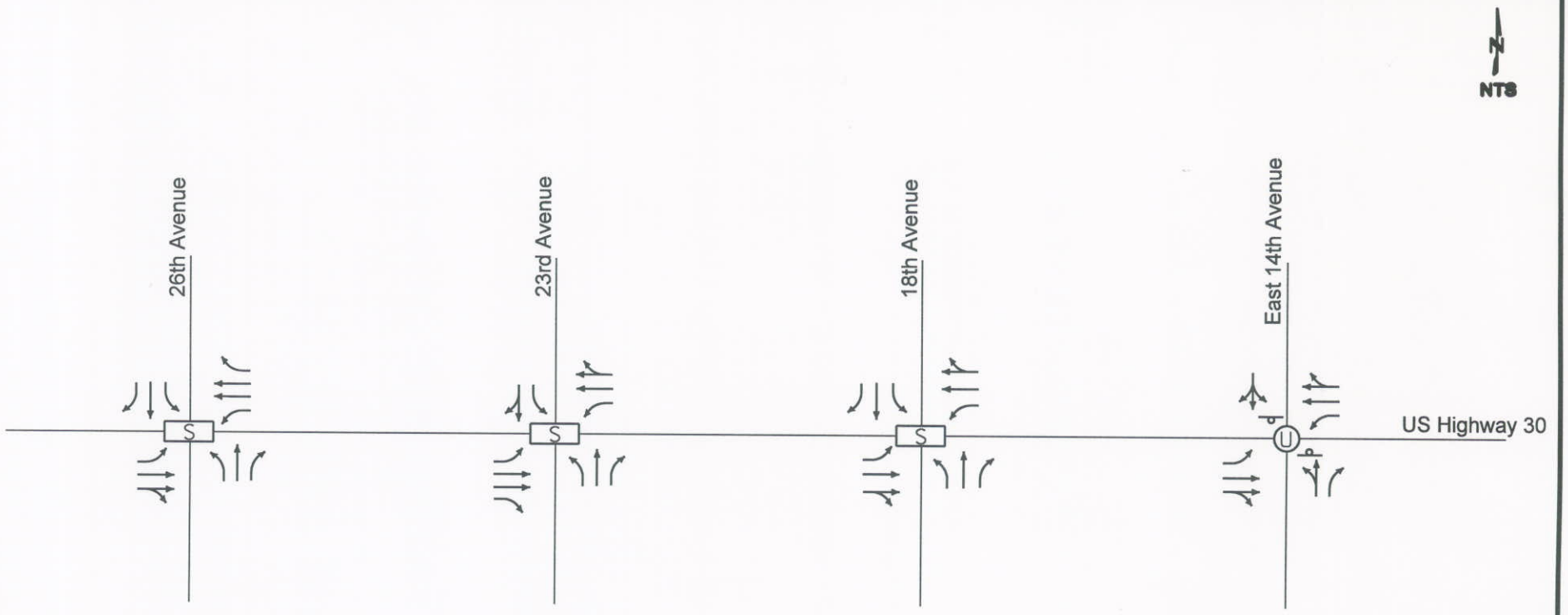

LEGEND

- Stop Sign
- Unsignalized Intersection
- Signalized Intersection
- Existing Lane

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Existing Lane Configurations and Traffic Control

FIGURE 1B

These volumes were collected for use in capacity analyses and signal warrant evaluations. A summary of the peak hour counts is illustrated in Figures 2A and 2B.

The data collection effort also included conducting 24-hour counts at seven locations throughout the City of Columbus. These locations were collected to provide external count data for the model calibration/validation process. This data was collected at the following locations:

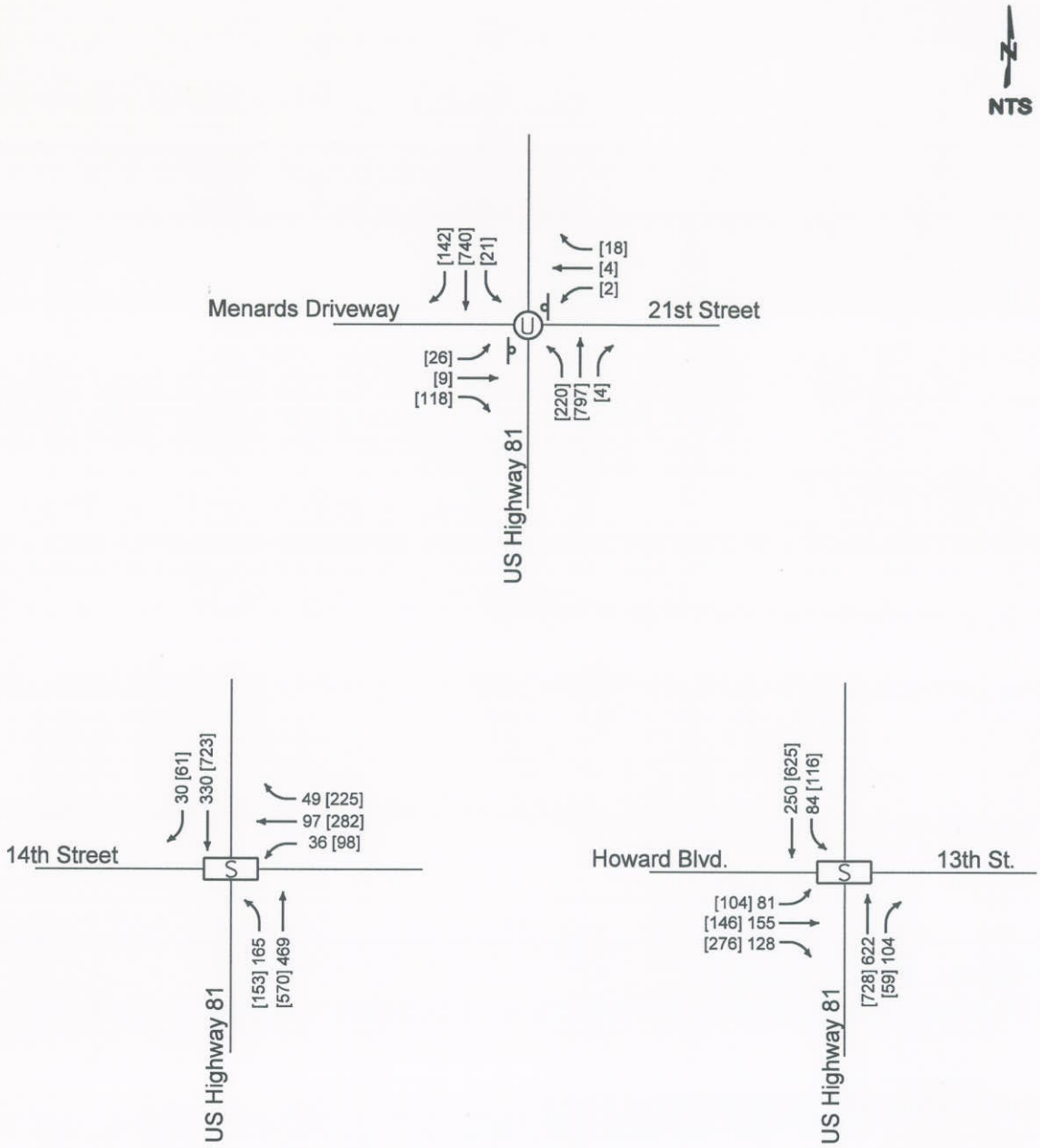
- US Highway 81 at the Loup River Bridge
- US Highway 81 at the Rail Bridge
- 33rd Avenue south of 23rd Street
- US Highway 81 west of 48th Avenue
- 23rd Street east of 33rd Avenue
- 23rd Street east of 10th Avenue
- US Highway 30 east of East 44th Avenue

1.3 Speed Studies

Spot speed studies were conducted along 38th Street from 18th Avenue to 48th Avenue. This study was performed due to concern from City staff that speed limits may need to be revised due to construction of the hospital east of 48th Avenue. Except for the hospital, the eastern and western portions of this corridor are mostly undeveloped. The eastern segment of 38th Street becomes more populated with several residential and commercial land uses, including an early development school and church. The speed studies were conducted during non-peak traffic periods to evaluate free flow conditions at the following locations:

- 38th Street near Hospital Parking Lot (currently posted at 50 mph)
- 38th Street west of 33rd Avenue (currently posted at 35 mph)
- 38th Street east of 33rd Avenue (currently posted at 35 mph)
- 38th Street & 26th Avenue (currently posted at 50 mph)

Typically, speed limits are set based on the 85th percentile speed, adjacent land use, crash data, roadway geometry, parking, pedestrians and engineering judgment. The results of the data indicate that there is very low compliance with the existing 35 mph speed zone. Motorists fail to slow down as they enter the 35 mph speed zone through the residential area. The fact that the 38th Street corridor is mainly undeveloped on both ends leads to increased speeds through the middle segment of 38th Street. The results of the speed studies are summarized in Table 1.



LEGEND

- Stop Sign
- Unsignalized Intersection
- Signalized Intersection
- [XX] XX — AM [PM] Peak Hour Volumes
  AM Peak = 7:30-8:30 am
  PM Peak = 4:30-5:30 pm

Source: OA, June 2003

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Existing Peak Hour Volumes

FIGURE 2A

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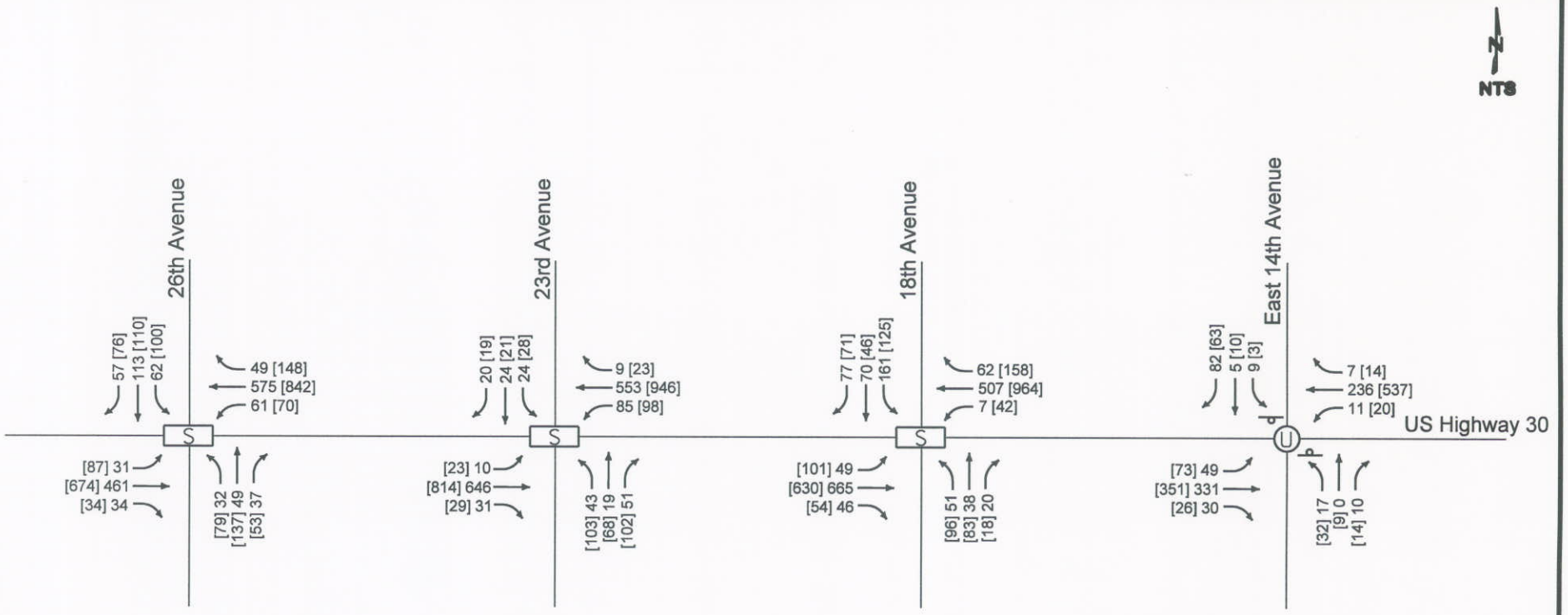


LEGEND

- Stop Sign
- Unsignalized Intersection
- Signalized Intersection
- [XX] XX — AM [PM] Peak Hour Volumes
  AM Peak = 7:30-8:30 am
  PM Peak = 4:30-5:30 pm

Source: OA, June 2003

OLSSON ASSOCIATES
CONSULTING ENGINEERS

Existing Peak Hour Volumes

FIGURE 2B

Table 1: Speed Study Data

Location	Date	Posted (mph)	85th Percentile (mph)
38th Street & Hospital Parking Lot	6/10/03	50	52.0
38th Street West of 33rd Avenue	6/11/03	35	45.0
38th Street East of 33rd Avenue	6/11/03	35	42.0
38th Street & 26th Avenue	6/12/03	50	48.8

Based on the results of the speed study a recommendation to raise the existing 35 mph speed zone along 38th Street could be justified. However, any recommendation to raise the speed limit must be approved by the City of Columbus and adjacent land users.

2.0 EXISTING CONDITIONS ANALYSES

Based on the field review and data collected at the selected intersections, an evaluation of traffic signal warrants was conducted. In addition, capacity analyses were performed for the existing traffic conditions at each location. A general review of the citywide accident history was conducted to highlight additional safety considerations. A summary of these tasks is provided below.

2.1 Signal Warrant Analysis

Based on the existing traffic volumes, signal warrants were evaluated for the study area intersections. The Manual on Uniform Traffic Control Devices (MUTCD) *Millennium Edition* provides eight warrants for evaluation of signalization at intersections. Typically, traffic signalization is warranted based on a complete review of traffic volume information including pedestrians, crash experience, and traffic progression. The preliminary need for signalization at study area intersections for the existing conditions scenario was evaluated based on the Four Hour Volume Warrant (Warrant 2) and the Peak Hour Volume Warrant (Warrant 3) contained in the MUTCD.

Based on this signal warrant evaluation, the existing signalized intersections of US Highway 81 with 13th Street/Howard Boulevard and US Highway 30 with 18th, 23rd and 26th Avenues satisfy the peak hour and four hour signal warrants. The existing signalized intersection of US Highway 81 with 14th Street satisfies the peak hour signal warrant. The existing unsignalized intersections of US Highway 30 with East 14th Avenue and US Highway 81 with Menards Driveway do not satisfy warrants for signalization. It should be noted that these warrants are based on traffic volumes alone.

2.2 Capacity Analysis

Capacity analyses were conducted to assess existing operations during both the morning and afternoon peak hours at the seven selected intersections. Signalized intersection capacity analyses were conducted using Synchro, version 5.0, which is based on the Highway Capacity Manual (HCM) delay methodology. Unsignalized intersection capacity analyses were conducted for the existing stop-controlled intersections within the study area in accordance with the Highway Capacity Manual (HCM) 2000 delay methodology, utilizing the Highway Capacity Software (HCS-2000).

