Central Avenue Bicycle Study

Final Report

March 15, 2010

Prepared for:

City of Minneapolis
Department of Public Works
300 Border Avenue North
Minneapolis, MN 55405-1528

Prepared by:

HDR Engineering, Inc.

701 Xenia Avenue South
Minneapolis, MN 55445

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EXECUTIVE SUMMARY

The City of Minneapolis, through the Non-Motorized Transportation Pilot Program (NTP), acted on an identified need to evaluate priority locations for bicycle improvements along segments of Hennepin Avenue and Central Avenue. This document reflects the findings of the study along Central Avenue, and is intended to develop capital improvement priorities for bicycle accommodations, an implementation strategy for these improvements, and to identify, evaluate and recommend improvements that affect bicycle travel along the corridors. The goal of the project has been articulated as follows:

Identify a preferred alternative that can be integrated in the corridor and community that serves all users.

PROJECT LOCATION

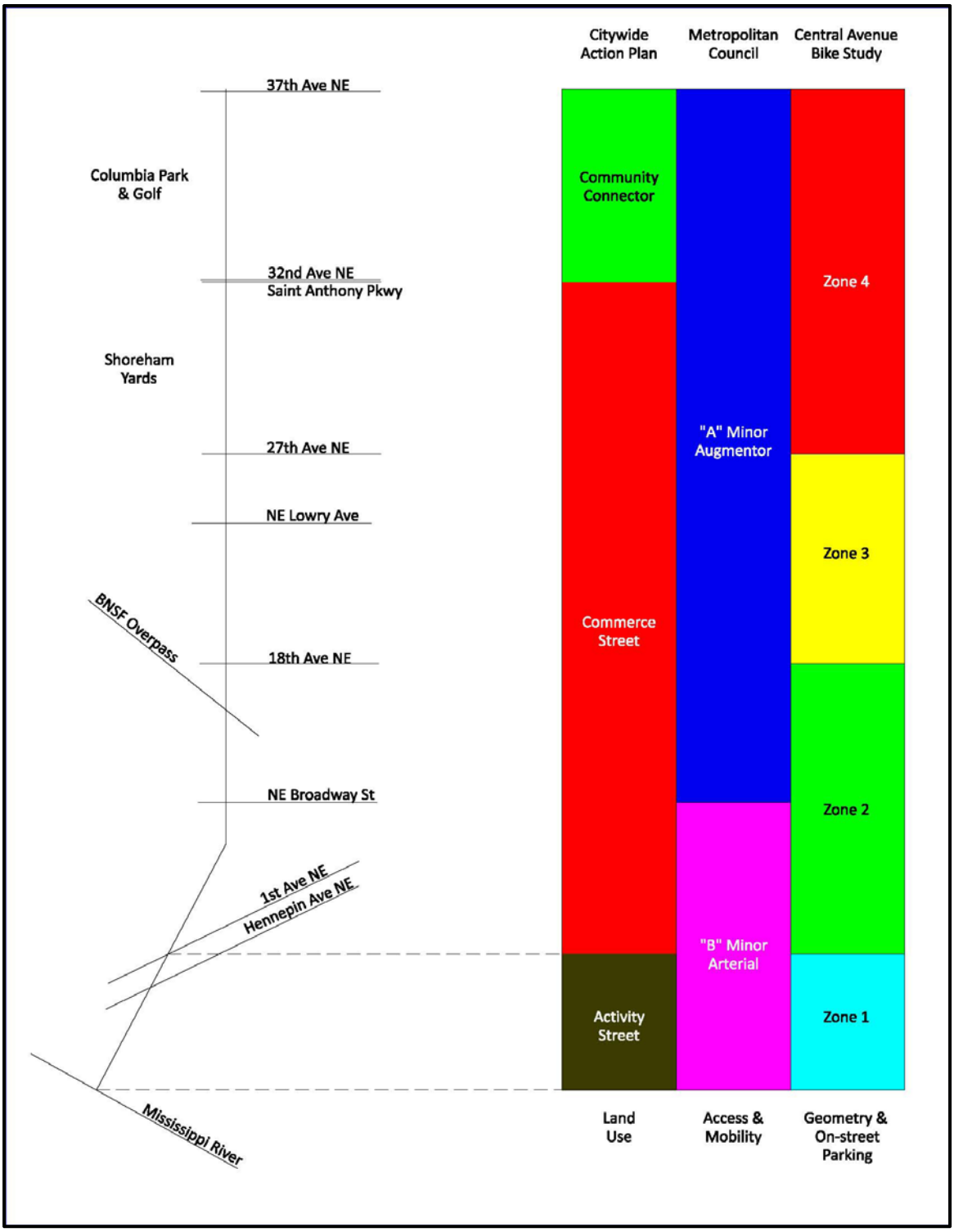
The study segment of Central Avenue begins just north of downtown Minneapolis, and extends north approximately three and a half miles to the city limits of Columbia Heights. This roadway is also known as Minnesota Trunk Highway 65 (TH 65), and the Minnesota Department of Transportation (Mn/DOT) maintains jurisdiction of this portion of the corridor. Central Avenue is the only continuous, non-freeway, north-south corridor in Northeast Minneapolis that provides direct access between downtown and the northern suburbs. As such, it provides an important transportation link for a variety of traffic modes and trip lengths.

This study has divided the corridor into four zones reflective of the various distinct identities it exhibits:

- Zone 1: Mississippi River to 1st Avenue NE
- Zone 2: 1st Avenue NE to 18th Avenue NE
- Zone 3: 18th Avenue NE to 27th Avenue NE
- Zone 4: 27th Avenue NE to 37th Avenue NE

From a cycling perspective, this corridor connects to other elements of the bicycle network at University Avenue SE, 5th Street SE, 8th Street SE, 3rd Avenue NE, 18th Avenue NE, 22nd Avenue NE, and Saint Anthony Parkway. **Figure ES-1** provides a graphical representation of the corridor.

FIGURE ES 1
PROJECT LIMITS



EXISTING BICYCLE-RELATED ISSUES

The following text summarizes issues related to the existing conditions in the context of the relationship between bicycles and the corridor's characteristics. Later in this document, alternatives that help reduce exposure to many of these issues will be introduced.

A. There are three locations where the roadway's width changes, adding complexity to the installation of continuous bicycle facilities (Spring Street, BNSF overpass north of 14th Avenue & short medians at 18th Avenue intersection).
B. The elevated intersection at Broadway Street contains expansion joints at 45-degrees to approaching traffic. Concern has been raised that they may catch bicycle tires and knock cyclists off balance. This concern is heightened when cyclists are adjacent to motorized traffic.
C. Central Avenue crosses over two rail lines. The vertical alignment exhibits relatively steep inclines on each approach. These inclines cause additional strain and potentially reduce a cyclists' situational awareness.
D. Much of the corridor exhibits on-street parallel parking. When cyclists travel next to parked cars without giving the vehicles an adequate passing buffer, an additional hazard is presented in the form of opening doors or vehicles pulling into or out of a parking space.
E. Buses provide a challenge to cyclists similar to that of on-street parking. Though transit buses are operated by professional drivers, the combination of larger blind spots, aggressive or inattentive motorists and cyclists sharing the same pavement provides for a segment of pavement containing increased conflict points.
F. From a vehicular congestion perspective, several intersections in Zone 1 operate at an LOS of D or worse during the PM Peak hour. Each instance, and the corresponding LOS is listed below:
   - 5th Street SE, E
   - 4th Street SE, D
   - University Avenue SE, F
   - 2nd Street SE, E
G. Bicycle storage around the corridor was generally sparse. The supply did not appear to be strategically located near bus stops, and large portions of the corridor lacked storage facilities altogether. A need became evident, as it was common to find bicycles attached to signposts, fences and trees.
H. Zone 1 (8.56) and Zone 3 (9.20) exhibited high vehicular crash rates when compared to the Metro average of 5.8 for similar types of roadways.

I. Intersections within Zone 3 generally exhibit higher than average bicycle accident rates compared to the rest of the corridor. This is especially true of Lowry Avenue and 26th Avenue, where the bicycle accident rates are more than one standard deviation above the average.

RECOMMENDED BICYCLE PLAN

The recommended bicycle plan is a product of stakeholder input and various iterations of analyses and evaluations throughout the course of the study. The corridor's bicycle related issues generated 21 scenarios that were evaluated from many perspectives, including geometry, operations, safety, and parking impact. A preferred alternative emerged through this process. The following section documents the recommended changes to the existing street network. It also provides advice for enhancing the plan to maximize user experience and ridership. A Layout of the recommended plan can be found in **Appendix A**. Additional details regarding the bicycle network, wayfinding, parking, a promotional awareness and maintenance plan, and cost estimate can be found in the main body of this document.