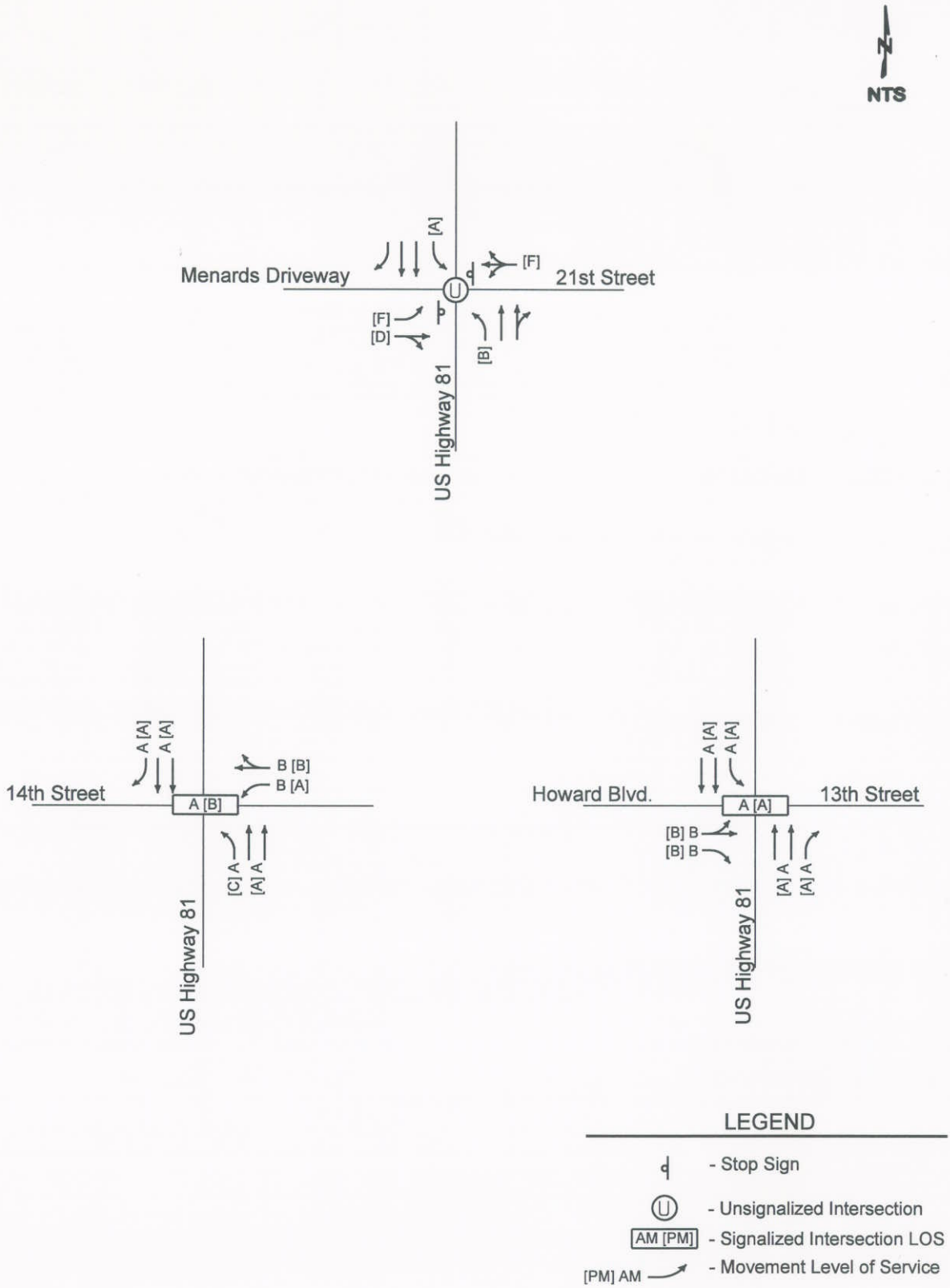
Level of Service (LOS) at signalized and unsignalized intersections is defined in terms of control delay. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The amount of delay is assigned a letter grade A through F, LOS A representing little or no delay and LOS F representing very high delay. LOS C or D operation is typically considered acceptable in most urban areas. Level of Service criteria for signalized and unsignalized intersections is summarized in Table 2.

Table 2: Level of Service Criteria

Level Of Service	Control Delay (seconds/vehicle)	
	Signalized Intersection	Unsignalized Intersection
A	≤ 10	≤ 10
B	> 10 and ≤ 20	> 10 and ≤ 15
C	> 20 and ≤ 35	> 15 and ≤ 25
D	> 35 and ≤ 55	> 25 and ≤ 35
E	> 55 and ≤ 80	> 35 and ≤ 50
F	> 80	> 50

All existing signalized intersections currently operate at LOS C or better during both the AM and PM peak hour periods with all individual movements at LOS C or better. The complete results of the analyses for each intersection are illustrated in Figures 3A and 3B.

Unsignalized intersection capacity analyses were conducted for the existing stop-controlled intersections within the study area. The results of these analyses indicate that all individual movements at the intersections of Howard Boulevard with 14th Street and US Highway 30 with East 14th Avenue currently operate with movements at LOS C or better operations during all peak periods. The east/west stop-controlled movements at the intersection of US Highway 81 and Menards Driveway operate at LOS D and F during the afternoon peak hour period. The high delay and large queue lengths at this intersection are due in part to both the high traffic volumes on US Highway 81 and the existing lane geometrics at the intersection. The opposing 21st Street and Menards Drive approaches currently are not aligned and the Menards Drive approach has excessive lane widths, which also leads to poor operations. Channelization of



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Existing Conditions Capacity Analysis Summary

FIGURE 3A

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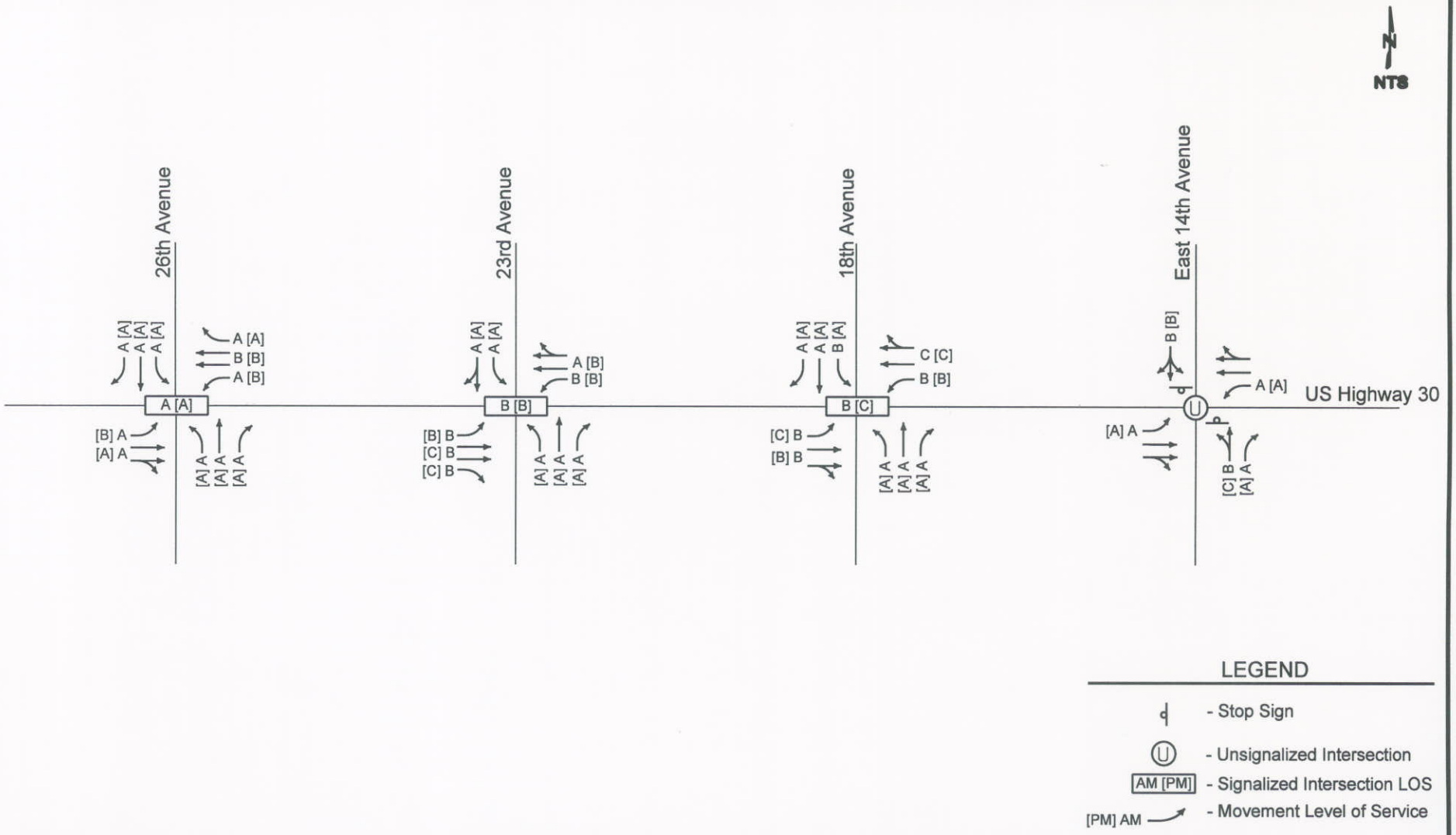
City of Columbus Comprehensive Plan
Existing Transportation Conditions



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Existing Conditions Capacity Analysis Summary

FIGURE 3B

northbound left-turners into Menards Drive would also improve operations.

2.3 Accident Data

The Nebraska Department of Roads (NDOR) provided accident data for the most recent three-year period. The number and type of accidents was also identified for each intersection. The accident rate is based on the frequency of accidents during the three-year period weighted by the traffic exposure. The accident rate is reported in terms of the number of accidents per million vehicles entering the intersection (acc/MEV).

Based on statewide accident rate data provided by the NDOR, the urban highway intersection rate averages 1.040 acc/MEV. Based on experience with similar communities, an intersection accident rate below 1.5 acc/MEV is considered typical in urban areas for intersections of similar functional class and traffic control and would generally not indicate any significant accident experience. A comprehensive review of all intersections within city limits was conducted to analyze the type and total number of crashes over the past three years. Based on this review, intersections of concern (greater than 1.5 acc/MEV) are shown in Table 3 below.

Table 3: Intersection Crash Summary

Intersection	Angle	Rear End	Total Crashes	Crash Rate
33rd Ave. & 8th St.	27	24	58	1.944
33rd Ave. & 13th St./Howard Blvd.	17	33	52	1.583
33rd Ave. & 14th St.	21	23	52	1.532
33rd Ave. & 23rd St.	36	61	114	2.225
23rd St & 36th Ave.	10	11	24	1.993
23rd St. & 45th Ave.	12	5	23	2.100

As seen in Table 3, several intersections have a crash rate that is higher than average for cities of similar size to Columbus. The City of Columbus and the NDOR have construction underway or have planned construction in the near future for the intersections of 33rd Avenue with 8th Street and 33rd Avenue with 23rd Street. The resulting improvements to alignment and geometrics should decrease the number of crashes at these intersections and in turn reduce the crash rates.

The majority of the crashes at the intersections of 33rd Avenue with 13th Street/Howard Boulevard and 33rd Avenue with 14th Street have been rear end or angle type crashes. The accidents can mainly be attributed to the minimal stacking that is provided for the back-to-back left turn lanes between these two intersections. Failure to yield by motorists in the existing free right-turn lanes as well as other geometric and/or striping deficiencies could be the cause of the large number of angle accidents at these intersections.

Although the intersections of 23rd Street with 36th Avenue and 45th Avenue have fewer total crashes, the crash rates are high due to lower ADT volumes at these locations. These intersections were not studied in depth during the field review so an exact cause of these accidents is not immediately known. However, inadequate alignments and an excessive number of access drives off of 23rd Street may be reasonable causes of these accidents. Further review of these intersections would be needed to give a complete cause of the accidents at these intersections.

3.0 RECOMMENDATIONS

Based on the results of the analyses, a number of potential improvement alternatives have been identified. These improvements will be refined based on input from the steering committee and further analysis as the transportation modeling and long-range transportation plan tasks are completed. Potential improvement alternatives for each location are outlined below:

US Highway 30 and 18th Avenue:

- Remove north/south medians and re-stripe to improve both alignment and vehicle stacking distance.
- Northbound and southbound right-turn lanes should be signed and striped.

US Highway 30 and 23rd Avenue:

- Lane alignment could be improved in the north/south approaches of 23rd Avenue.
- Eliminate free right-turn island on the south leg of intersection.

US Highway 30 and 26th Avenue:

- Lane alignment could be improved in the north/south approaches of 26th Avenue.
- Additional storage length should be provided for the southbound left-turn movement.
- The northbound right-turn lane needs to be striped and signed.

US Highway 30 and East 14th Avenue:

- 3-lane section on the south leg of the intersection and 2-lane section on the north leg that could be better aligned and north leg widened to provide future turn lane as volumes increase.
- Minimal stacking distance is provided for the southbound movement between US Highway 30 and the east/west frontage road.

US Highway 81 and Howard Blvd./13th Street & US Highway 81 and 14th Street:

- Minimal stacking is provided for back-to-back left-turn lanes along US Highway 81 between the 13th Street and 14th Street intersections.
- The potential change in the one-way pairs should be evaluated as part of the transportation model.
- Consider improving geometrics at each intersection by removing free right-turn lanes.

US Highway 81 and Menards Drive/21st Street:

- Lane alignment could be improved in the east/west approaches of Menards Drive and 21st Street.
- The west leg of the Menards Drive should be channelized with raised median to improve operations and circulation into the parking lot.

38th Street Corridor from 48th Avenue to 18th Avenue:

- Consider raising speed limit to 40 mph on 38th Street from 30th Avenue to 36th Avenue based on review with City staff and area residents.

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APPENDIX B

Travel Demand Model Documentation

CITY OF COLUMBUS

TRAVEL DEMAND MODEL DOCUMENTATION

MARCH 2004

Prepared by Lima & Associates

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INTRODUCTION

The purpose of this report is to document the development and validation of the transportation model for the City of Columbus, Nebraska. The model was developed using the TransCAD transportation forecasting microcomputer software and was calibrated using the year 2001 transportation network and estimated 2001 socioeconomic data. This model was developed with the most recent release of TransCAD version 4.5. Figure 1 displays the model study area.

This section presents a brief description of the overall transportation demand modeling process: trip generation, trip distribution, trip assignment, and model calibration. The next section describes the development of the roadway network. Trip generation and trip distribution are discussed in detail in the third section. The fourth section describes the assignment of vehicle trips, and the final section presents the results of the model calibration and validation. A glossary of modeling terms is also included.

TRANSPORTATION MODELING PROCESS OVERVIEW

The transportation planning model is a representation of the Columbus area's transportation facilities and the travel patterns using these facilities. The traffic model contains inventories of the existing roadway facilities and of residential and non-residential units by traffic analysis zones (TAZs).

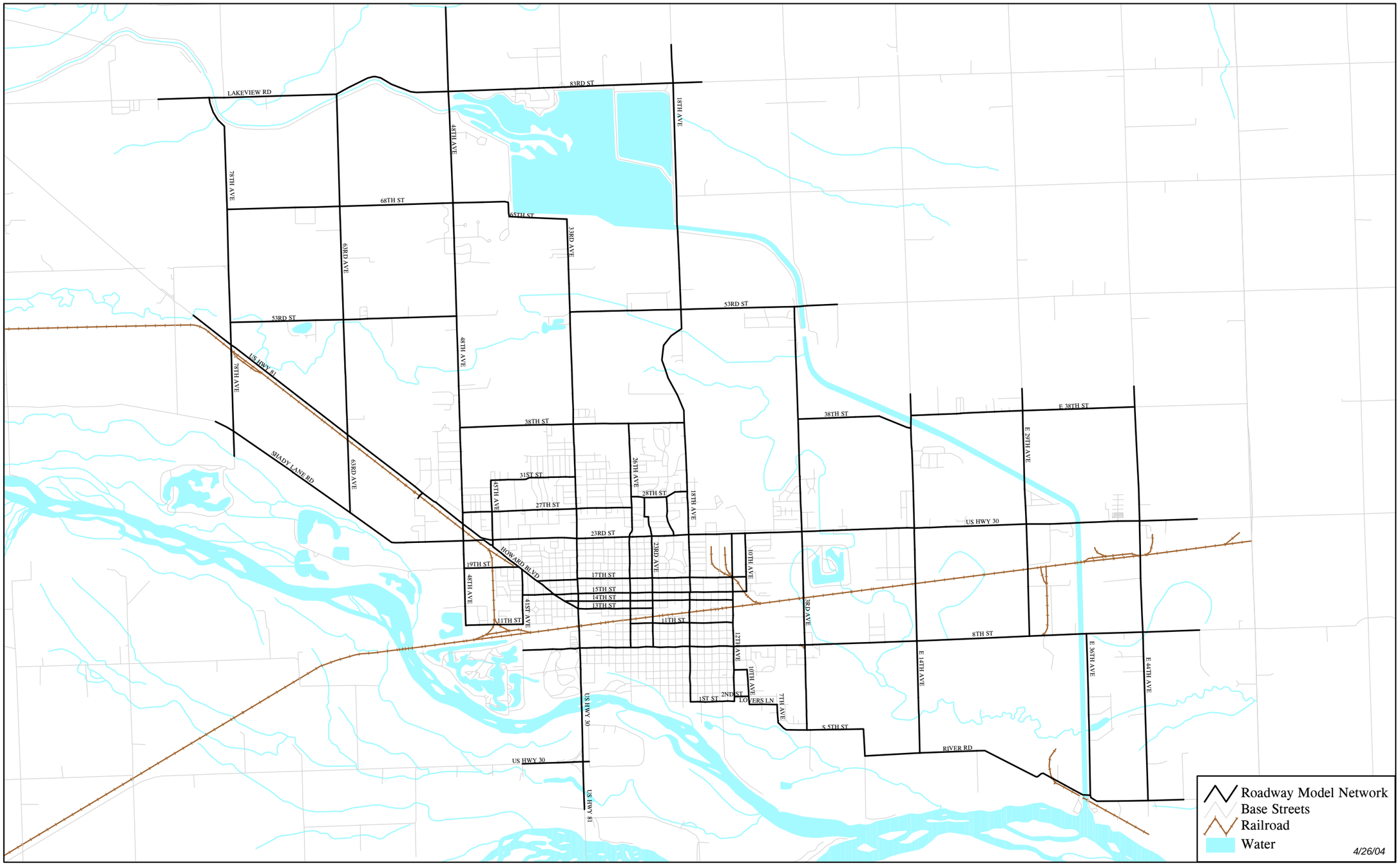
In general, the traffic model process consists of several steps including estimating the number of daily vehicle trips by TAZ from the socioeconomic inventory, distribution of vehicle trips by TAZ, and then assigning the vehicle trips to the street network. The traffic model assignments are then compared with current traffic counts. When the model matches the traffic counts within acceptable ranges of error the model can then be used to test future year scenarios. These scenarios may contain changes in numbers of housing units, employment centers, travel behavior patterns, or roadway improvements. The transportation planner or engineer, using the traffic-forecasting model can project future traffic volumes, which in turn can aid in making planning and project programming decisions.

The Columbus transportation modeling process included the following steps:

- Development of 2001 transportation roadway network
- Determination of 2001 land use data
- Trip generation - generation of vehicle trips
- Trip distribution - geographical distribution of vehicle trips between origin and destination zones
- Trip assignment - assignment of traffic volumes to specific network routes.

A brief description of each modeling step is given next.

FIGURE 1. STUDY AREA AND ROADWAY NETWORK



Transportation Model Development

Roadway Network Definition

The initial step in the travel demand modeling process was the development of the geographical roadway network comprised of nodes and links. A node is an intersection of two or more links such as an intersection of two street segments. A network link is a street segment between two nodes (A node and B node).

The 2001 Columbus TransCAD model network was created using the street center line that is available as part of the TransCAD software. The street center line file is comprised of a roadway network, however, no associated transportation data such as number of lanes, speeds, etc is included. Subsequently, the study team collected the necessary data in order to develop the model network parameters. The TransCAD model network database includes but is not limited to the following information:

- Roadway Functional Classification
- Link Distance
- Speed
- Daily Link Capacity
- Daily Traffic Volume (ground counts)
- Link Number of Lanes

As part of the model network development, streets classified as collector streets or higher were used to identify which streets to be included in the model. The model also included local streets and unpaved roads when necessary to "load" traffic to the model network. The street classifications are based on the National Functional Classification obtained from Nebraska Department of Roads (NDOR) for the City of Columbus and Platte County. Figure 2 illustrates the defined network based on the roadways' functional classification.

Land Use Data

Land use was developed for different categories and allocated to TAZs. The TAZs are generally bounded by either the roadway network or another geographic boundary. Within the model network, a TAZ is defined by a node called a centroid. For transportation modeling, it is assumed that all trips within a TAZ begin and end at the zone centroid. Each TAZ centroid is connected to a roadway link by centroid connectors, which represent the local streets feeding traffic to the major streets.

The Columbus model consisted of two zone types: internal and external. Internal zones were those zones central to the study area, and external zones were placed along roadways entering and leaving the Columbus model area.

The TAZs developed for the 2001 study were created using boundaries such as the roadway network, rail road, and water features. The TAZ boundary extends beyond the City limits to include possible growth beyond this area in the future. The transportation model and TAZ structure is roughly bounded by 83rd Street to the north, East 44th Avenue to the east, the Loup and Platte Rivers to the south, and West 78th Avenue to the west.

FIGURE 2. 2001 ROADWAY NETWORK FUNCTIONAL CLASSIFICATION

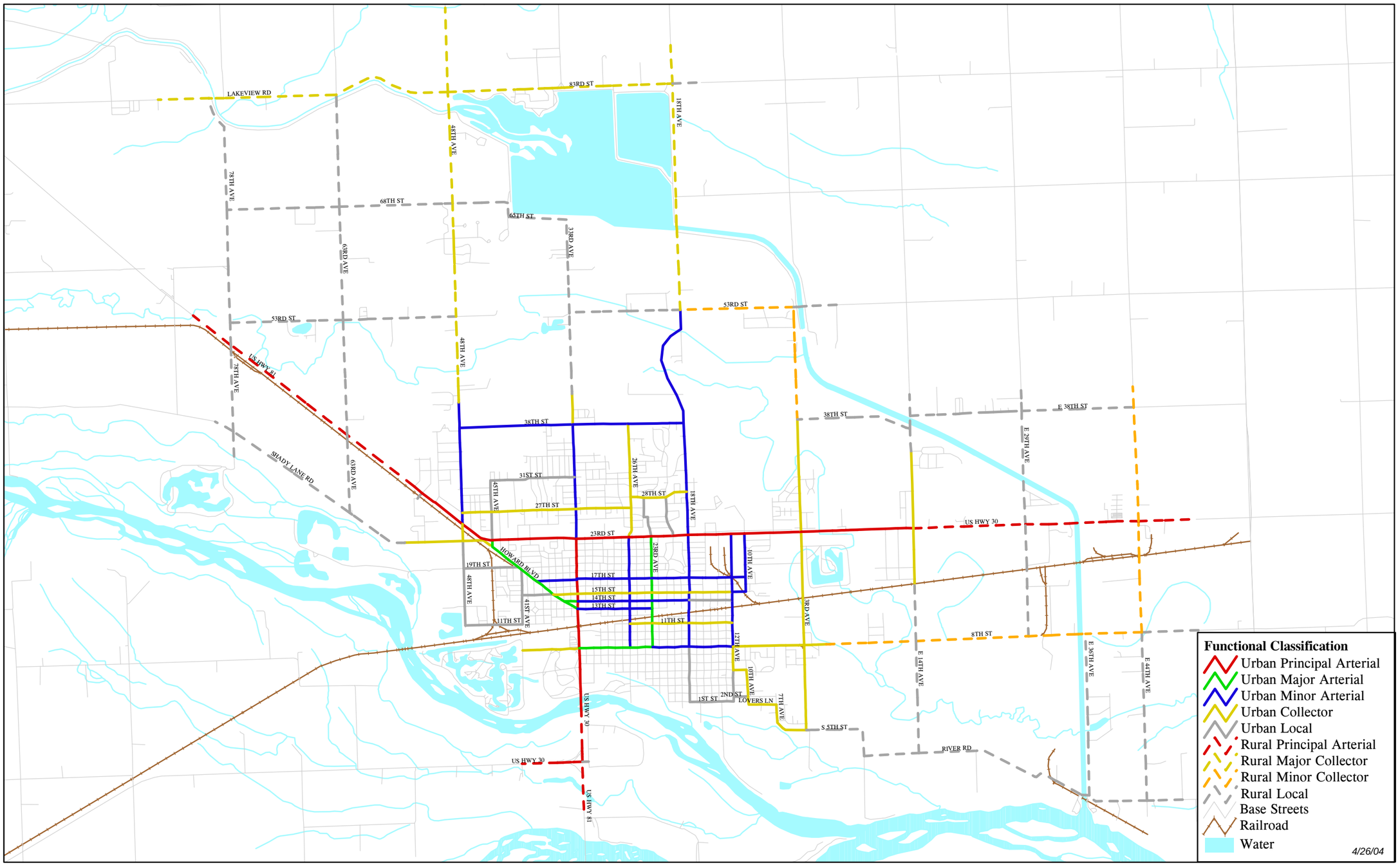


Figure 3 shows the TAZ boundaries developed for this study. There are a total of 171 zones with the internals numbered from 1 to 156 and external zones numbered from 157 to 171. Several “extra” internal zones were created to allow for possible division of zones for future use. These “extra” zones are numbered from 145 to 156.

The estimated 2001 study area demographic data was developed using the 2000 Census data and collected by the study team for each TAZ. The socioeconomic data was also summarized by TAZ and by land use classifications. The socioeconomic classifications consisted of 13 separate categories.

Trip Generation

The final product of the trip generation phase is the total number of trips produced within and/or attracted to each TAZ. A trip is defined as a one-way trip between an origin and a destination.

The number of trips generated by a TAZ is a function of the residential and/or commercial land use characteristics. Residential land uses are generally referred to as "producers" of trips, commercial land uses are generally referred to as "attractors" of trips. Residential trip production is a function of the number of dwelling units. Commercial trip attraction is a function of non-residential employment data.

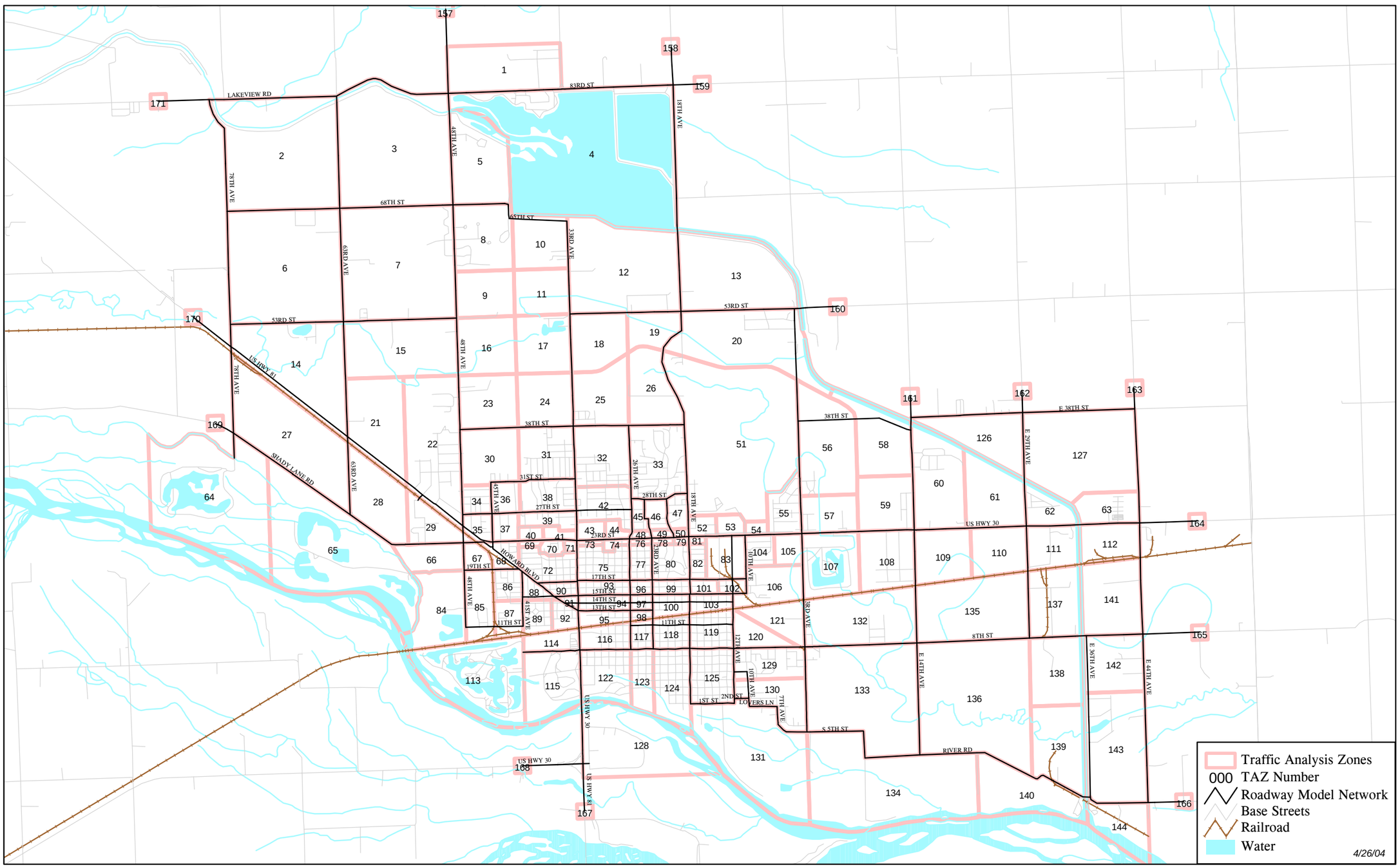
Trip Distribution

The final product of the trip distribution phase is a vehicle trip table specifying the number of vehicle trips that travel among all the TAZs. Trip tables are estimated for each of the trip purposes. The distribution of trips between TAZs (for example, zone I and zone J) are a function of the following variables:

- The number of trips produced in zone I
- The number of trips attracted to zone J
- The travel time between zone I and zone J
- The magnitude of the total "attractiveness" of all the zones in the network

The number of trips traveling between zone I and zone J are directly proportional to the total number of trips generated in zone I and the total number of trips attracted to zone J. For example, the total number of trips traveling between zones I and J increase as the number of residential trips increases in zone I. The number of trips between zones I and J are inversely proportional to the travel time between the two zones. The number of trips traveling between the two zones decreases as the travel time increases between the zones.

FIGURE 3. TRAFFIC ANALYSIS ZONES



Traffic Assignment

The traffic assignment phase allocates the trips to one specific network route based on the travel times between the various zones. The traffic assignment process includes the following:

- Computation of the minimum time paths between the TAZs based on free flow link speeds (i.e., posted speed limits)
- Initial assignment of the trips to the links which lie on the minimum time paths between the TAZs
- Computation of volume-to-capacity (v/c) ratios on the links after initial assignment
- Computation of travel times on the links as a function of the v/c ratio
- Reiteration of the assignment process until the traffic volumes on the links replicate the traffic ground counts

The final product of the traffic assignment process is the traffic volumes on each link in the network.

Model Calibration

The transportation model was calibrated and validated using the transportation network, socioeconomic estimates, and traffic counts for the year 2001.

The series of calibration simulation runs involves the review of the assumptions used to construct the model. In the distribution portion of the simulation, the exponents to the distance function of the gravity model were examined. During the assignment portion of the simulation, the assumptions for link speeds, capacities, and delay parameters were studied. Between each run, different parameters were evaluated and necessary adjustments made so that the desired results (i.e., calibration) were reached. Before any adjustments to the Columbus model parameters were made, they were justified either through the collected travel pattern data, local knowledge of travel conditions, or by empirical knowledge of the study team. The model validation included review of several performance measures such as percent assignment error, root mean square error (RMSE), and screenline analysis.

ROADWAY NETWORK

The primary goal of this transportation planning model is to simulate the daily travel on the roadway network in the Columbus area. In order for this simulation to be effective, it was important to obtain all transportation related data for that period to create a "snapshot" of time. The simulation was to replicate a typical year 2001 weekday.

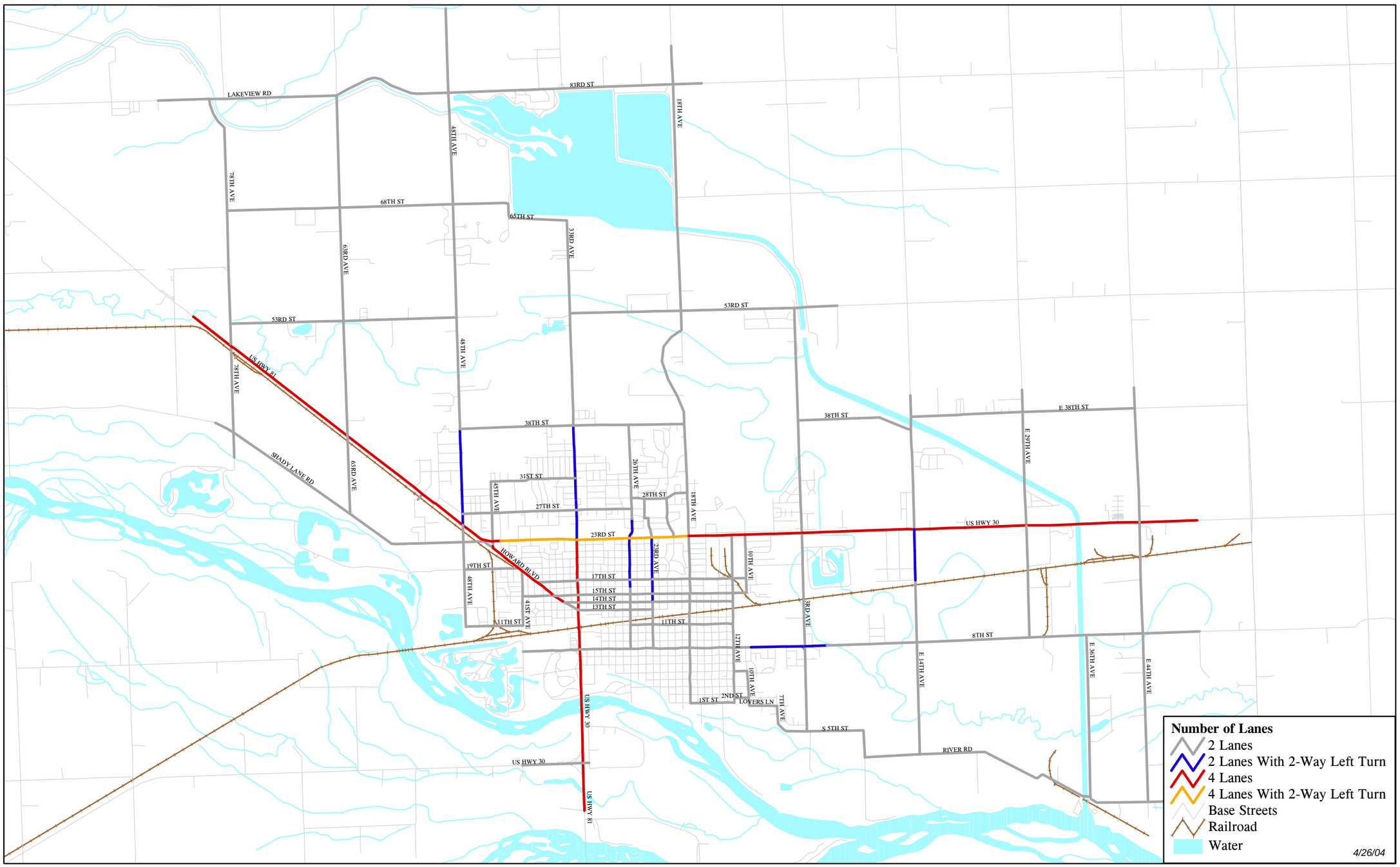
In coordination with the City of Columbus, the link attributes were populated in the network database, as shown in Table 1. Figure 4 illustrates the 2001 roadway network for the study area with the corresponding number of lanes.