PROPOSED CHANGES TO STREET NETWORK

Zone 1

The segment of the corridor between the Mississippi River and 8th Street SE is recommended to take on two distinct layouts, with a transition between Hennepin Avenue and 1st Avenue. Recommendations for this part of the corridor include:

- Between the river and Hennepin Avenue, install sharrow pavement markings in each outside lane. Supplement pavement markings with complimentary signing.
- Between Hennepin Avenue and 1st Avenue:
    - In the northbound direction, begin a six-foot wide dedicated bicycle lane. Install a two-foot buffer between the outside vehicular lane and the bicycle lane between Hennepin Avenue and 1st Avenue to absorb the extra pavement within this area. This will allow the vehicular lanes to remain along their existing alignment and maintain a constant width.
    - In the southbound direction, maintain the shared outside bicycle lane with sharrow pavement marking.
    - Remove five metered parking stalls (No parking 4-6 PM, Monday – Friday; $0.50 per hour, two-hour limit) along the southeast corner of Central Avenue and 1st Avenue.
- Between 1st Avenue and 8th Street SE:

- In the NB direction, shift the bicycle lane to retain on street parking between 7th Street and 8th Street.
- In the SB direction, install a six-foot bicycle lane that feeds into the shared lane on Central Avenue as well as the dedicated lane on 1st Avenue.

Zone 2

Most of the segment between 8th Street SE and 18th Avenue NE is divided, with the exception occurring between 13th Avenue and 14th Avenue. This one-block long segment is also the only part of the zone to accommodate on-street parking, which serves small, local businesses. Recommendations for this zone include:

- Maintain the dedicated bicycle lanes developed at the north end of Zone 1.
- Between 8th Street and 13th Avenue, narrow the bicycle lanes to a five-foot width to account for the reduction in roadway width.
- Where the geometry narrows along the approaches to Spring Street, provide a clear indication that the dedicated lane will be transitioning to a shared lane. Resume the dedicated bicycle lanes on the far side of Spring Street, where the roadway width once again will accommodate them.
- Between 13th and 14th Avenues:
    - Remove 14 on-street parking stalls on the east side of Central Avenue, beginning at the south end of the block: 1 hour parking, 8 AM to 6 PM.
    - Remove five on-street parking stalls on the west side of Central Avenue, beginning at the north end of the block: 1 hour parking, 8 AM to 6 PM.
    - Widen the southbound bicycle lane to six feet as it travels adjacent to on-street parking.
- North of 14th Street, provide a relatively short-term configuration that consists of six-foot bicycle lanes in each direction, with appropriate buffers between the bicycle lanes and vehicular lanes where the pavement width allows for it.
    - Remove six unrestricted on-street parking stalls on the east side of Central Avenue, beginning at the south end of the block.
    - Reduce the length of the median extending north from the center bridge pier to retain the on-street parking for businesses on the west side of Central Avenue.
    - Monitor progress of the plan to replace the BNSF railway's bridge over Central Avenue. Currently, it is programmed for replacement during Mn/DOT's 2014 fiscal year.

Zone 3

The commercial segment between 18th Avenue and 27th Avenue is the subject of the most substantial change. The elements of the proposed changes are outlined below.

- Introduce a 3-lane section similar to that on the "Eat Street" segment of Nicollet Avenue:
    - Parking on both sides of the road
    - Six foot bicycle lanes in each direction
    - One thru lane in each direction
    - A two-way center left turn lane to separate left turning vehicles from thru traffic and better accommodate various queue lengths and midblock driveways
- Remove the short center medians and signal poles on either side of 18th Avenue.

Zone 4

The northern segment of the corridor, between 27th and 37th Avenues, is the most residential in nature, and has unique redevelopment opportunities in the Shoreham Yards area. This segment is also unique in that it was recently reconstructed, and consequently, the pavement remains in excellent condition. Recommendations for this segment are below:

- Install shared lanes along the entire segment.
- Monitor the progress of the extension of the multi-use trail on the west side of Central Avenue.

1.0 INTRODUCTION

The City of Minneapolis, through the Non-Motorized Transportation Pilot Program (NTP), acted on an identified need to evaluate priority locations for bicycle improvements along segments of Hennepin Avenue and Central Avenue. This document reflects the findings of the study along Central Avenue, and is intended to develop capital improvement priorities for bicycle accommodations, an implementation strategy for these improvements, and to identify, evaluate and recommend improvements that affect bicycle travel along the corridors. The goal of the project has been articulated as follows:

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1.1 PROJECT LOCATION

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This study has divided the corridor into four zones reflective of the various distinct identities it exhibits:

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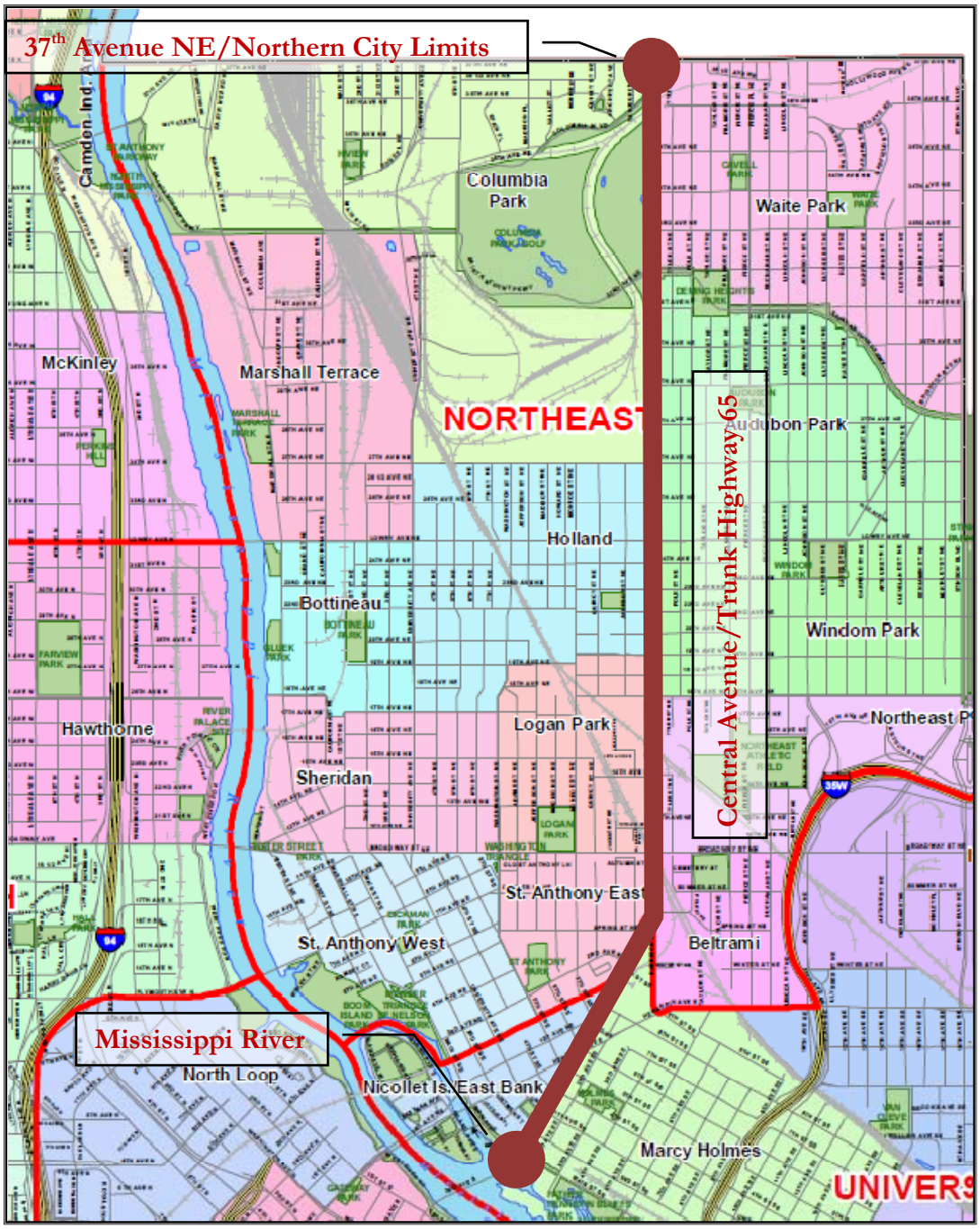
- Zone 4: 27th Avenue NE to 37th Avenue NE

From a cycling perspective, this corridor connects to other elements of the bicycle network at University Avenue SE, 5th Street SE, 8th Street SE, 3rd Avenue NE, 18th Avenue NE, 22nd Avenue NE, and Saint Anthony Parkway. **Figure 1** provides a graphical representation of the corridor.

FIGURE 1
PROJECT LOCATION[1]



[1] Map Source: City of Minneapolis Neighborhood Boundary Map

1.2 DESIGN GUIDELINES

The design of bikeways is supported by various local, state and national guidelines, listed below:

- American Association of State Highway and Transportation Officials (AASHTO) Guide for Development of Bicycle Facilities, 1999
- Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD), 2005
- Minnesota Department of Transportation (Mn/DOT) Bikeway Facilities Manual, 2008
- Access Minneapolis: Ten Year Transportation Action Plan
    - City-wide Action Plan
    - Design Guidelines for Streets & Sidewalks, 2008
- The 2001 Bicycle Master Plan is currently being updated, but is not expected to be published in time to be included in this report.

To make the implementation of this project as feasible as possible, this study focused on applications that did not involve modifications to curb and gutter. This means that improvements were limited to the existing roadway. There are cases throughout the corridor where existing conditions do not meet current design guidelines. The reasoning behind previous design decisions is unknown, and the recommendations included in this report will generally not attempt to bring existing deficiencies up to current guidelines.

TABLE 1
DESIGN GUIDELINES

Roadway Element	Condition	Jurisdiction	Design Guideline
Thru Lane	Next to Curb	Mn/DOT	12 feet incl. gutter
Thru Lane	Next to Lane/Shoulder	Mn/DOT	11 feet
Turn Lane	Next to Curb	Mn/DOT	12 feet incl. gutter
Turn Lane	Next to Lane/Shoulder	Mn/DOT	11 feet
Parking Lane	Commerce Street Community Connector Activity Area Street	City	8 feet
	Minor Arterial	Mn/DOT	10 feet
Bicycle Lane	ADT 10k to 20k	Mn/DOT	6 feet

In most cases, the recommendations included in this report will conform to the design guidelines identified in **Table 1**. However, certain unique opportunities arose that allowed for an overall improvement along certain parts of the corridor. These deviations were applied with a context-sensitive approach and kept to a minimum.

1.3 STAKEHOLDER ENGAGEMENT

The ultimate goal of a public involvement program is community approval. This is most successfully achieved when three elements are attained:

- Understanding of project issues
- Understanding the concerns of others
- Consensus on the process

This process began early in the study during meetings with agency partners. The goal of these meetings was to introduce the project, learn about the history of this corridor, discuss design guidelines, and exchange information regarding alternative solutions. Meetings were held with the following:

- City's Engineering Services
- City's Principal Planner in the project area
- Minnesota Department of Transportation Metro Division

Public stakeholders were engaged early and throughout the study. Early on, these opportunities offered an opportunity to introduce the project, present current alternatives and gather feedback, which would then be used at subsequent meetings. The public engagement process concluded with a presentation of the recommended alternative. Below is a chronological listing of the public meetings:

- January 24, 2009: Presentation of concepts to the East Side Bicycle Task Force. This presentation was recorded and replayed on the city's public television station.
- April 21, 2009: The city's NTP Coordinator created a project website on the city's bicycling website.
- July 1, 2009: Presentation of current concepts to the City's Bicycle Advisory Committee (BAC).
- July 28, 2009: Activated online website capable of receiving project related comments.
- July 30, 2009: Presentation of current concepts to area community members.
- September 29, 2009: Open house presentation of the recommended plan. [2]

The results of the public engagement process yielded a number of comments that can be found in **Appendix D**.

[2] Community members were invited through each of the affected Neighborhood Associations: Marcy Holmes, Nicollet Island/East Bank, St. Anthony East, Beltrami, Logan Park, Holland, Windom Park, Audubon Park, Columbia Park, Waite Park. An email announcing each meeting open to the public was sent out to the City's bicycle list serve. Finally, the business community was invited via the Chamber of Commerce.

2.0 TRANSPORTATION NETWORK

Central Avenue changes in context many times along the corridor. The corridor serves a vital role in the transportation and economic systems of Northeast Minneapolis. It connects to other arterial roadways and distributes traffic to and from the local grid system. It serves as an avenue for local as well as regional trips and serves a variety of automobile, truck, bus, bicycle and pedestrian users. Any attempt to improve the corridor should be undertaken in a manner to preserve the corridor's strengths and be flexible enough to accommodate subsequent improvements.

2.1 FUNCTIONAL CLASSIFICATION AND CHARACTERISTICS

The Federal Highway Administration states that the street and highway network plays a dual role in providing access to property and travel mobility. It charges each state transportation agency, in cooperation with local officials, with the responsibility of developing a functional classification system that applies to all public roads.

In the Twin Cities Metro Area, functional classification consists of four classes of roadways:

- Principal Arterials
- Minor Arterials
- Collector Streets
- Local Streets

North of Broadway Street, Central Avenue has been classified as an "A" Minor Augmentor, which is a subset of the Minor Arterial classification. In this sense, it is intended to support the principal arterial system by carrying medium to long trips. South of Broadway Street, it has been classified as a "B" Minor Arterial. This lower class of arterial places a higher emphasis on access, though mobility is still its primary function.

Minneapolis' Design Guidelines for Streets and Sidewalks characterizes the study segment in three distinct classifications. Between the Mississippi River and 1st Avenue NE, Central Avenue is an Activity Area Street. Between 1st Avenue NE and 32nd Avenue NE, it is a Commerce Street. Lastly, north of 32nd Avenue NE, it is a Community Connector. Central Avenue's speed limit is 30 MPH throughout the study corridor. **Figure 2** provides a comparison between the street types utilized in Minneapolis and references their equivalent functional classification.

FIGURE 2
STREET DESIGN TYPE CHARACTERISTICS[3]

Ten-Year Transportation Action Plan

Design Guidelines
Streets and Sidewalks

Figure 2-4 Street Design Type Characteristics

Proposed Street Types	Description	Equivalent Functional Class	Through Traffic Lanes	Target Operating Speed	Transit	Pedestrian Facilities	Bicycle Facilities[5]	Freight	Connection to Freeway System	Median	Turn Lanes	Curb Parking[6]	Curb Extensions	Driveway Access	Trees and landscaping
Commuter Street	High capacity, carries through traffic, serves longer trips and provides limited access to land uses	Principal or A Minor Arterial	4-6[1]	40 mph	PTN	Yes	Yes (on Parallel paths)[4]	Regional truck routes	Yes	Yes	Yes	No	No	Limited; access from alleys or access lanes	Yes
Commerce Street	Medium capacity; supports retail, service commercial and higher intensity residential land uses on a corridor basis	A and B Minor Arterials	2-4	30 mph	PTN and Local routes	Yes	Yes if in Master Plan	Local truck routes	Yes	Optional	Optional	Yes	Yes	Limited; access from alleys	Yes
Activity Area Street	Medium capacity; provides access to abutting properties in activity centers, growth centers, transit station areas, and neighborhood commercial nodes	A and B Minor Arterials, Collectors, and Locals	2-4	30 mph	PTN and Local routes	Yes	Yes if in Master Plan	Local delivery	Provisional	Optional	Optional	Yes	Yes	Yes	Yes
Community Connector	Medium capacity; connects neighborhoods together and with commercial corridors and other districts. districts with each other serves as the main street of a neighborhood commercial node. Some streets have a commuter function that require special frontage design	B Minor Arterials and Collectors	2-3[2]	30 mph	PTN and Local routes	Yes	Yes if in Master Plan	Local truck routes	Provisional	Optional	Optional	Yes	Yes	Allowable where side or rear not feasible	Yes
Neighborhood Connector	Low capacity; connects neighborhoods with each other. Some streets have a commuter function that require special frontage design	Collectors	2	30 mph	PTN and Local routes	Yes	Yes if in Master Plan	Local deliveries	Provisional	Optional	Optional	Yes	Yes	Yes	
Industrial Connector	Low capacity; connects districts with neighborhoods and serves abutting property in single use (industrial/ employment) districts	Collectors	2-3[2]	30 mph	PTN and Local routes	Yes	Yes if in Master Plan	Local truck routes	Provisional	Optional	Optional	Optional	Yes	Yes	Yes
Parkway Street	Low-capacity thoroughfare designed to provide circulation adjacent to and through parkland	Locals	1-2	25 mph	Provisional	Yes	Yes (on Parallel paths)	No	No	Optional	Optional	Recessed in bays	Yes	Optional	Yes
Local Street	Low capacity; serves abutting property in residential neighborhoods or single use (industrial/employment) districts	Locals	1-2[3]	30 mph	Local Routes	Yes	Yes if in Master Plan	Local deliveries	No	No	Optional	Yes	Yes	Yes	Yes
Alley	Property and parking access	Locals	1-2	5 mph	No	No	No	Local deliveries	No	No	No	No	No	Yes	No

Notes
[1] Six lanes is an exception for surface streets in Minneapolis
[2] These lane streets are two-way streets with one travel lane in each direction and left turn lane (not necessarily continuous)
[3] One lane streets are two-way yield streets with parking on one or both sides and one wide travel lane
[4] Parallel paths - shared bicycle/pedestrian facilities adjacent to streets, but separated by wide planting areas
[5] If in Bicycle Master Plan, bicycle facility should be provided on target street or on a parallel street serving the same travel shed.
[6] Curb extensions should be provided except in conditions where the parking lane is used as a traffic lane during peak periods or space is required at the intersection for a turn lane.