TABLE 1. TRANSCAD LINK ATTRIBUTES

TransCAD Field	Network Link Attribute
Length	Link Distance (00.00 miles)
Dir	0 = Two-way Directional Link 1 or -1 = One-way Directional Link
AdjLength	Adjusted Link Distance for Centroid Connectors (00.00 miles)
StreetName	Street Name
Network	0 = Non Model Network 1 = Model Network 2 = Centroid Connector 3 = Future Roadway Network
FunClass	Roadway Functional Classification (see Table 2)
_Lanes	Number of Directional Through Lanes
CLane	0 = No Center Two-way Left Turn Lane (TWLTL) 1 = TWLTL
_Speed	Directional Free Flow Speed (mph)
AreaType	1 = Rural 2 = Urban 3 = Central Business District (CBD) or Outlying Business District (OBD)
CountsXX	Daily Traffic Counts
_Parking	0 = No Parking 1 = On-Street Parking
Surface	0 = Unpaved 1 = Paved
_CapID	Used in determining Daily Capacity (FunClass & AreaType)
_Capacity	Directional Daily Capacity
_TravelTime	Directional Travel Time
Alpha	Volume Delay Function

Note: "_" represents directional AB and BA link attributes

FIGURE 4. 2001 ROADWAY NETWORK WITH NUMBER OF LANES



Roadway Link Capacity

Capacity is expressed in terms of vehicles per day for each link by direction. Due to the number of links contained in the Columbus model, it was not possible to complete individual capacity analyses on each link to find suitable capacities. Therefore, a global link capacity system was used which was based on functional classification, area type, and on-street parking. The capacities were based on *Highway Network Capacity Development Methodology,* Clark County Regional Transportation Commission, June 26, 1998, and also on the *Highway Capacity Manual*, Transportation Research Board, 2000.

The capacities are used for both model operation and network analysis. In the context of model operation, the capacities are used in conjunction with link speeds, link lengths, and link delay functions to derive a realistic travel speed to be used in the distribution of travel and the derivation of appropriate travel routes. In the context of network analysis, the capacities are used to identify deficiencies and recommend improvements. In both cases, it is desired that the capacities used in the model be as accurate and realistic as possible. Table 2 represents the capacities used for the model.

TABLE 2. ROADWAY LINK CAPACITIES

Model Identification Number	National Functional Classification Code[1]	Roadway Functional Classification	Directional Daily Lane Capacity (Level of Service E) by Area Type	
			Urban/Rural	CBD or OBD
1	14	Urban Principal Arterial	11,500	10,500
2	15	Urban Major Arterial	11,500	10,500
3	16	Urban Minor Arterial	8,400	7,900
4	17	Urban Collector	6,700	6,200
5	19	Urban Local	3,350	3,100
6	02	Rural Principal Arterial	12,000	-
7	06	Rural Minor Arterial	12,000	-
8	07	Rural Major Collector	9,000	-
9	08	Rural Minor Collector	7,000	-
10	09	Rural Local	3,500	-

[1] National Functional Classification, NDOR, November 5, 1999
CDB = Central Business District. OBD = Outlying Business District
Note: Unpaved roads have directional daily capacities of 200. Roadway facilities with on-street parking were reduced in capacity by 10% per direction.

Turn Prohibitors and Penalties

In order to accurately reflect travel behavior for the study area, turn prohibitors and penalties were used in the model. Turn prohibitors are typically used where specific turning movements are not allowed or are physically restrained. Turn penalties are added delay for a specific movement due to unique intersection operations and driver behavior. In the Columbus model, both of these network characteristics were applied.

Turn prohibitors were assigned to locations where specific movements could not occur. One example of this is for the restricted left turns at 17th Street and 33rd Avenue. In locations where one-ways are coded within the model, TransCAD automatically prohibits travel in the opposite direction of a one-way. Therefore, turn prohibitors are not required at these intersections.

As part of the model calibration process, the at-grade rail crossings were reviewed to evaluate the impacts of travel routing through the transportation model. The previous report *City of Columbus Transportation Study*, dated April 1997, by HDR Incorporated was reviewed for the impacts of the rail crossings.

Utilizing the gate-down survey, initial delays were developed and tested during the model calibration. It was determined that adding minor additional delay at the rail crossings in the model produced unrealistic routing of the traffic flows. Although the rail crossings do have an impact on the traffic flows for short periods of time, over a 24-hour period, which the model is based on, the delays are minor. This is confirmed in the *Columbus Transportation Study* as noted:

> *The impact of the gate operation on vehicular traffic operations was also observed. In general, few vehicles approached the crossing and stopped. In fact, a total of 83 vehicles stopped during the 24-hour period which represents an average of less than two vehicles per gate operation...Finally, pedestrians were observed to be waiting during the gate operation on only two occasions. These observations seem to indicate that train operations are generally not a detriment to traffic flow.*

Subsequently, the rail delays were not incorporated in the model and the resulting traffic routing appears to represent existing traffic operations.

Volume Delay Function

Travel time on each individual link typically increases as the traffic volume on the link approaches capacity. The amount of travel time increase depends on the functional classification of the link as well as the region and the behavior of the drivers using that link. TransCAD offers the ability to update travel times iteratively based on link performance functions, which are mathematical descriptions of the relationships between travel time and v/c ratio.

The conical volume-delay function incorporated in TransCAD was used in the development of the Columbus model. The equation is as follows:

$$f(x) = 2 + \sqrt{a^2(1-x)^2 + b^2} - a(1-x) - b$$

where: $b = \frac{2a - 1}{2a - 2}$, x = V/C, and α is a constant larger than 1

During calibration analysis, link operating speeds were reviewed. This analysis was used in comparison with collected operating speeds to adjust the volume delay function. The final values used in the model calibration are shown in Table 3.

TABLE 3. VOLUME DELAY FUNCTION PARAMETERS

Model Identification Number	Roadway Functional Classification	a
1	Urban Principal Arterial	6
2	Urban Major Arterial	6
3	Urban Minor Arterial	6
4	Urban Collector	6
5	Urban Local	3
6	Rural Principal Arterial	6
7	Rural Minor Arterial	6
8	Rural Major Collector	6
9	Rural Minor Collector	6
10	Rural Local	3

TRIP GENERATION AND TRIP DISTRIBUTION

TRIP GENERATION

Trip generation for the Columbus travel demand model was accomplished using a trip rate model. Vehicle trips were generated based on socioeconomic variables, such as the number of dwelling units and a daily trip generation rate for each socioeconomic variable. Initial vehicle trip rates were obtained from the report *Trip Generation*, Institute of Transportation Engineers, 6th Edition, 1997. Trip productions for internal residential trips were estimated using a daily trip rate per dwelling unit. Trip attractions for the internal commercial land uses were estimated using a trip rate per unit (square feet, students, hospital beds, etc.). Table 4 gives the trip generation characteristics for the various land-use categories used in the trip generation analysis.

As can be seen from Table 4, trips rates applied in the model are generally comparable to ITE *Trip Generation* rates. Differences between these rates can be attributed due to local variation.

As part of the models' trip generation estimates, most transportation planning models are stratified by multiple trip purposes. For the Columbus model, trips were estimated based on three trip purposes:

- Home-Based Work (HBW)
- Home-Based Other (HBO)
- Non-Home-Based (NHB)

When the gravity model is applied to the productions and attractions, different trip purposes allow for different travel characteristics. For example, the home-based work trip, which has a trip end at the home location, is different than a non-home based trip, which represents a work to shopping trip end. Typically, home-based work trips have longer trip lengths than home-based other or non-home-based work.

TRIP DISTRIBUTION

The purpose of trip distribution is to produce a trip table of the estimated number of trips from each TAZ to every other TAZ within the study area. Vehicle trip distribution for this study was estimated using the TransCAD Gravity Model program. The Gravity Model assumes that the number of trips between two zones is 1) directly proportional to the vehicle trips produced and attracted to both zones, and 2) inversely proportional to the travel time between the zones.

TABLE 4. TRIP GENERATION RATES

Model ID	Socioeconomic Description	Socioeconomic Type	Units	Model Daily Rate	ITE Daily Rate
1	Residential	Single Family	DU	9.57	9.57
2	Residential	Multi Family	DU	6.63	6.63
3	School	Elementary/Jr. High	Students	1.22	1.02
4	School	Sr. High	Students	1.79	1.79
5	School	College	Students	1.54	1.54
6	Commercial/Retail	Major Shopping Center	Employees	26.50	28.40
7	Commercial/Retail	Commercial/Retail	Employees	38.18	38.18
8	Commercial/Retail	Hotel/Motel	Rooms	8.92	8.92
9	Office	Office	Employees	4.50	3.32
10	Medical	Hospital	Employees	5.17	5.17
11	Medical	Medical Office	Employees	8.91	8.91
12	Ind/Man/Ware/Util	Warehousing	Employees	3.98	3.89
13	Ind/Man/Ware/Util	Industrial/Manufacturing	Employees	4.90	4.50

The Gravity Model formulation states that the number of trips between each zone is equal to:

$$T_{ij} = \frac{P_i \, A_j \, F_{ij}}{\sum (A_j \, F_{ij})}$$

where:

T_{ij} = number of trips between zone i and zone j
P_i = number of trips produced in zone i
A_j = number of trips attracted to zone j
F_{ij} = an empirically derived friction factor which is a function of the travel time between zone i and zone j

Friction factors express the effect that travel time has on the number of trips traveling between two zones. Vehicle trips were distributed for the three trip purposes.

The number of vehicles were calculated using the base year land use data and trip generation rates by trip purpose. Data from the external traffic zones were combined with the internal zone trips to create the total productions and attractions for the model. The productions and attractions were balanced to ensure that for each production generated by the model there was an attraction. Table 5 gives a summary of the vehicle trip productions and attractions by trip purpose for the whole study area.

TABLE 5. 2001 VEHICLE TRIP SUMMARY

Trip Purpose	Total Trips	Percent Trips
Home-Based Work	32,287	22.3%
Home-Based Other	72,694	50.2%
Non Home-Based	39,781	27.5%
Total Trips	**144,762**	**100%**

The percent of trips by trip purpose appear reasonable as compared to the report *Travel Estimation Techniques for Urban Planning,* NCHRP Report 365, 1998. Similarly with variation of trip generation rates, the breakdown of trip purpose is a function of the local travel behavior of the Columbus area.

The friction factors were created using the following gamma function:

$$F(c_{ij}) = ac_{ij}^{-b} e^{-c(c_{ij})}$$

where the parameters a, b, and c were initially used from the report *Travel Estimation Techniques for Urban Planning*. However, these parameters can vary by model size and local travel behavior. During the model calibration process, these values were further evaluated and checked for reasonability based on screenline and traffic count error analysis. The final values used are displayed in Table 6.

TABLE 6. TRAVEL ESTIMATION TECHNIQUES FOR URBAN PLANNING GAMMA FUNCTION PARAMETERS

Trip Purpose	a	B	C
HBW	28,507	-2.9	0.60
HBO	139,173	-2.5	0.95
NHB	219,113	-2.7	1.00

VEHICLE TRIP ASSIGNMENT

The purpose of trip assignment is to assign vehicle trips to specific paths, or routes, in the transportation network. Trip assignment is a function of 1) the shortest travel time along paths between zones, and 2) the level of congestion of the links within those paths. Vehicle trips for the study area were assigned to the transportation network using the TransCAD Stochastic User Equilibrium Assignment Algorithm.

TransCAD provides several other traffic assignment methods. The User Equilibrium (UE) is a commonly used assignment method that is widely used in regional models. The UE uses an iterative process to achieve a convergence in which no travelers can improve their travel times by shifting routes. However, with the Stochastic User Equilibrium (SUE) method, assignments produce more realistic results from the UE method since SUE permits use of less attractive as well as the most attractive routes. Less attractive routes will have lower utilization, but will not have zero flow as they do under the UE method.

The SUE assignment reads in the vehicle origin-destination trip table and the roadway network and assigns the vehicle trip table to the network based on the modified equilibrium assignment method. The SUE assignment is premised on the assumption that travelers have imperfect information about the network paths and/or vary in their perceptions of network attributes. Equilibrium occurs when a trip in the system cannot be made by an alternate path without increasing the total travel time of all trips in the network.

The assignment process assigns both internal and external vehicle trips to the network. Internal vehicle trips are those trips with either an origin or a destination inside the study area. The gravity model described in the previous section produces an internal vehicle trip table. However, vehicle trips through the study area must also be assigned to the network. External-to-external trips are through trips, those with both an origin and destination outside of the study area.

The external-external vehicle trip table was developed using the previous origin and destination study documented in the *Columbus Transportation Plan*. The 1997 origin and destination study was used as a basis in apportioning to reflect 2001 conditions based on traffic count data.

The internal vehicle trip table is then added to the external trip table to give a total vehicle origin-destination table. This origin-destination table is then assigned to the regional network.

For this study, external TAZs are located at the following locations:

Zone 157 – 48th Avenue (North)
Zone 158 – 18th Avenue (North)
Zone 159 – 83rd Street (East)
Zone 160 – 53rd Street (East)
Zone 161 – E 14th Avenue (North)
Zone 162 – E 29th Avenue (North)
Zone 163 – E 44th Avenue (North)
Zone 164 – US Highway 30 (East)
Zone 165 – E 8th Street (East)
Zone 166 – SE 16th Street (East)
Zone 167 – US Highway 81 (South)
Zone 168 – US Highway 30 (West)
Zone 169 – Shady Lane Road (West)
Zone 170 – US Highway 81 (West)
Zone 171 – 83rd Street (West)

MODEL CALIBRATION/VALIDATION

Calibration is an iterative process — upgrading or adjusting entered data, program coefficients or parameters, and assumptions on successive simulation runs, until the volumes and traffic patterns produced by the model approximate known traffic counts within acceptable limits.

One source that was utilized for acceptable limits is the report *Calibration and Adjustment of System Planning Models,* Federal Highway Administration, December 1990. The primary premise behind these guidelines is that simulated model data should not significantly differ from actual count data to cause inappropriate under- or over-design of roadway facilities. However, the percent difference between modeled volumes and actual counts may be large, but is only significant in relation to its functional classification and the magnitude of the volume itself. The following performance measures were reviewed:

- Percent assignment error
- Root Mean Square error
- Coefficient of Determination; R^2
- Screenline Analysis

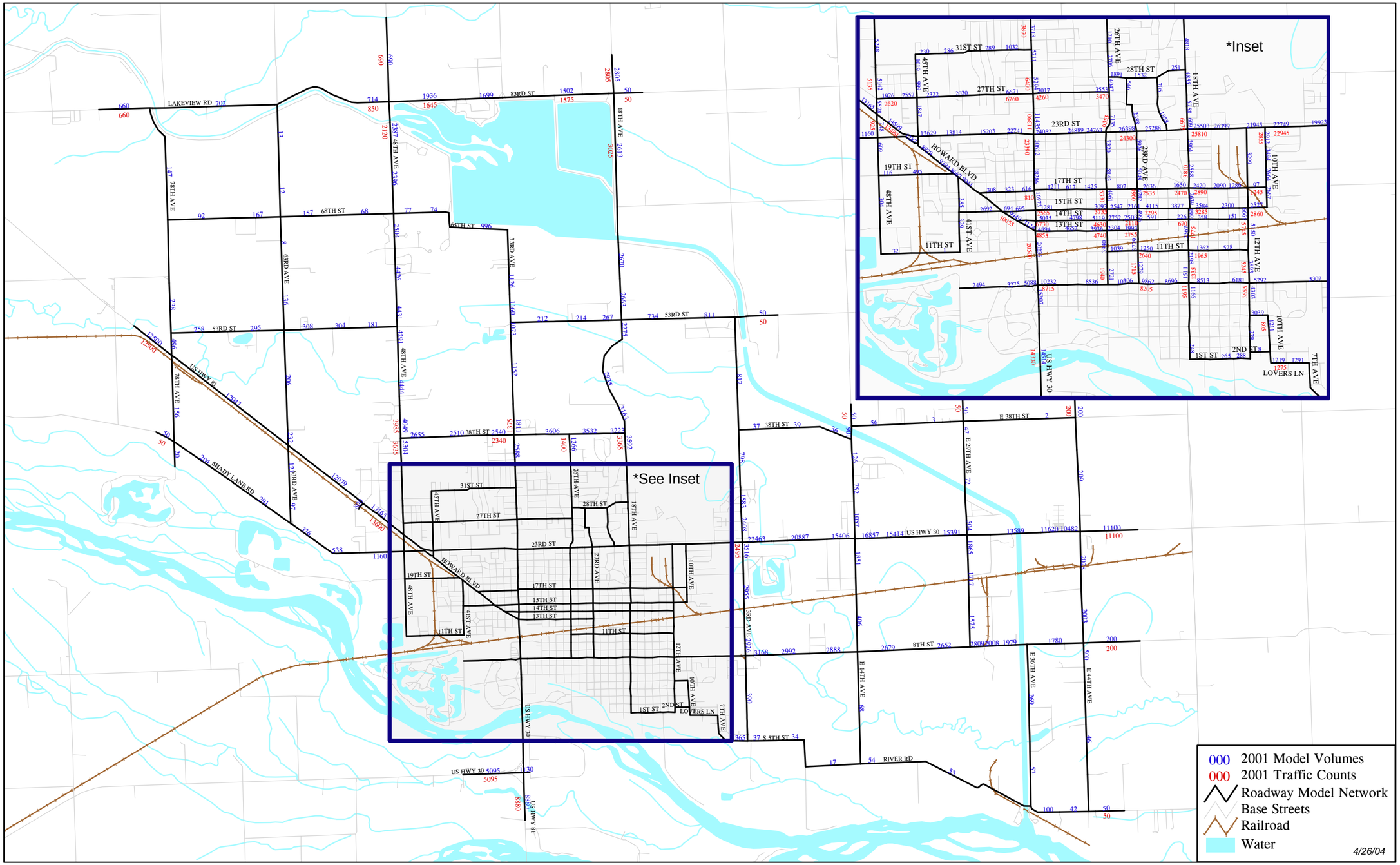
The assigned 2001 daily traffic volumes were compared with the counted daily traffic volumes for individual links. The comparison indicated the following: 1) the computed vehicle miles traveled (VMT) in the study area are approximately 379,665 per day, 2) the estimated vehicle hours traveled (VHT) in the study area are approximately 11,325 per day, and 3) the average daily speed on the network equated to approximately 33.52 miles per hour. The VMT, VHT, and computed average daily speed does not include the centroid connectors. The resulting traffic assignments volumes for the year 2001 are shown in Figure 5.

Percent Error of Traffic Assignment

The percent error of traffic assignment indicates the accuracy with which the transportation model replicates the actual traffic counts. Percent error is the difference between the assigned traffic volumes and the counted traffic volumes divided by the counted traffic volumes. Based on the report *Calibration and Adjustment of System Planning Models,* the following are suggested error limits:

- Freeways — Less than 7 percent
- Principle Arterials — Less than 10 percent
- Minor Arterials — Less than 15 percent
- Collectors — Less than 25 percent
- Frontage Roads — Less than 25 percent

FIGURE 5. 2001 MODELED TRAFFIC VOLUMES



Since the Columbus model consists of different roadway functional classification, the above classifications were regrouped in order to provide a similar comparison with the model classifications. The computed percent error absolute value is given in Table 7 along with suggested error ranges.

TABLE 7. PERCENT ASSIGNMENT ERROR

Functional Class	Percent Error	
	Computed	**Suggested Range***
Urban Principal Arterial	1.8%	<10%
Urban Major Arterial	8.4%	<15%
Urban Minor Arterial	2.3%	<15%
Urban Collector	4.3%	<25%
Urban Local	2.4%	N/A
Rural Principal Arterial	N/A	<10%
Rural Minor Arterial	0%	<15%
Rural Major Collector	0.5%	<25%
Rural Minor Collector	N/A	<25%
Rural Local	N/A	N/A
Total Network	**1.5%**	**<5%**

*Source: *Calibration and Adjustment of System Planning Models,* Federal Highway Administration, December 1990.

As the table shows, the percent error of the traffic assignment for the network as a whole was 1.5 percent, which is within the recommended five percent error, an indication of how well the model is calibrated.

Root Mean Square Error

Another measure of the model's ability to assign traffic volumes is the percent RMSE. The RMSE measures the deviation between the assigned traffic volumes and the counted traffic volumes and is given as:

$$\%\ \text{RMSE} = \frac{100 * \sqrt{\dfrac{\sum_j (Model_j - Count_j)^2}{(Number\ of\ Counts - 1)}}}{\left(\dfrac{\sum_j Count_j}{Number\ of\ Counts}\right)}$$

A large percent RMSE indicates a large deviation between the assigned and counted traffic volumes; whereas, a small percent RMSE indicates a small deviation between the assigned and counted traffic volumes. The percent RMSE by facility type is given in Table 8.

TABLE 8. PERCENT ROOT MEAN SQUARE ERROR

Functional Class	Percent RMSE
Urban Principal Arterial	7.25%
Urban Major Arterials	19.24%
Urban Minor Arterials	17.65%
Urban Collector	24.55%
Urban Rural	N/A*
Rural Principal Arterial	0%
Rural Minor Arterial	13.38%
Rural Major Collector	N/A*
Rural Minor Collector	0%
Total Network	**15.34%**

* Only one count available for comparison

Currently, there are no national guidelines for model verifications of RMSE. However, common engineering practice is that a model with a RMSE of 35% and lower is representative of a good model. National regional model summary statistics for the RMSE were obtained in order to provide a comparison with the Columbus model. Of the 18 regional models obtained, the RMSE ranged from a 22% to 50% with an average of approximately 44%. The Columbus model's RMSE is less than 15.5%, which is lower than the best RMSE from other regional areas.

Coefficient of Determination

Another tool to measure the overall model accuracy is the coefficient of determination or R^2 (see formula below). The R^2, or 'goodness of fit' statistic shows how well the regression line represents the assignment data. The desirable R^2 is 0.88 or higher. A value of 1.00 is perfect, but even if traffic counts were compared against themselves, the daily variation would not allow for a regression coefficient of 1.00. The value of 0.98 achieved for the Columbus illustrates that the model validation is also very good.

$$r^2 = \left(\frac{n\sum(x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{\left[n\sum x_i^2 - \left(\sum x_i\right)^2\right]\left[n\sum y_i^2 - \left(\sum y_i\right)^2\right]}} \right)^2$$

where: x = counts
y = model volumes
n = number of counts

Screenline Analysis

A screenline is an imaginary line composed of one or more straight line segments crossing a number of network links. Screenline analysis compares the results of a trip assignment with the traffic counts on network links. More precisely, the process compares the directional sum of ground count daily traffic volumes across a screenline with the directional sum of assigned daily traffic volumes across the same screenline.

The average of ratios over all the screenlines can be also used to measure the overall accuracy of the model. The screenlines and associated volumes used in this analysis are illustrated in Table 9 and Figure 6.

At the conclusion of a simulation run, assigned volumes from the simulation run are compared against the known screenline count data. An acceptable level of error as outlined in NCHRP 255 and cited in the *Calibration and Adjustment of System Planning Models* report is presented in Figure 6. In comparing the Columbus model screenlines summary statistics with Figure 6, all screenlines are within the allowable deviation. Screenline 1, which has the greatest volume difference of 13.0%, is within approximately half of the allowable deviation as shown in Figure 7.

TABLE 9. SCREENLINE ANALYSIS

Screenline	Counted Volume	Assigned Volume	Difference	Percent Difference
1	12,270	13,880	1,610	13.0%
2	31,665	32,647	982	3.0%
3	15,580	15,048	-532	3.0%
4	28,020	27,752	-268	1.0%
5	49,437	49,753	316	1.0%
6	16,675	17,862	1187	7.0%
7	33,950	33,700	-250	0.10%
Total	**187,597**	**190,642**	**3,045**	**1.6%**

FIGURE 6. SCREENLINES

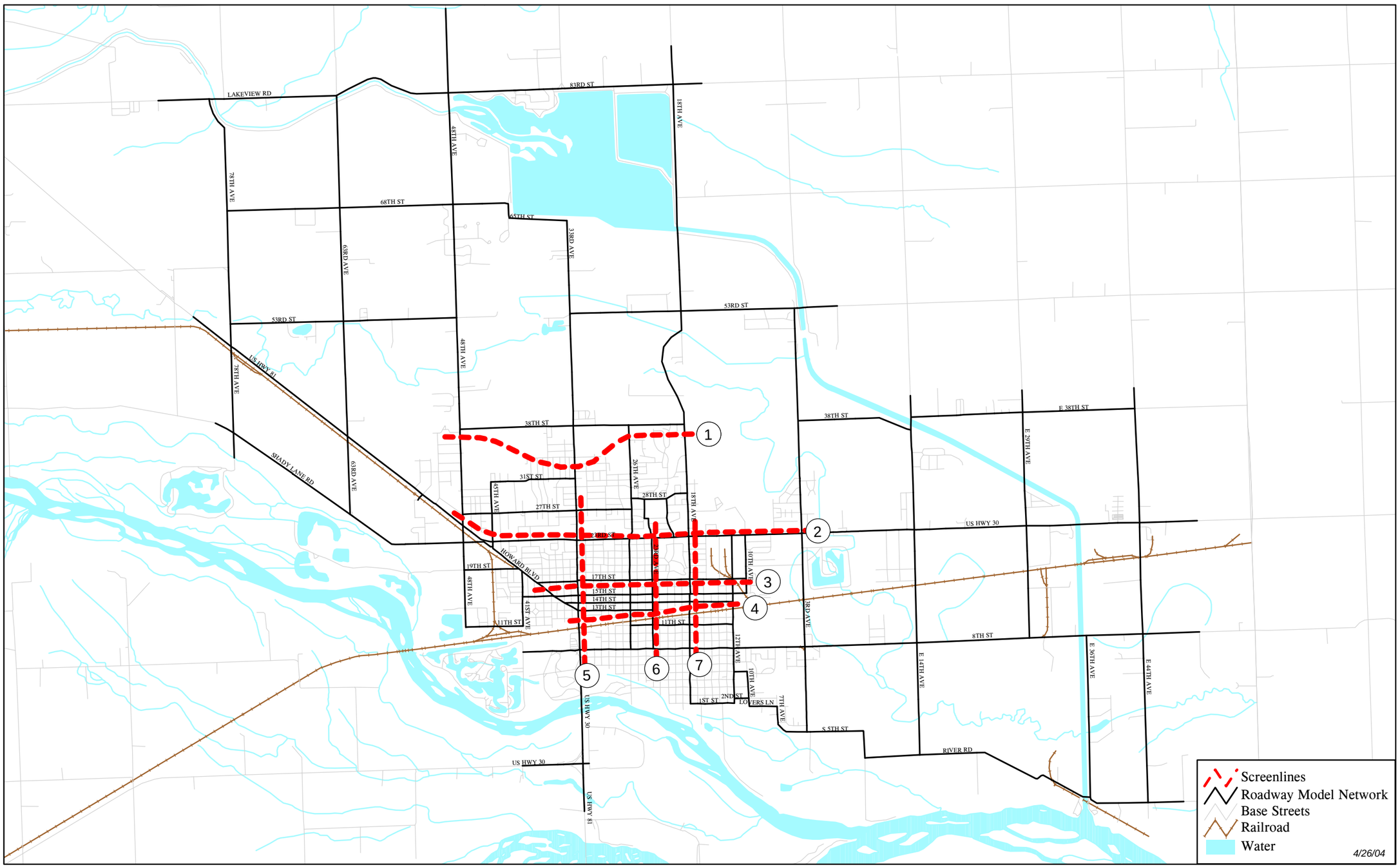
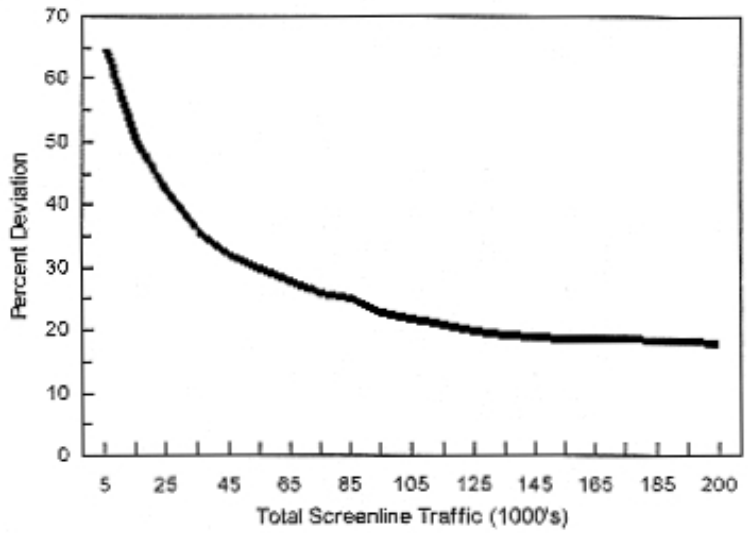


FIGURE 7. MAXIMUM DESIRABLE DEVIATION IN TOTAL SCREENLINE VOLUMES



Source: NCHRP 255 p.41 (cited in FHWA, Calibration and Adjustment of System Planning Models, Dec. 1990)