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2.2 RELATED PLANS & STUDIES

The City of Minneapolis' Department of Community Planning and Economic Development (CPED) and their partners have completed or continue to develop a number of plans and studies that overlap this effort. Brief summaries of each, relative to bicycle travel on or across the project corridor, are below:

Access Minneapolis[4]

This is the city's transportation action plan, which consists of a number of different elements, including the Citywide Action Plan, Street and Sidewalk Design Guidelines, and

[3] Source: Access Minneapolis - Design Guidelines for Streets and Sidewalks, 2008

[4] Source: Access Minneapolis website: http://www.ci.minneapolis.mn.us/public-works/trans-plan/

the future Bicycle Master Plan. These elements call out specific steps to implement the policies in the Minneapolis Plan. This includes many bicycle related initiatives communicated throughout this document.

Central Avenue Small Area Plan, 2008:
Location: 7th Street SE to 37th Street NE
Recommendations:

- Close gaps in bicycle system, such as the 18th Avenue trail.
- Multiple north-south and east-west connections across Northeast Minneapolis.
- Bicycle lanes on Central Avenue, recognizing that it may not be a comfortable place to ride for all.
- Additional bicycle routes on Fillmore Street and Monroe Avenue.
- Additional bicycle racks along the sidewalk, especially in new developments.
- Centralized bicycle parking facilities, such as bike corrals at 29th Avenue, 22nd Avenue and 18th Avenue.

Shoreham Yards (ongoing)[5]:
Location: 2800 Central Avenue
Intent: To redevelop a 230-acre train, trucking and distribution site to light industrial businesses that provide high job density, good wages and low impact on the surrounding community.

Audubon Park Neighborhood Small Area Plan, 2008[4]:
Location: East of Central Avenue, between Lowry Avenue and Saint Anthony Parkway.
Recommendations:

- Ensure that new residential and commercial development provides an adequate number of bicycle parking stalls.
- Encourage bicycle parking at convenient locations throughout the neighborhood for bicyclists to park their bicycles and walk to their destinations.
- Improve connection to Grand Rounds Scenic Byway and Audubon Park.
- Explore design options for bicycle lanes along streets parallel to Central Avenue, Johnson Street, 29th Avenue and Lowry Avenue.

Columbia Heights Pedestrian and Bicycle Mobility Plan, 2008[6]

[5] Source: CPED website: http://www.ci.minneapolis.mn.us/cped/projects_list_current.asp#east
[6] Source: http://www.ci.columbia-heights.mn.us/departments/pdf/Ped%20and%20Bike%20Mobility%20Plan.pdf

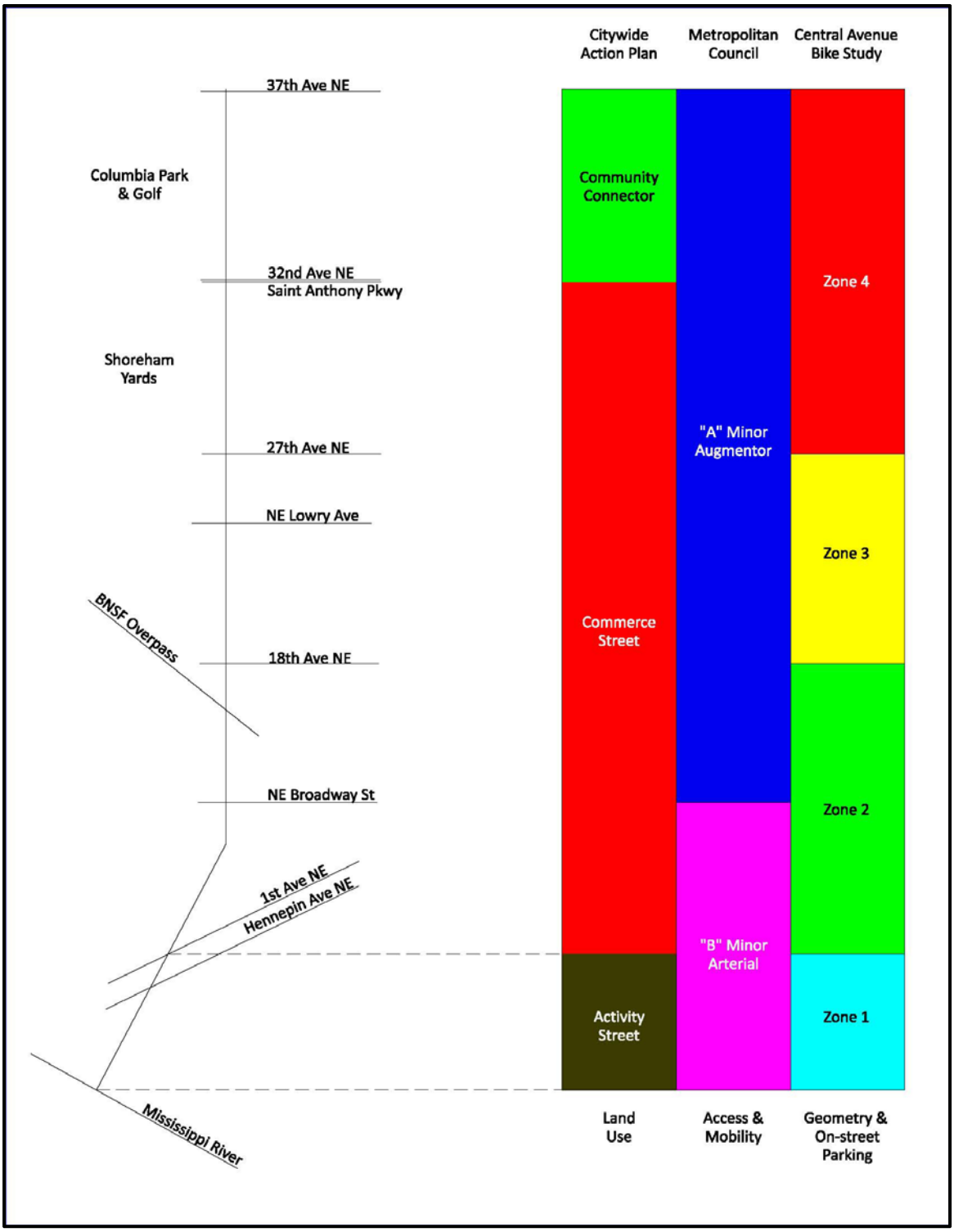
Location: North of 37th Avenue NE
Recommendation: The primary city trail loop shall extend south on Central Avenue to connect to the Grand Rounds Scenic Byway, Columbia Park and Columbia Golf Course.

A number of other local plans were identified, such as the Lowry Avenue Plan and Northeast Arts Action Plan. These plans are now dated, and reviews of these plans were not completed.

2.3 EXISTING GEOMETRY

The functional classification and street design type characteristics help define the corridor in terms of access and mobility. For the purposes of evaluating bicycle facilities, this study opts to break the corridor down further, and bases the resulting zones primarily on the existing roadway geometry and nature of the adjacent community. Currently, there are no dedicated bicycle lanes along the project corridor.

FIGURE 3
ROADWAY CLASSIFICATION



The southern portion of this corridor (See **Zone 1** photo, below) exhibits many of the characteristics of outer downtown, with on-street parking and a four-lane undivided roadway adjacent to multi-story buildings and short blocks. Moving north past 1st Avenue NE, the corridor's characteristics evolve to a divided roadway surrounded by a residential grid system with occasional commercial elements (**Zone 2**). Four through lanes are maintained, though there is no on-street parking present. At 18th Street NE, the corridor again becomes undivided and enters a predominantly commercial district characterized by small businesses that serve the local community (**Zone 3**). In this zone, on-street parking on both sides helps to serve these businesses. At 27th Avenue NE, the corridor transforms yet again to that of a residential grid system on the east side. On the west side, there is a rail yard, then Columbia Park (**Zone 4**). The northernmost portion of this zone becomes commercial. The roadway is again divided, this time in the form of wide planted medians. On-street parking is only provided on the east (northbound) side of the road.

ZONE 1

Four-lane undivided with on-street parking

ZONE 2

Four-lane divided without on-street parking

ZONE 3

Four-lane undivided with on-street parking

ZONE 4

Four-lane parkway with east-side on-street parking

A street's width is a primary component when considering the use of bicycle facilities on a given roadway. For the purposes of this study, it was deemed important to be able to install the facilities within the existing roadway to keep implementation costs from becoming prohibitive. In some cases, the existing street width allowed for alternatives that included separate bicycle lanes. Other portions of the corridor were too narrow for them to be a viable option. Street width information and roadway features were documented by electronic CAD-based drawings and aerial photography, then confirmed with field measurements. Details of these dimensions can be found in **Appendix B**.

For the most part, the street widths and cross sections in the corridor are constant within each block. There are three exceptions worth noting.