REFERENCES

1. Caliper Corporation, *Travel Demand Modeling with TransCAD Version 4.5*, 2002.

2. Federal Highway Administration, *Calibration and Adjustment of System Planning Models*, 1990.

3. Institute of Transportation Engineers, *Trip Generation, 6th Edition*, 1997.

4. Transportation Research Board, *NCHRP 365. Travel Estimation Techniques for Urban Planning*, 1998.

GLOSSARY

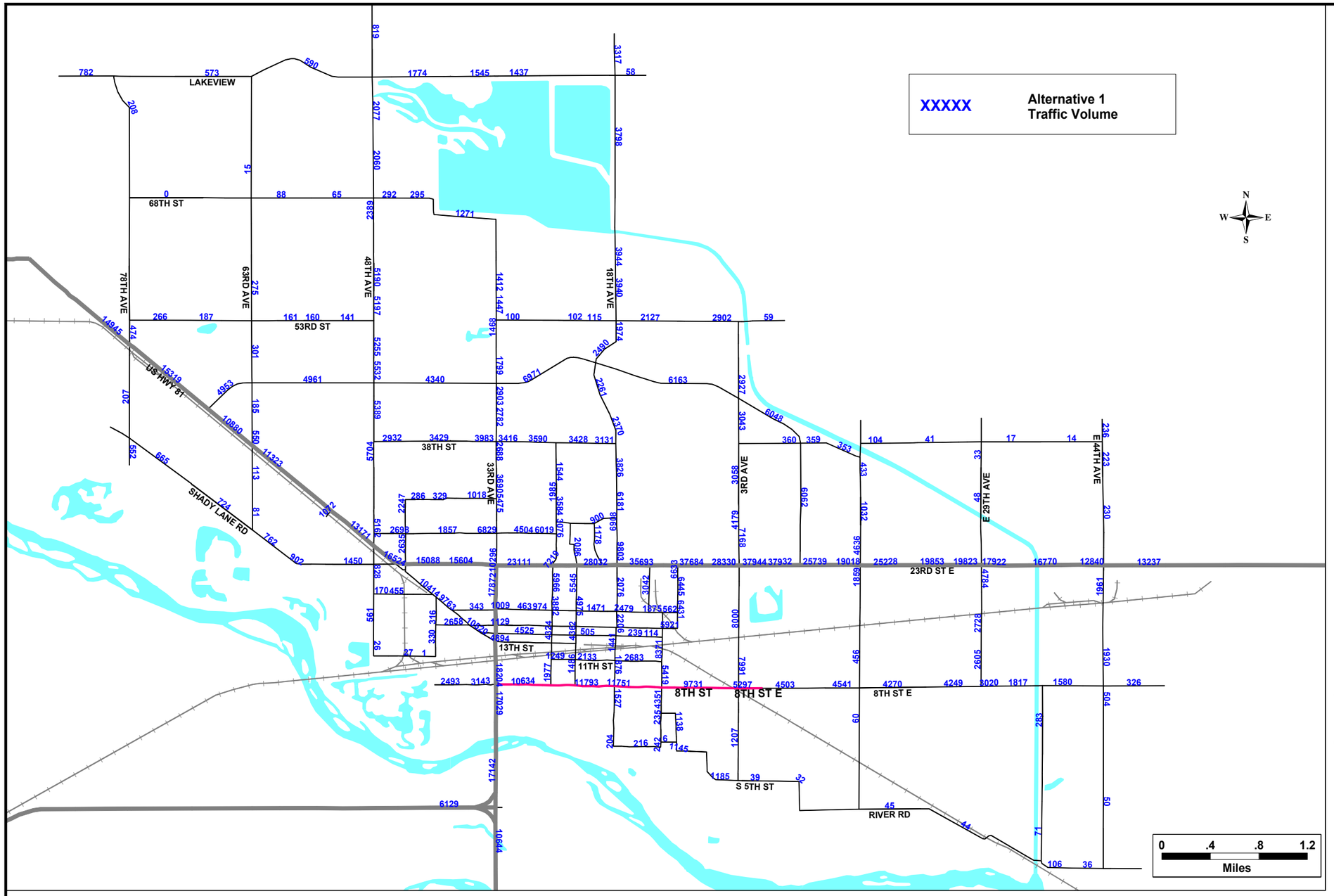
ADT:	Average Daily Traffic - average daily traffic volume as measured over a certain number of days.
Calibration:	The process of defining and adjusting model parameters until the model replicates the travel patterns exhibited in the study area.
Capacity:	The maximum number of vehicles or persons that can be carried past a point on a transportation system in a specified time.
Capacity Restraint:	The limiting of traffic movement on a link by applying a volume-to-capacity ratio (which measures congestion) based traffic assignment.
Centroid:	A representative node in the transportation network that is assumed to be the location of all trips generated to and from a zone.
Ground Count:	An actual traffic volume count.
Intra-zonal Trips:	Those trips occurring totally within a zone (TAZ).
Link:	An element in a transportation network representing a street section that connects two nodes.
Minimum Path:	The travel route between two points which yields the minimum travel time. This data is displayed in a matrix.
Network:	A system of links and nodes that describes a transportation system.
Network Coding:	The process of representing a real transportation system in terms of a network "model" used for computer processing.
Node:	A point on a highway network where links intersect, end or change direction.
Screenline	A screenline is an imaginary line of one of more line segments crossing a number of network links. Screenline analysis are used for calibration purposes.
TAZ:	Traffic Analysis Zone - a geographical area used as a basis for estimating socioeconomic variables and trip generation.

GLOSSARY (Continued)

Travel Time:	The amount of time needed to travel between two points or places.
Frequency Distribution:	A table or graphical representation that shows the percentage of total trips within each travel time increment.
Trip Assignment:	A process that assigns trips to various paths or routes in a network.
Trip Distribution:	The process that estimates the number of trips traveling between geographical zones in a transportation network.
Trip Generation:	The process that estimates the number of trips generated by the land use within each zone.
Trip Table:	A table (matrix) which illustrates the number of trips from each zone to every other zone in the study area.
Validation:	Running the calibrated model(s) with the current socioeconomic data and comparing to the ground traffic counts.
VHT:	Vehicle hours of travel - the number of vehicles on a link, generally for a daily period, multiplied by the length of the time traveled, in hours. The VHT for a study area is the sum of the VHTs for each link.
VMT:	Vehicle miles of travel - the number of vehicles on a link, generally for a daily period, multiplied by the length of the link, in miles. The VMT for a study area is the sum of the VMTs for each link.

APPENDIX C

Alternative Traffic Volume Assignments Plots



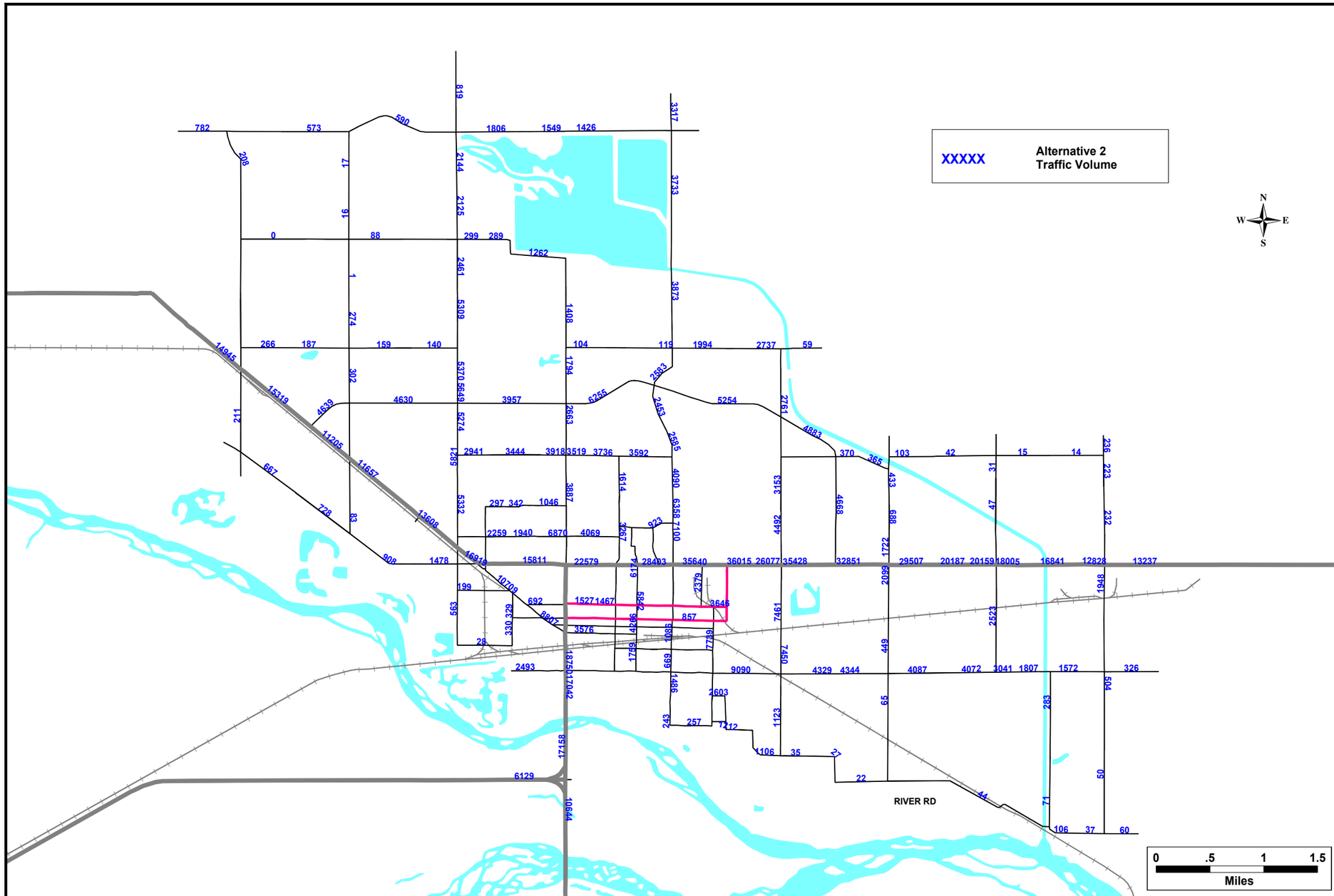
CITY OF COLUMBUS

Comprehensive Plan Update

Alternative 1 Traffic Assignment

Widening of 8th Street to
a 3-Lane roadway section

OLSSON ASSOCIATES
ENGINEERS • PLANNERS • SCIENTISTS • SURVEYORS



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Alternative 2 Traffic Assignment

15th Street & 17th Street as a One-Way Pair

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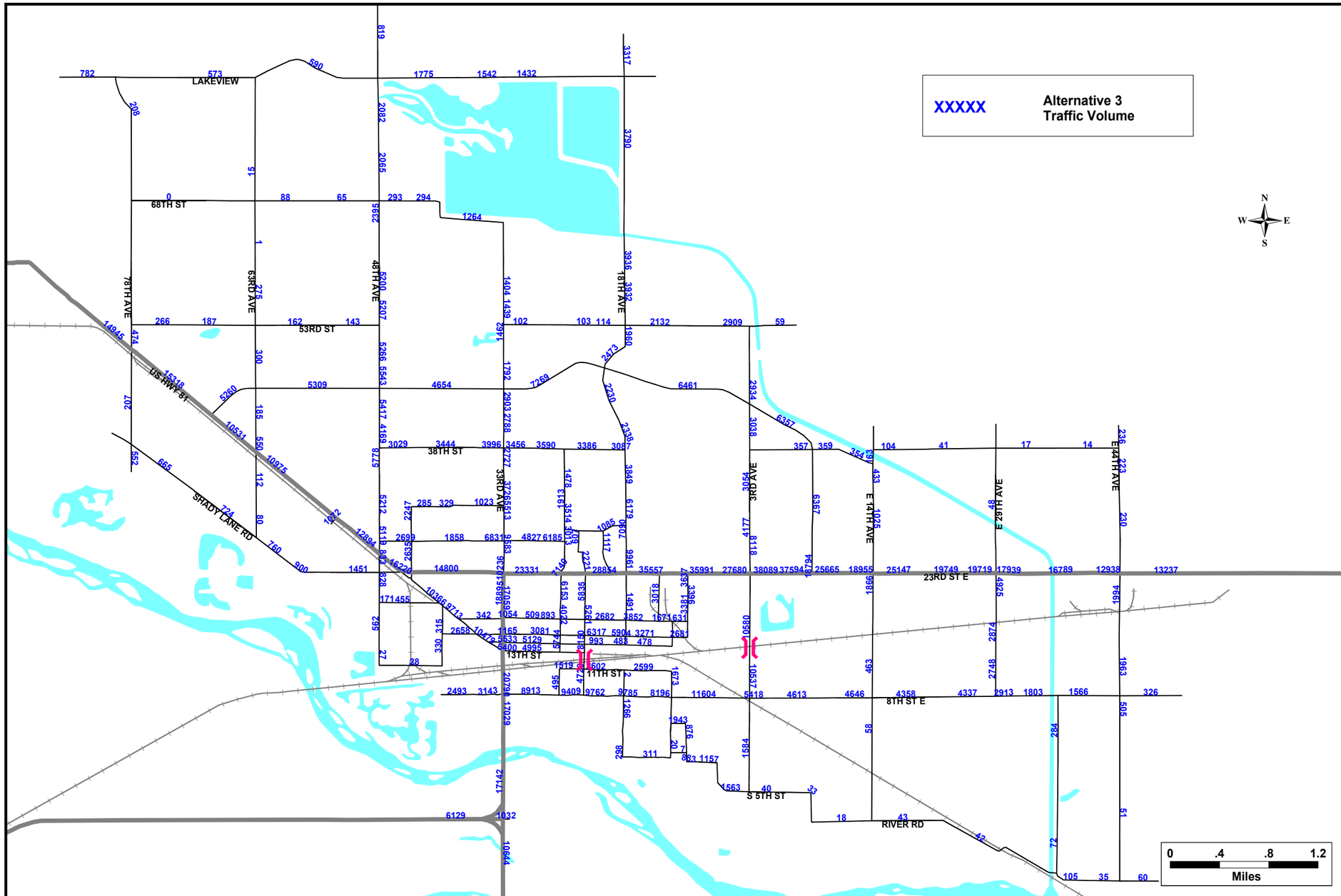

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Alternative 3 Traffic Assignment

Railroad Viaduct on 3rd Ave & 23rd Ave

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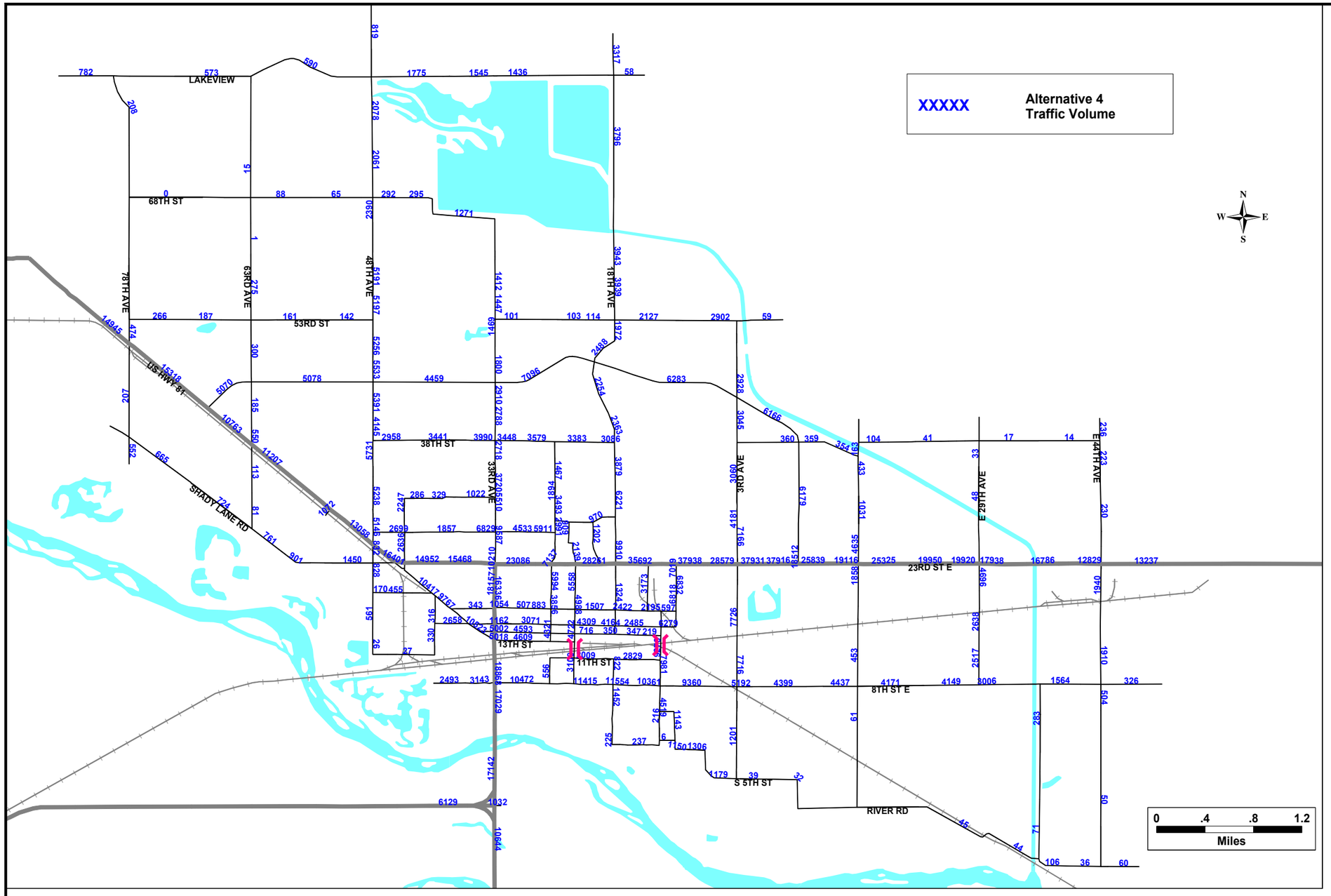