1. At the intersection with Spring Street, Central Avenue narrows by approximately six feet on each approach.
2. Between 14th and 18th Avenues, a BNSF railroad bridge spans Central Avenue. The bridge is supported by three piers, located in the median, and adjacent to the sidewalk on either side of the roadway. The outside piers extend into, and narrow the shoulder from approximately eight feet to four feet. The median protecting the center pier extends down to the intersection with 14th Avenue, but only extends about a third of the 830 feet up to 18th Avenue. It should be noted that this bridge is currently programmed for replacement in Mn/DOT's 2014 fiscal year.
3. At the 18th Avenue intersection, there are two short (20-foot long) medians that protect signal poles in the center of the street.

2.4 PAVEMENT TYPE

2.4.1 CONDITION & MATERIAL

The type and age of the corridor varies from place to place. Much of the corridor consists of aging bituminous pavement. However, the segment north of 27th Avenue (Zone 4) was reconstructed in 2005 utilizing concrete pavement. The remainder of the corridor consists of a combination of concrete and bituminous pavements of varying conditions and is programmed to be resurfaced as part of an upcoming Mn/DOT mill and overlay project. This programmed improvement provides a good opportunity to implement a different pavement marking layout without having to pay for the removal of existing marking. Furthermore, the resurfacing project provides the opportunity to utilize more durable pavement marking materials, such as poly-preformed plastic.

2.4.2 BRIDGES

Central Avenue crosses over two existing railroads, utilizing bridges to span the lines. Typical bridge construction provides expansion joints at critical locations along the bridge to allow for pavement and structural materials to naturally expand and contract with climate conditions without damaging the structural integrity of the bridge.

These expansion joints vary in width from less than an inch to several inches, depending on the design of the bridge and the environment that it is built on. The joint is placed at an elevation slightly lower than the adjacent pavement, causing an audible and sometimes jarring sensation when crossed. Typically, these joints are perpendicular to the flow of traffic. In the case of the intersection of Central Avenue and Broadway Street, the intersection is elevated to cross over the BNSF railway. The design of this bridge is rare in that the expansion joints have been placed at approximately 45-degree angles to the approaching traffic[7]. The relationship between these joint widths and the number and width of a vehicle's tires is such that a vehicle's traction is not threatened. However, bicycle tires, especially road tires, are narrow enough to fit into the joint, impairing the cyclist's ability to steer. Further complicating the situation is that these joints lie near the top of an extended incline.

[7] On approaches to the intersection, the joint travels from the curb to the center of the roadway. On departures, the joint travels from the center of the roadway towards the curb.

This induces additional strain on cyclists' physical abilities, and thus decreases their ability to recover from this hazard.

No reported injuries have been documented related to this issue, though repeated concerns have been raised. As a result, the City is coordinating parallel efforts to investigate possible mitigation strategies regarding the negative effects of bridge joints on bicycle travel.

2.5 VERTICAL CONSIDERATIONS

On roadways such as Central Avenue that have relatively low speed limits, cyclists can typically minimize the speed differential between themselves and motorized traffic. However, vertical grade changes may reduce cyclists' speeds. While the majority of the corridor is relatively flat, the roadway does cross over two railways. These locations are in Zone 2, between 8th Street SE and 3rd Avenue NE and again over the Broadway Street intersection. Each of these cases exhibits grades significant enough to cause the speed differential to increase and/or require additional effort by the cyclist such that their situational awareness may be reduced. A bicycle lane at these locations would be particularly helpful at it would allow for easier passing of slower moving cyclists.

2.6 ON-STREET PARKING

As indicated in Section 2.2, there are many portions of the study corridor that offer on-street parking. These stalls come with a variety of restrictions and metering, depending on the nature of the adjacent land use and anticipated demand. A detailed inventory of the number and type of on-street parking available in the corridor is provided in **Appendix B**.

It is recognized that convenient on-street parking provides a vital resource to the local business. In situations where right-of-way is limited, or where the roadway is existing, on-street parking and bicycle facilities compete for the same pavement. This study aims at maintaining as much on-street parking as possible, especially in highly utilized areas.

2.7 TRANSIT CHARACTERISTICS

Transit provides the opportunity to extend a bicycle trip by utilizing bicycle racks mounted on the front bumper of buses. Central Avenue's strategic location in the metro area has deemed it to be designated a High-frequency route, meaning that service is provided at least every 15 minutes on weekdays between 6 AM and 7 PM, and Saturday between 9 AM and 6 PM.

Buses travel exclusively in mixed lanes along the study segment. Most bus stops are located on shoulders adjacent to travel lanes, though the 2005 construction in Zone 4 created pull-out bays for buses in the southbound direction.

Central Avenue is not only a transit line itself, but provides access to many lines that cross the corridor. **Table 2** provides a summary of the current transit lines that run along or cross the study corridor. **Figure 4** identifies the bus stops along the corridor. In general, it was found that the corridor was provided with adequate bus stop density as it related to cyclists utilizing transit as a mode switch along their routes.

TABLE 2
CENTRAL AVENUE TRANSIT ROUTES[8]

Route	Service Type	Limits in Corridor[9]	Service Area	Frequency (min.)	Peak Hour Buses[10]	Daily Buses	Connecting Routes[11]
10	Local, Hi-Freq.	Mississippi River to 37th Ave; Zones 1-4	Blaine Spring Lake Park Fridley Hilltop Columbia Heights NE Minneapolis Downtown Minneapolis	Rush hours: 10 Midday: 10 Evening: 20-30 Saturday: 15-30 Sun./Holiday: 15	78	113	2, 4, 6, 17, 25, 32, 61, 118, 260, 261, 270
829	Limited Stop	Mississippi River to 37th Ave; Zones 1-4	Blaine Spring Lake Park Fridley Columbia Heights NE Minneapolis Downtown Minneapolis	Rush hours: 10 Midday: none Evening: none Saturday: none Sun./Holiday: none	2-6 trips	11	2, 4, 6, 11, 25, 32, 61, 118, 260
118	Local, Limited Stop	37th Ave. to Lowry Ave; Zones 3 & 4	University of Minnesota Columbia Heights NE Minneapolis	Rush hours: 5-15 Midday: 10-15 Evening: 30 Saturday: 15-30 Sun./Holiday: 30	8	9	6, 10
17	Local	Mississippi River to 27th Ave; Zones 1-3	Hopkins St. Louis Park Uptown Downtown Minneapolis NE Minneapolis	Rush hours: 5-15 Midday: 10-15 Evening: 30 Saturday: 15-30 Sun./Holiday: 30	78	113	2, 4, 6, 17, 25, 32, 61, 118, 260, 261, 270

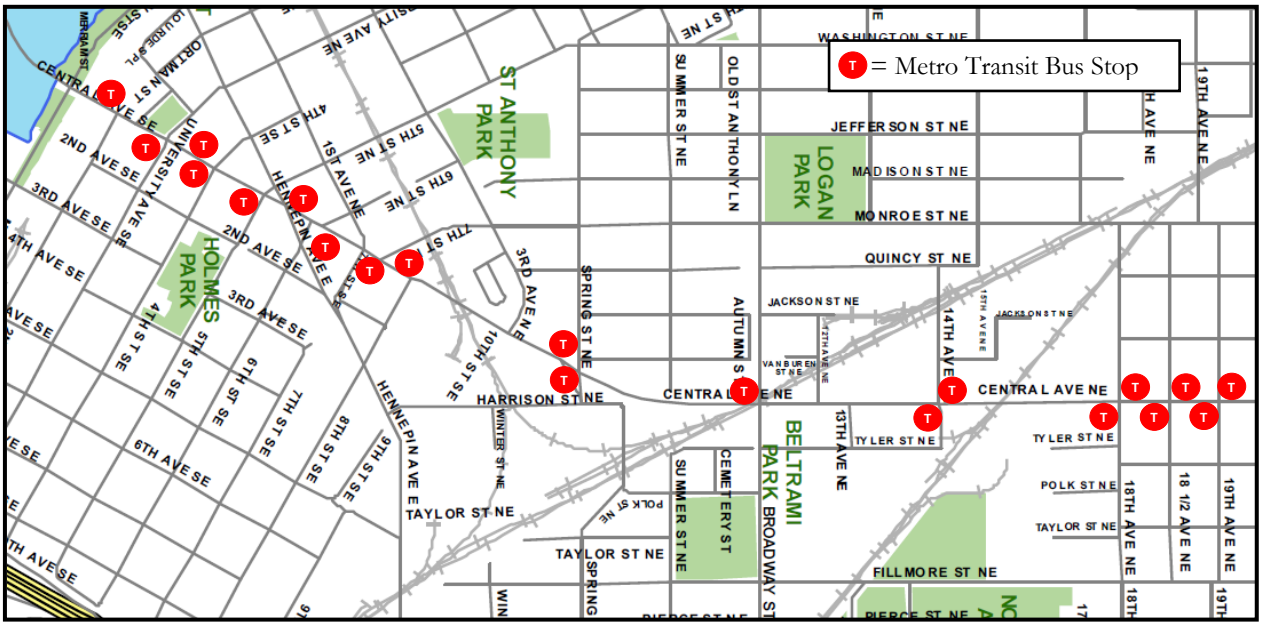
[8] Source: Metropolitan Council's Metro Transit Website

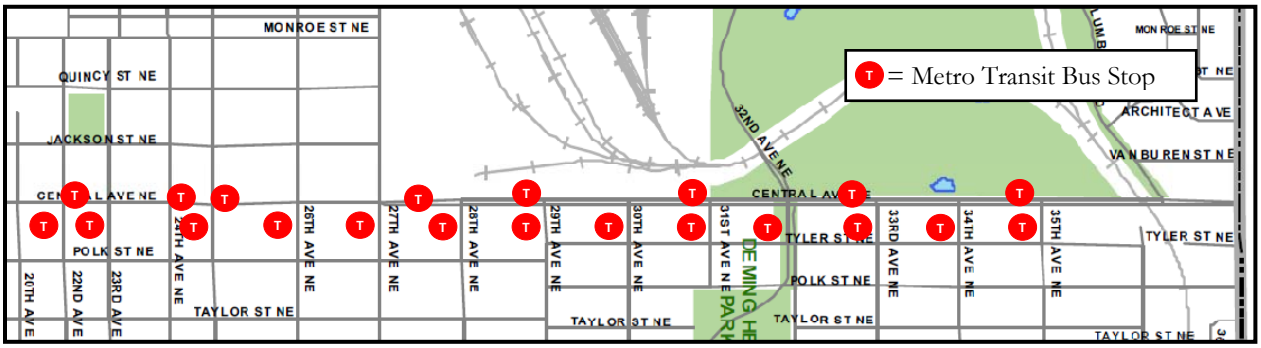
[9] Refers to the portion of the study corridor covered by a particular transit route.

[10] Includes northbound and southbound buses. Peak hour is defined by the shaded times on the bus schedule and includes morning and afternoon peak hours.

[11] Within study Corridor.

FIGURE 4
BUS STOP LOCATIONS[12]





2.8 MOTOR VEHICLE & BICYCLE DEMAND

Traffic volumes provide another element to the discussion when considering the use of bicycle facilities on a roadway. It is important to know what type of user the roadway carries, and when the roadway is used. Understanding these relationships helps determine where a roadway can benefit from modifications.

[12] Map Source: City of Minneapolis website

2.8.1 MOTORIZED TRAFFIC

A look at the historical trend of the corridor shows a general decrease in volumes along the corridor. **Table 3** shows the historical volume trend within the study corridor dating back to 2001, where available. It should be noted that the 35W bridge impact was heaviest at the south end of the corridor, nearest the bridge site, and that Average Annual Daily Traffic (AADT) values for both 2007 and 2008 were influenced by the rerouted traffic.

TABLE 3
AADT HISTORICAL DATA[13]

Year	Over River	Btwn. 4th & 5th	S of Spring	At Summer	N of Lowry	S of 37th
2009	17,258	12,968	11,282	12,177	13,107	13,336
2008	23,322	17,444			11,388	
2007	31,225	25,613	16,881	19,408	17,585	15,734
2005	16,208	12,200	12,100	13,500	14,500	12,500
2003	15,363	14,014	13,432	17,445	15,852	13,800
2001	18,422	6,863	15,207	15,914	14,464	14,173
	Zone 1	Zone 1	Zone 2	Zone 2	Zone 3	Zone 4

Motorized traffic and bicycle volume information was collected throughout the corridor through a combination of sources. AADT and turning movement count information was collected from the City of Minneapolis' Transportation Data Management System (TDMS). It should be noted at the time the analysis was conducted, 2007 turning movement volume data was the most recent available. However, as with AADT count information, it was not considered representative of the corridor due to influences from the closure of the 35W bridge over the Mississippi River (August 1, 2007 to September 18, 2008). Therefore, 2006 turning movement data was used as a base for determining "existing" (2009) and design year (2029) forecasted volumes. In order to arrive at a conservative estimate that accounts for potential growth in the corridor, a half-percent annual growth rate was applied to the 2006 data to arrive at "existing" 2009 and 2029 design year volumes. A summary of the corridor's turning movement volumes can be found in **Appendix B**.

A capacity analysis was conducted of the existing corridor to determine the current ability for the corridor to carry additional traffic. This was done utilizing Synchro, version 7. This software was chosen because of its ability to replicate the analysis procedures defined in the 2000 Highway Capacity Manual. This manual quantifies traffic performance at intersections

[13] Source: Transportation Data Management System website.

in terms of seconds of delay. The weighted average for each approach lane of traffic for a signalized intersection is the intersection's Level of Service (LOS). LOS categories range from "A" (free flow, insignificant delays) to "F" (gridlock conditions with excessive delays). **Table 4** shows the LOS associated with the AM, PM, and off-peak hours.

TABLE 4
EXISTING LEVEL OF SERVICE

Intersection	AM Peak Hour	Off Peak Hour	PM Peak Hour
37th Ave	C	C	C
35th Ave NE	A	A	A
St. Anthony Pkwy	B	B	B
29th Ave NE	A	A	A
27th Ave NE	A	B	B
26th Ave NE	A	B	A
Lowry Ave NE	B	B	B
24th Ave NE	A	A	A
22nd Ave NE	A	A	A
20th Ave NE	A	A	A
19th Ave NE	A	A	A
18th ½ Ave NE	A	B	A
18th Ave NE	A	B	B
14th Ave NE	A	A	A
Broadway St	C	C	C
Spring St	A	A	B
1st Ave NE/7th St SE	C	B	C
E Hennepin Ave	B	C	C
5th St SE	A	B	E
4th St SE	B	B	D
University Ave SE	C	D	F
2nd St SE	A	A	E

2.8.2 BICYCLE TRAFFIC

Bicycle use of the corridor today is primarily limited to experienced cyclists, especially in the southern part of the corridor. Cyclist commuters are common along the corridor as it is one of the few north-south roadways that reaches both downtown and the city limits. In Zone 3, more casual cyclists are commonly observed using the corridor, as this area exhibits dense residential development and small businesses. It was only along the off-street, multi-use path adjacent to Columbia Park that more family-oriented cyclists were observed.

Manual bicycle turning movement counts were taken at six of the busiest vehicular intersections. Care was taken to conduct these counts when the climate was representative of

commuting and recreational bicycle use. For instance, when the project began in late October of 2008, Minneapolis was enjoying sustained weather in the 70's. Manual bicycle counts began at four of the six count locations. However, on November 1st, the weather changed drastically, and it was decided to postpone the remainder of the counts until the climate returned to a more comfortable level for the average cyclist. Furthermore, it was decided that the counts should not begin until the weather had been relatively nice for a number of weeks to account for as many cyclists as possible having returned to this mode of travel. **Table 5** documents the observed bicycle use at six of the corridor's busiest intersections.

It should be noted that the volumes identified below did not necessarily correspond to the vehicular peak hour. In many cases, bicycle volume increased after the vehicular AM peak hour. In the afternoon, it was common for the greatest concentration of bicycles to approach the intersection prior to the vehicular peak hour. The complete 13-hour count summary at each of these intersections can be found in **Appendix B**.

TABLE 5
EXISTING BICYCLE PEAK HOUR VOLUMES[14]

Location	AM Peak Hour	PM Peak Hour	13-hour Count
37th Ave	12	6	113
St. Anthony Pkwy	24	25	230
Lowry Ave	5	14	188
Broadway St[15]	13	26	153
Hennepin Ave	18	42	269
University Ave[15]	27	53	482

These manual counts confirmed that Central Avenue is already being used by cyclists for more than commuting purposes. However, the nature of the corridor greatly limits the type of cyclists to those relatively comfortable with cycling in traffic. Less experienced cyclists were observed riding on sidewalks.

2.9 BICYCLE COMPATIBILITY INDEX

In 1998, the Federal Highway Administration developed a method to evaluate the capability of urban and suburban roadway sections to accommodate both motorists and cyclists (in

[14] Counts include entering bike volumes to the intersection from all approaches. Peak hour data refers to the vehicular peak hour. The bicycle peak hour did not necessarily coincide with the vehicular peak hour.