CITY OF COLUMBUS

Comprehensive Plan Update

Alternative 4 Traffic Assignment

Railroad Viaduct on 12th Ave & 23rd Ave

OLSSON ASSOCIATES
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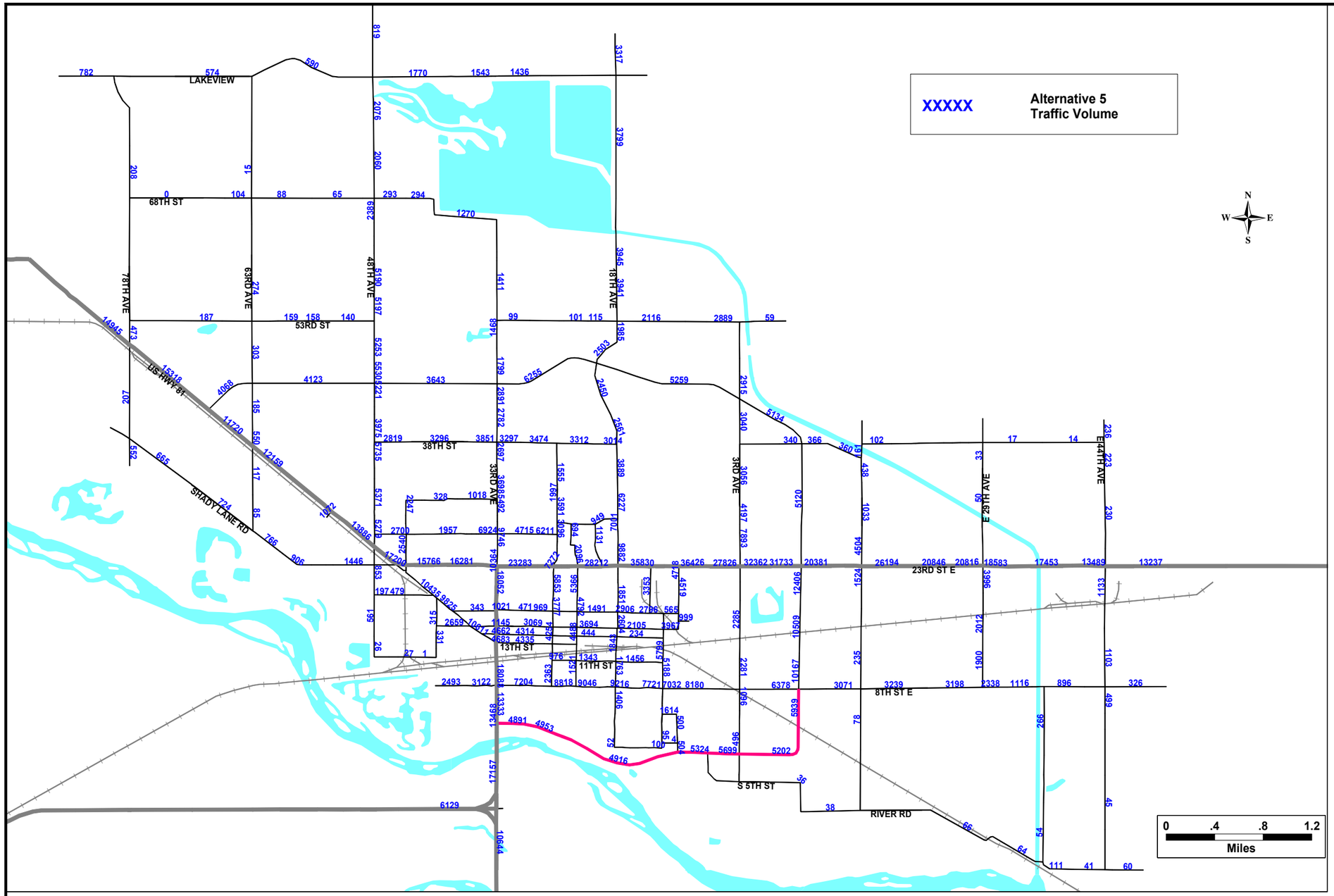

CITY OF COLUMBUS

Comprehensive Plan Update

Alternative 5 Traffic Assignment

Arterial Roadway North of the Loup River

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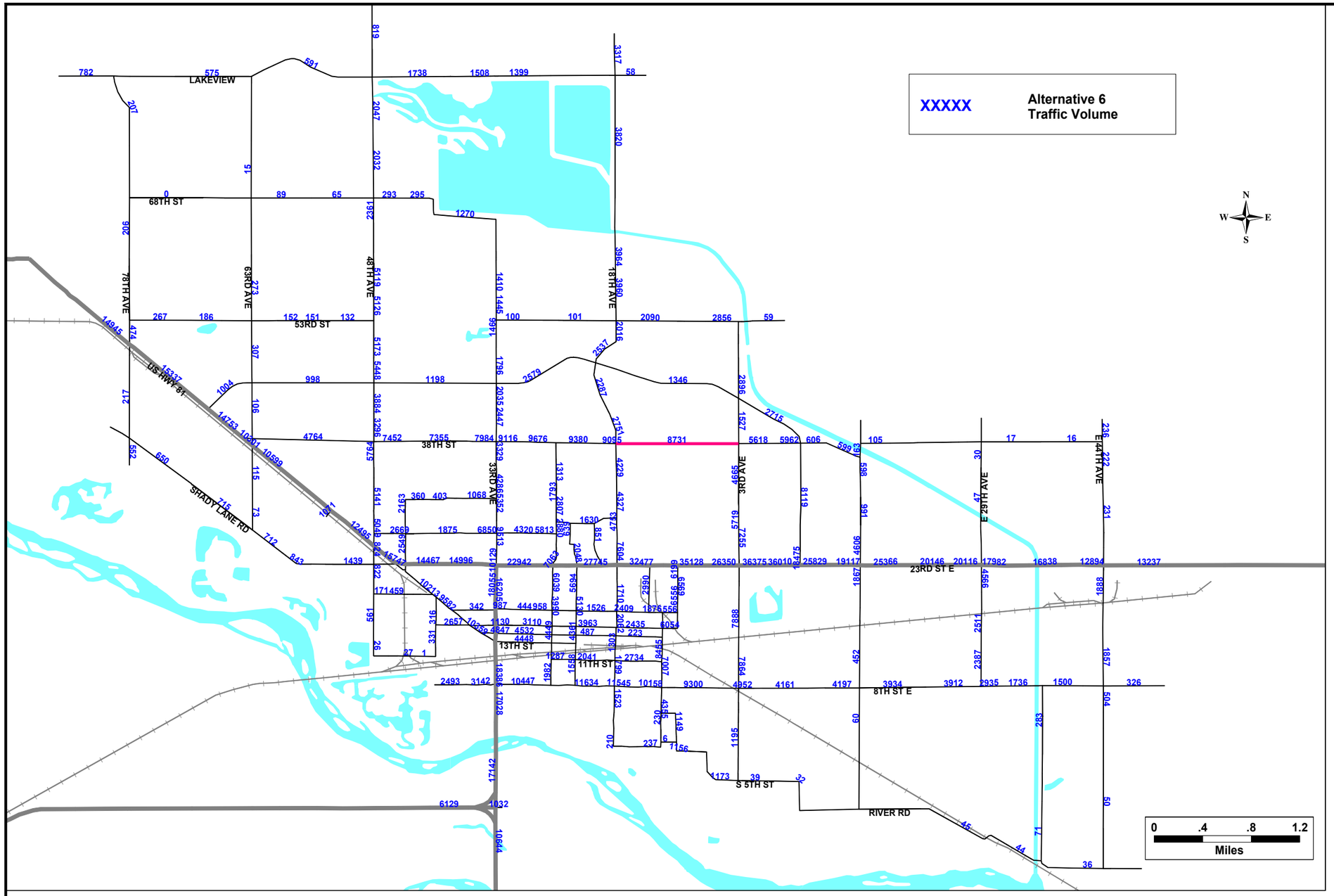

CITY OF COLUMBUS

Comprehensive Plan Update

Alternative 6 Traffic Assignment

38th Street Extension between
18th Avnue and 3rd Avenue

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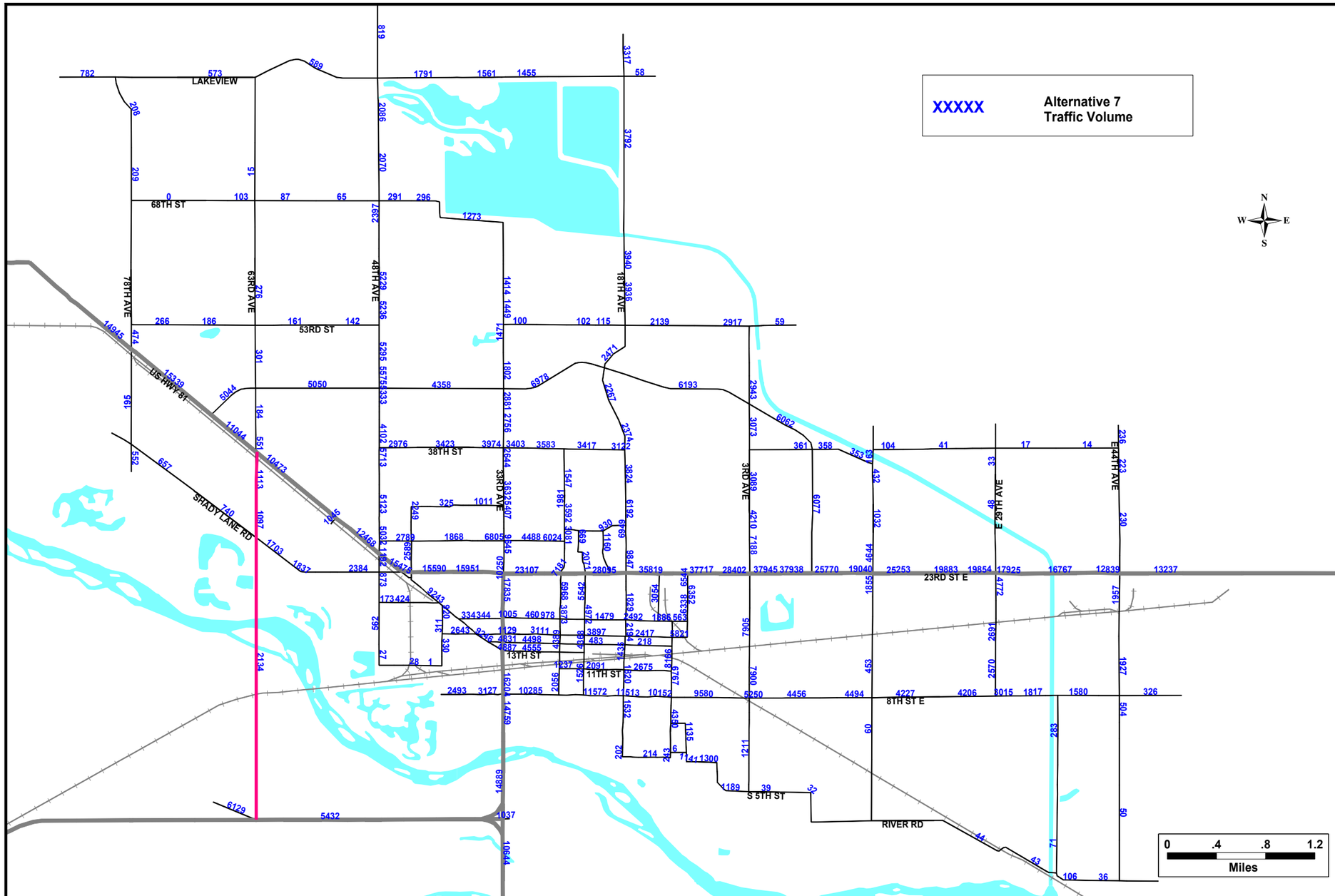

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Alternative 7 Traffic Assignment

63rd Avenue Extension between
US Hwy 81 & US Hwy 30

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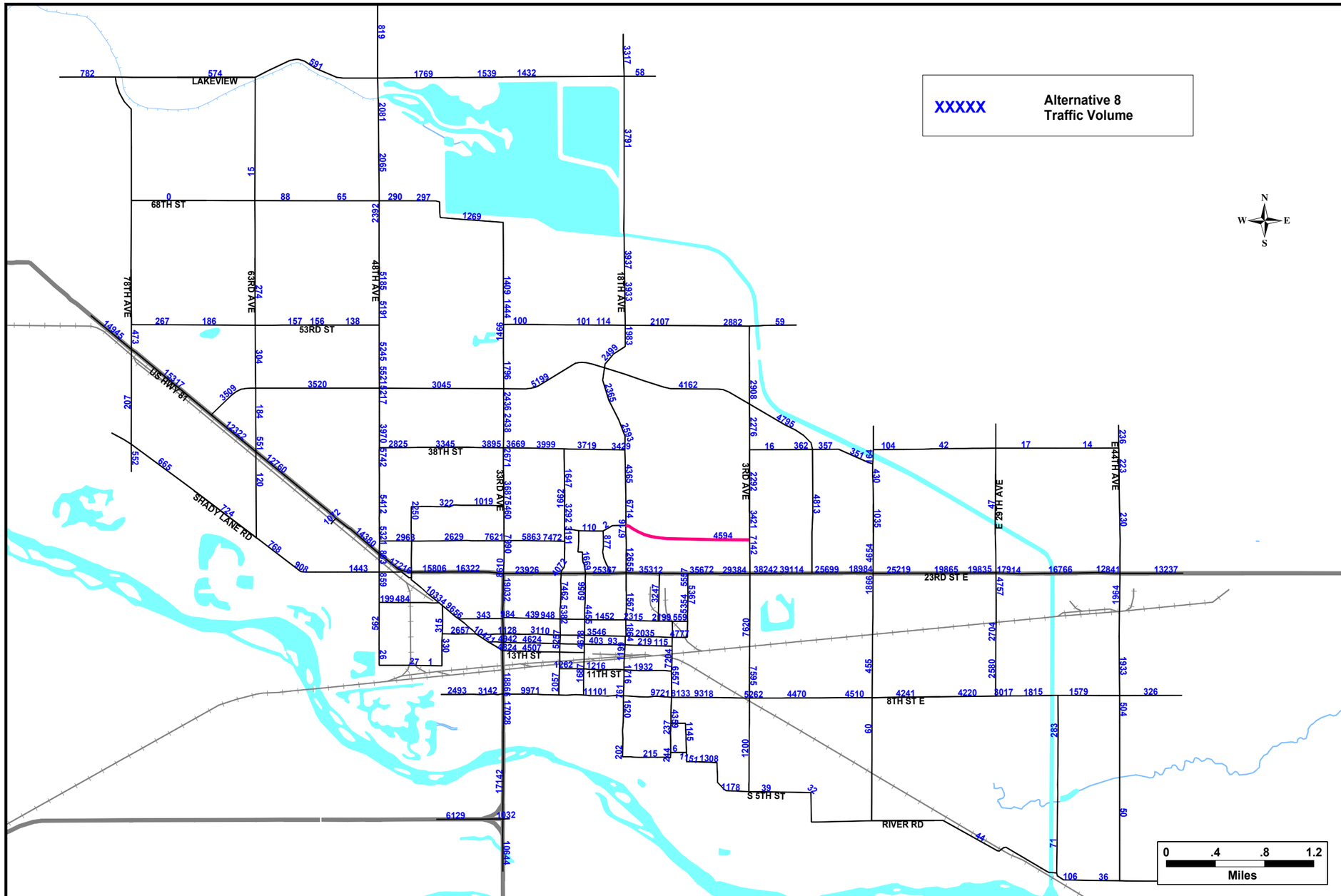

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Comprehensive Plan Update

Alternative 8 Traffic Assignment

27th Street Extension between
18th Avenue and 3rd Avenue

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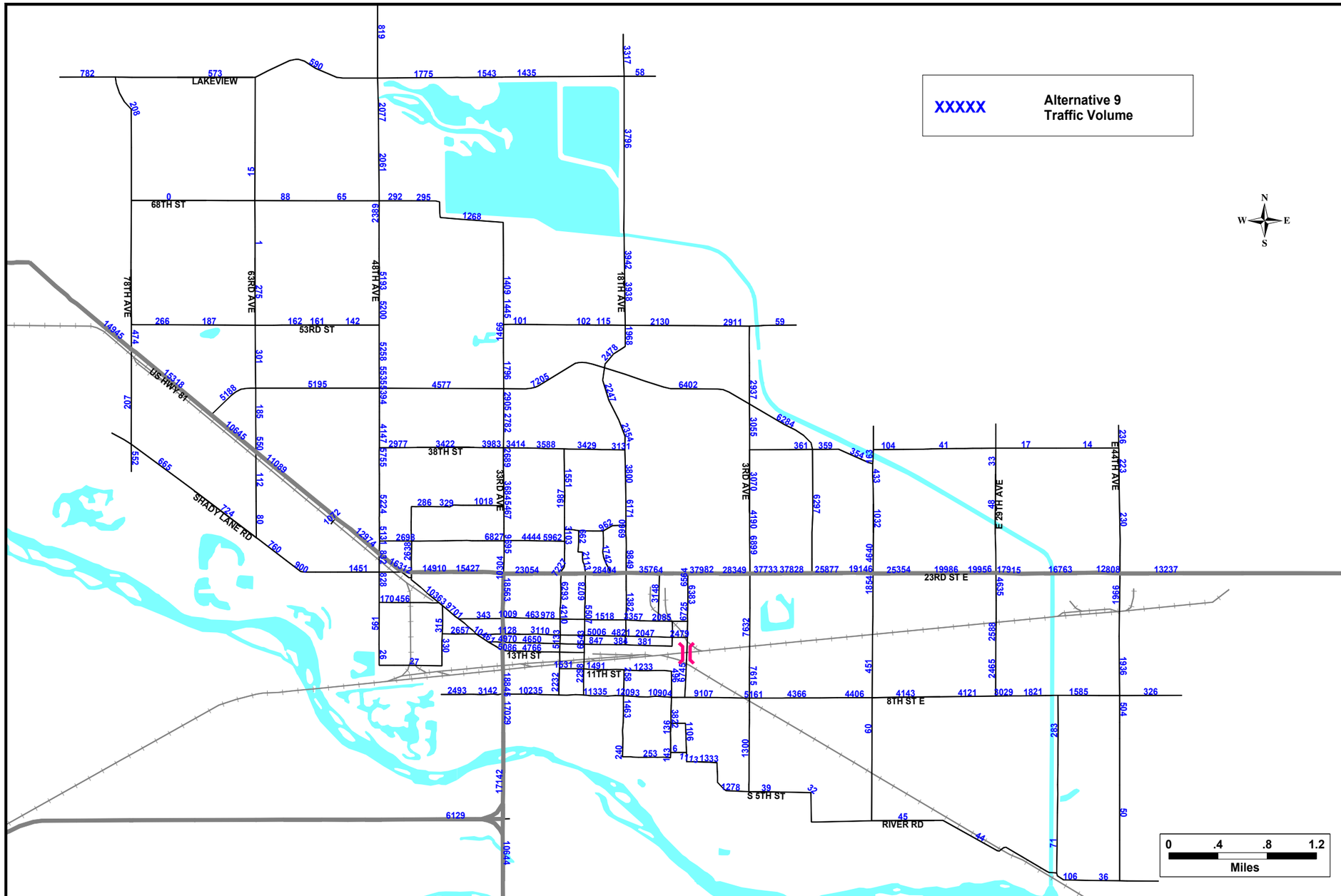

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Alternative 9 Traffic Assignment

Railroad Viaduct on 10th Ave

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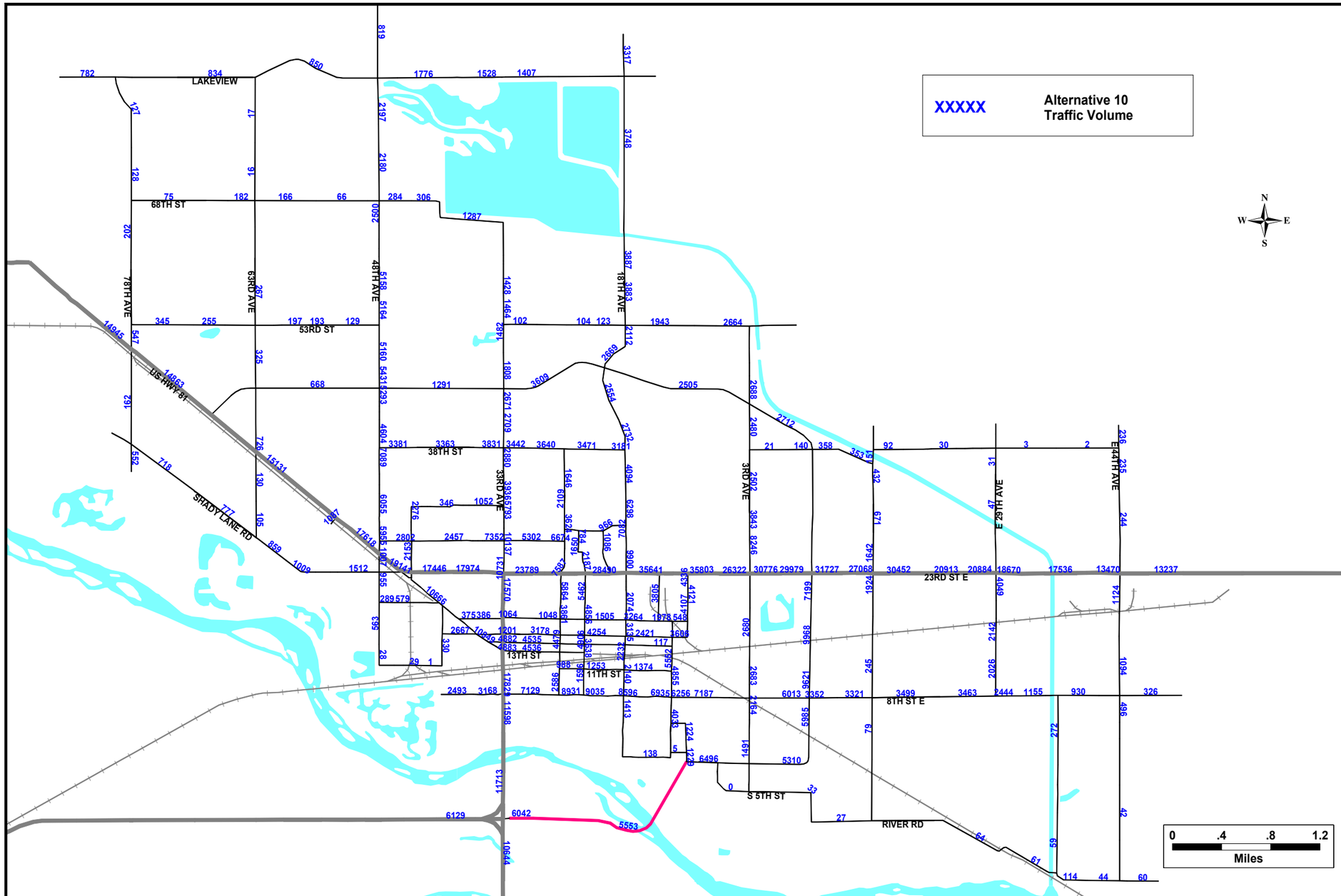

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Alternative 10 Traffic Assignment

South Arterial Roadway

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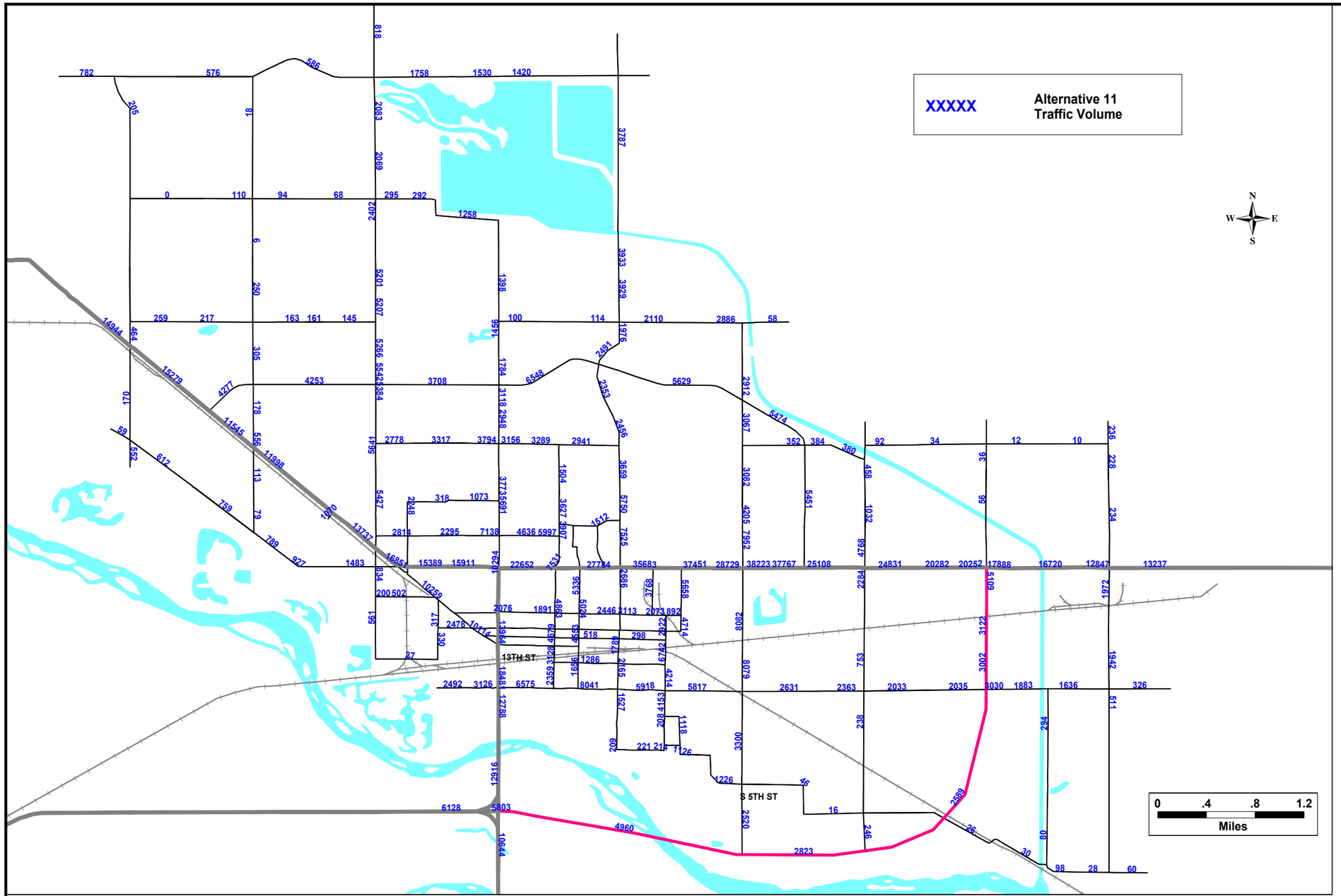

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Alternative 11 Traffic Assignment

Southeast Bypass Roadway

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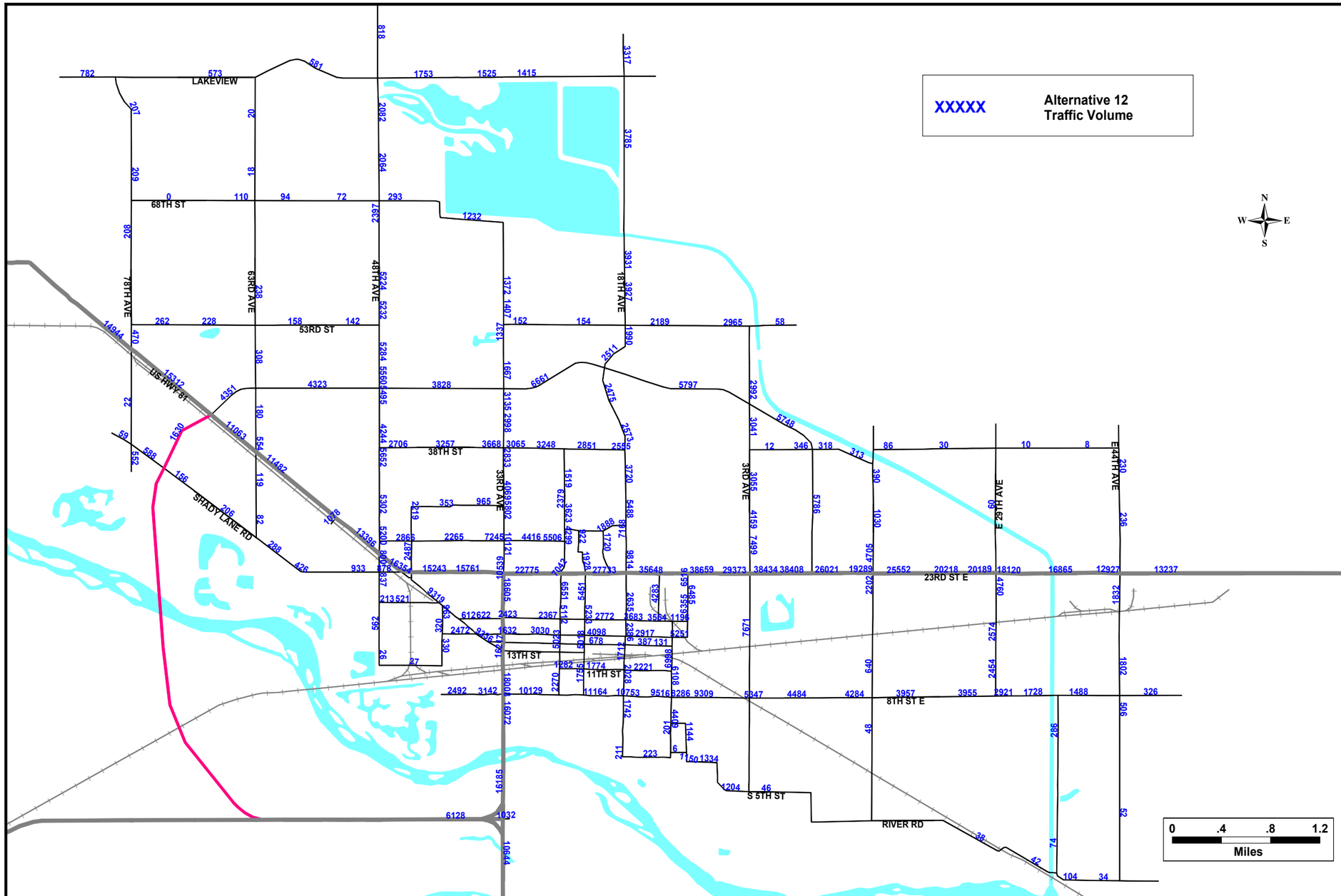

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Alternative 12 Traffic Assignment

West Bypass Roadway

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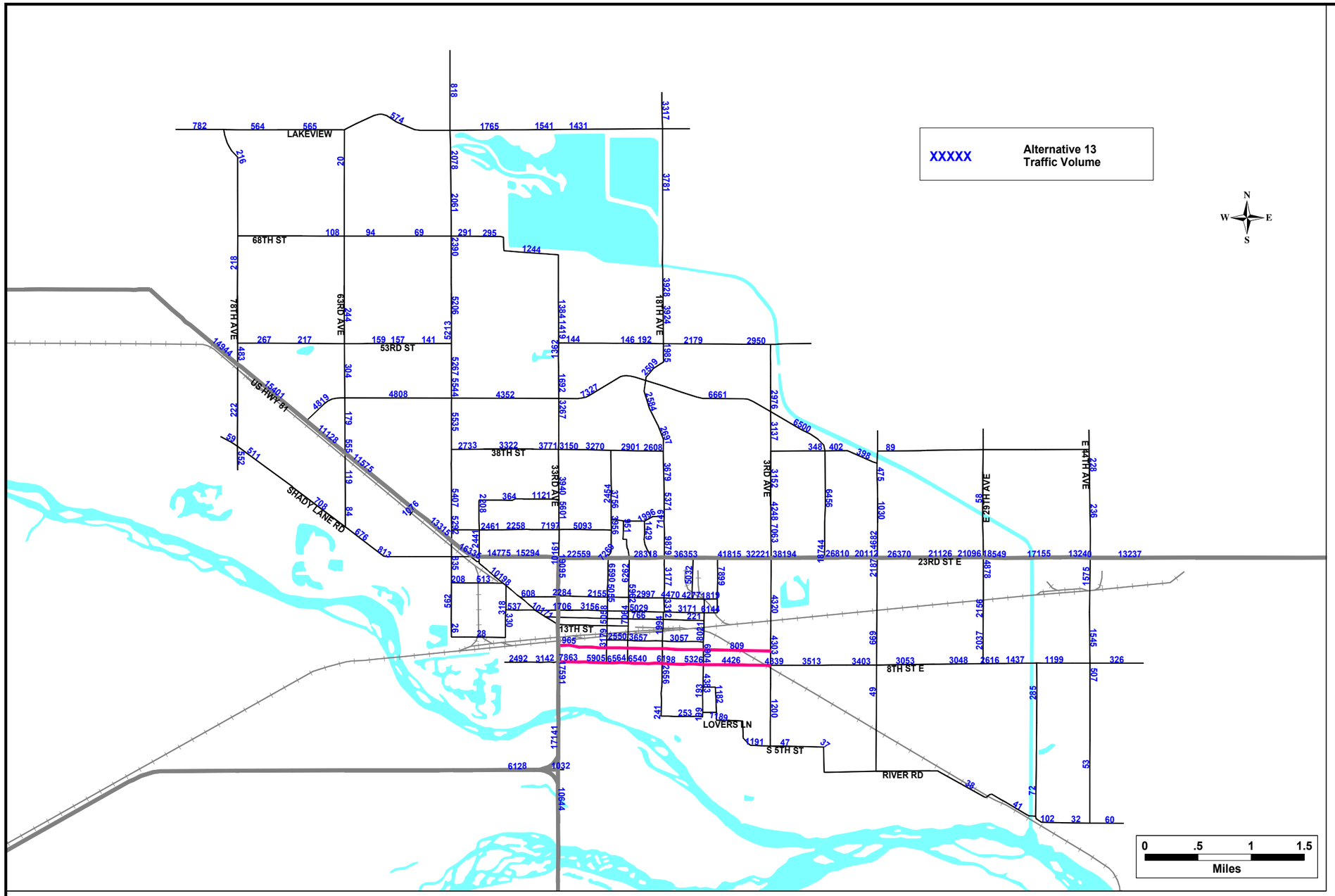

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Alternative 13 Traffic Assignment

8th Street & 10th Street as a One-Way Pair

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