[15] Source: City of Minneapolis Public Works

separate, dedicated lanes).[16] This effort was made in an attempt to increase the number of walking and biking trips and to simultaneously reduce the number of pedestrians and cyclists killed or injured by ten percent. The result of this study is the Bicycle Compatibility Index (BCI), an equation that factors in a variety of roadway characteristics to provide a roadway segment's compatibility level with respect to on-street bicycle travel. The BCI correlates this compatibility level with a Level of Service concept similar to that used for vehicular capacity analysis. However, to avoid confusion between the two LOS types, this study will only report the actual BCI along with the associated bicycle compatibility level (BCL). The BCI methodology factors in the 11 roadway characteristics, listed below:

- Presence of a bicycle lane or a paved shoulder greater than three feet
- Width of the bicycle lane of paved shoulder (if present)
- Width of the vehicular travel lane closest to the curb
- Volume in the vehicular travel lane closest to the curb (one direction)
- Volume in the remainder of the lanes (one direction)
- 85th percentile speed (or posted speed limit)
- Parking lane with 30% occupancy
- Type of roadside development
- Factors for amount of truck volumes, parking turnover & right turn volumes

As noted in the list above, BCI accounts for many of the roadways characteristics. However, it does have some limitations, and as such it should be used as only part of the conversation when considering bicycle facilities. For instance, it does not explicitly factor in crash history. Another limitation is the inflexibility of certain factors that heavily influence the BCI. An example of this is that Zone 4 has a northbound parking lane. The southbound direction has no such lane. Another example is parking may only be allowed on part of a particular block, or for portions of the day. **Table 6** summarizes the BCI and associated compatibility level associated with the existing street geometry and lane configuration. A lower BCI value denotes a segment of roadway more compatible with designated on-street bicycle facilities. For example, the segment between Summer and Broadway Streets has a BCI of 3.28, indicating that this

[16] Source: The Bicycle Compatibility Index: A Level of Service Concept, Implementation Manual, FHWA-RD-98-095, 1998

segment is moderately highly compatible with designated on-street bicycle lanes.

TABLE 6
BICYCLE COMPATIBILITY INDEX

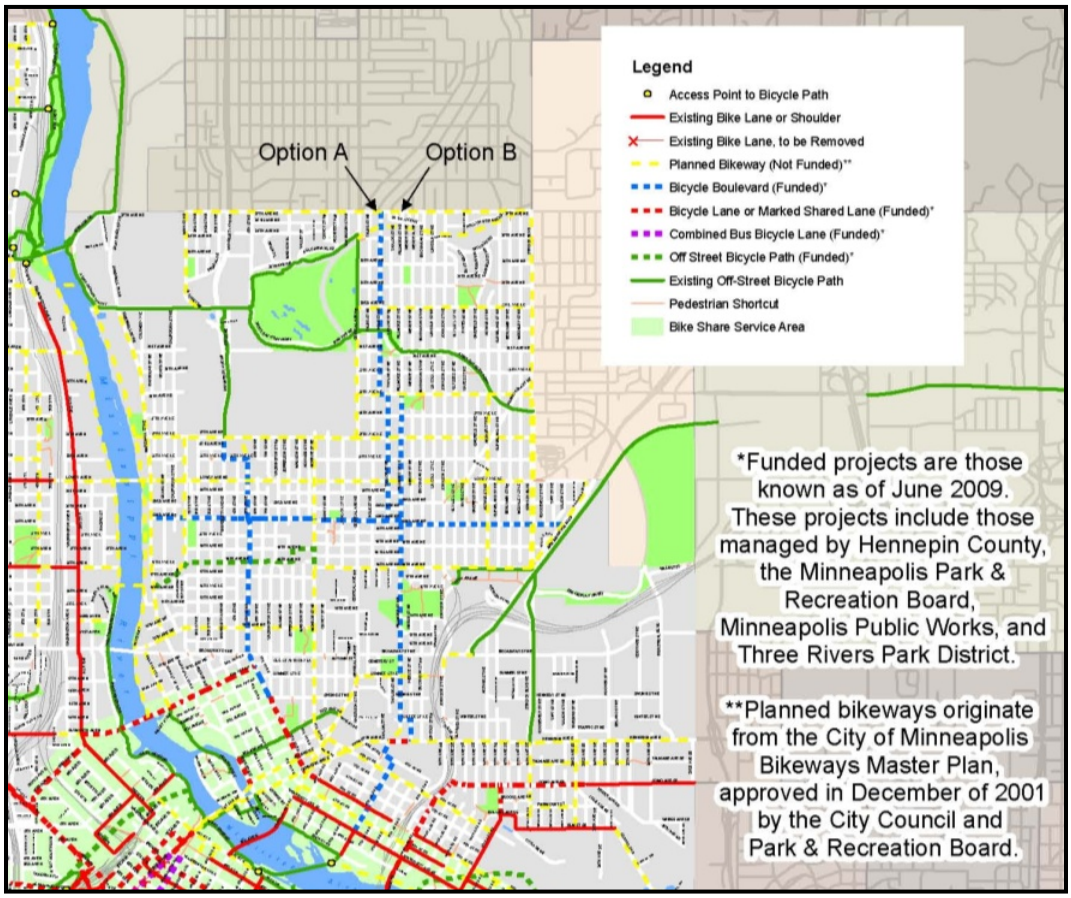
Zone	Intersection	BCI	BCL
1	2nd St SE	2.18	Very High
	Ortman St SE	4.00	Moderately Low
	University Ave SE	4.23	Moderately Low
	4th St SE	4.19	Moderately Low
	5th St SE	4.10	Moderately Low
	Hennepin Ave E	4.53	Very Low
	6th St NE	4.51	Very Low
	7th St NE/1st Ave NE	4.50	Very Low
	Zone 1 Average =	**4.03**	**Moderately Low**
2	8th St NE	3.29	Moderately High
	3rd Ave NE	3.29	Moderately High
	Spring St NE	3.68	Moderately Low
	Summer St NE	3.29	Moderately High
	Broadway St NE	3.28	Moderately High
	12th Ave NE	3.44	Moderately Low
	13th Ave NE	3.59	Moderately Low
	14th Ave NE	4.76	Very Low
	Zone 2 Average =	**3.58**	**Moderately Low**
3	18th Ave NE	3.71	Moderately Low
	18 1/2 Ave NE	4.09	Moderately Low
	19th Ave NE	4.13	Moderately Low
	20th Ave NE	4.38	Moderately Low
	22nd Ave NE	4.49	Very Low
	23rd Ave NE	4.41	Very Low
	24th Ave NE	4.38	Moderately Low
	Lowry Ave NE	4.43	Very Low
	26th Ave NE	4.28	Moderately Low
	Zone 3 Average =	**4.26**	**Moderately Low**
4	27th Ave NE	3.92	Moderately Low
	28th Ave NE	3.86	Moderately Low
	29th Ave NE	3.74	Moderately Low
	30th Ave NE	3.86	Moderately Low
	31st Ave NE	3.59	Moderately Low
	St. Anthony Pkwy	3.61	Moderately Low
	33rd Ave NE	3.59	Moderately Low
	34th Ave NE	3.59	Moderately Low
	35th Ave NE	3.61	Moderately Low
	Columbia Pkwy	3.59	Moderately Low
	37th Ave NE	3.77	Moderately Low
	Zone 4 Average =	**3.70**	**Moderately Low**

2.10 BICYCLE NETWORK

A bicycle network becomes more appealing to potential cyclists if they know that their needs can be met reliably and with some degree of convenience. A wide, continuous bicycle path with smooth pavement that takes a cyclist miles from their intended route might be less desirable to some than a more direct route that requires travel with traffic. Likewise, a destination becomes more attractive to cyclists when they have some assurance that there will be a place to securely park their bicycle once they arrive. Minneapolis is commonly recognized for its trail system and cycling community. This is supported by a bikeway building boom, in which 45 miles of bikeways will be built

over the 2009 and 2010 construction seasons. Other bicycle facilities, such as the one being discussed in this study, may be implemented as soon as 2011. This is leading toward an interconnected, comprehensive network of bikeways throughout the city. **Figure 5** shows the existing, funded and planned bikeways in Northeast Minneapolis as of June 2009. It should be noted that the subject of this study has not yet officially been added. The planned bikeway along Central Avenue between 27th Avenue and Saint Anthony Boulevard refers to an off-street extension of the existing facility that borders Columbia Park.

FIGURE 5
EXISTING, FUNDED & PLANNED BIKEWAYS
IN NORTHEAST MINNEAPOLIS[17]



It is the city's desire to supplement this network with infrastructure, investments and partnerships that maximize the opportunities that it brings. These enhancements include

[17] Source: City of Minneapolis Bicycling Website; New Projects Page

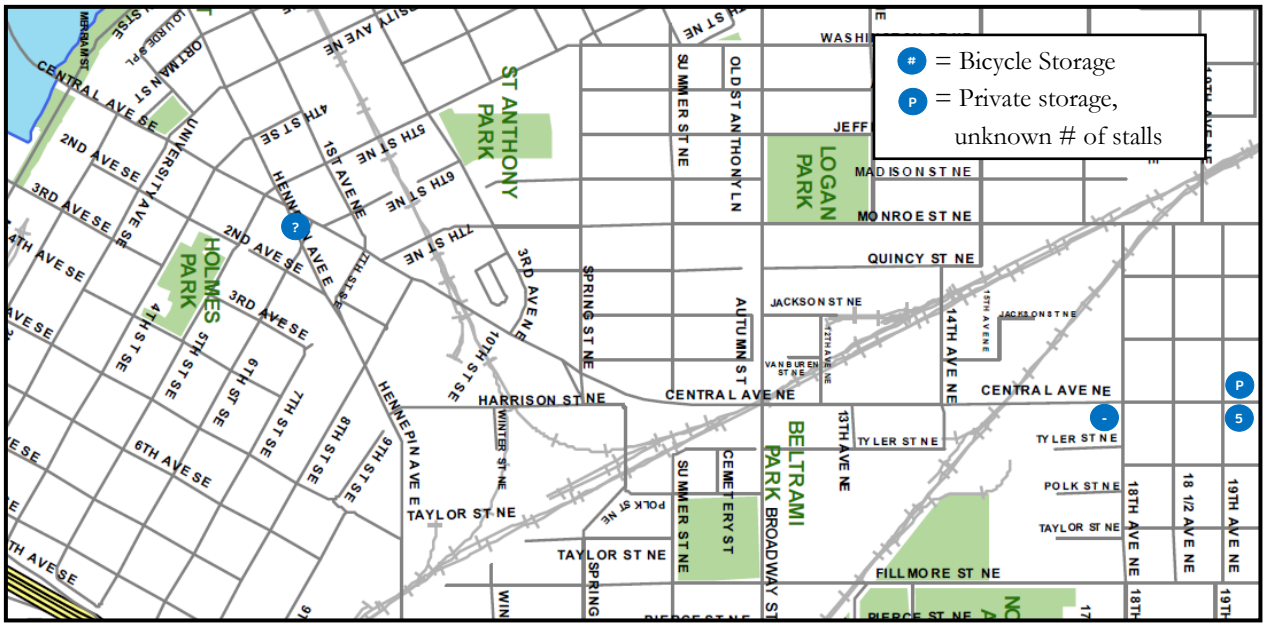
bikeway identification, signing of connecting routes, additional parking facilities and regular maintenance.

2.11 BICYCLE STORAGE

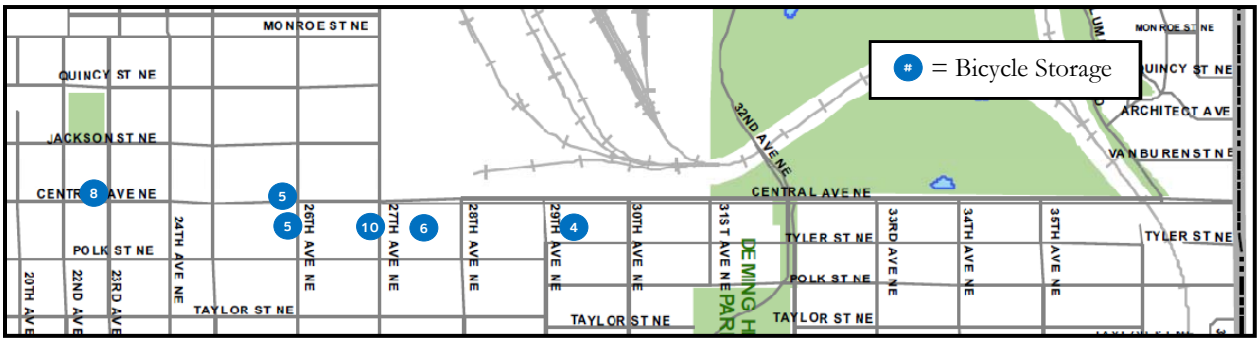
The field inventories taken as part of this study included documentation of the existing bicycle parking facilities. The inventory findings were limited to those on public property or storage on private property that could be seen while standing on the sidewalk[18]. This information was compared to the Bike Racks & Lockers Draft Map found on the city's bicycling website, and the results are displayed in **Figure 6**.

Bicycle parking in front of White Castle

FIGURE 6
BICYCLE STORAGE



[18] There appeared to be bike storage at the former Burger King site south of 18th Street. However, the Burger King has been closed for business. Since this site is on private property, the available bike storage is also considered closed.



These findings yielded a couple items of note. First, there was an overall lack of bicycle storage along the corridor. This is especially true outside of Zone 3, the corridor's most commercialized segment. Second, there did appear to be a demand for bicycle racks as it was common throughout the corridor to find bicycles chained to trees, fences or sign posts.

2.12 SAFETY

2.12.1 VEHICULAR SAFETY

A review of the crash history of the corridor was conducted to better understand how the corridor might benefit or detract from the addition of bicycle facilities. The City of Minneapolis provided crash data for the 5-year period between January 2004 and December 2008. A summary of the corridor's crash history, separated by intersection, accident type and zone, is shown below in **Table 7**. These accidents represent only those that were reported to the Department of Public Safety.

A total of 449 crashes occurred along the corridor's 36 intersections during the five-year period. The 129 rear end crashes accounted for 29% of the corridors total. No other accident type totaled more than 68 (right angle). Seven intersections each exhibited 5% or more of the corridors total crashes. They include:

- Lowry Avenue (51; 11.3%)
- Broadway Street (47; 10.4%)
- 18th Avenue NE (33; 7.3%)
- University Avenue (28 crashes; 6.2%)
- 4th Street SE (24; 5.3%)
- Saint Anthony Parkway (23; 5.1%)
- 26th Avenue NE (21; 4.7%)

TABLE 7
CRASH HISTORY: 2004-2008[19]

Zone	Description	Intersection	Rear End	Side Swipe	Left Turn	Fixed Object	Right Angle	Right Turn	Backing/ Parking	Parked Vehicle	Head On	Pedestrian	Bicycle	Intersection Total	Zone Total
1	Mississippi River to 1st Avenue NE	2nd St SE	5	1		1					1		1	9	111
		Ortman St SE	2	1										3	
		University Ave SE	5	2	8	1	4			4		4		28	
		4th St SE	5	1	2	2	8			3		2	1	24	
		5th St SE	3	2									1	6	
		Hennepin Ave E	14	1		1	1							17	
		6th St NE	1	2			5					2		10	
		7th St NE/1st Ave NE	4	4			4		1	1				14	
2	1st Avenue NE to 18th Avenue NE	8th St NE	3				3				2		2	10	86
		3rd Ave NE				3								3	
		Spring St NE	1		1	3	3		1				1	10	
		Summer St NE				1								1	
		Broadway St NE	24	1	7	4	5		1	1	2	1	1	47	
		12th Ave NE							1				1	2	
		13th Ave NE				1							1	2	
		14th Ave NE	3	2	1	2					1	1	1	11	
3	18th Avenue NE to 27th Avenue NE	18th Ave NE	4	2	6	8	6	1	1	1		2	2	33	163
		18 1/2 Ave NE	3		3			1		3				10	
		19th Ave NE	2	2							2	1	1	8	
		20th Ave NE					1			5				6	
		22nd Ave NE	7				2			2		2	1	14	
		23rd Ave NE	2				2			2		1	1	8	
		24th Ave NE	2	3			2		1	1	1	1	1	12	
		Lowry Ave NE	11	3	8	2	9	3	1	3	1	4	6	51	
		26th Ave NE	4	1	2	1	3		1	6			3	21	
4	27th Avenue NE to 37th Avenue NE	27th Ave NE	3	1	2	3	5					1	1	16	89
		28th Ave NE	1		1	1				1				4	
		29th Ave NE	2			1	1						1	5	
		30th Ave NE		1			1						2	4	
		31st Ave NE		1						1				2	
		St. Anthony Pkwy	4	3	3	7	3			1	2			23	
		33rd Ave NE	1		1					4				6	
		34th Ave NE				1						1		2	
		35th Ave NE	1			1				1		1	1	5	
		Columbia Pkwy	5			1								6	
		37th Ave NE	7		2	4		1					2	16	
		Total	129	34	47	49	68	6	8	40	12	24	32	449	

To put these crashes in perspective, it is helpful to analyze them in terms of crash rate. This method of analysis helps compare segments with varying volumes and lengths to more clearly determine where safety problems have occurred.

The crash rate is defined as the number of crashes occurring per million vehicles[20]. Two similar formulas are utilized depending on whether one is looking for the crash rate of a segment within a corridor or at an intersection. **Equations 1 & 2** describe the difference.

EQUATION 1
CRASH RATE FOR A SEGMENT WITHIN A CORRIDOR

$$\text{Crash Rate}_{\text{(per million vehicle miles)}} = \frac{\text{(\# crashes)*(1 million)}}{\text{(segment length)*(\# years studied)*(segment ADT)*(365)}}$$

[19] Source: City of Minneapolis

[20] Source: Mn/DOT Traffic Safety Fundamentals Handbook, 2008

EQUATION 2
CRASH RATE AT AN INTERSECTION

$$\text{Crash Rate}_{\text{(per million entering vehicles)}} = {}^{\text{(\# crashes)*(1 million)}}/_{\text{(\# years studied)*(intersection ADT)*(365)}}$$

Table 8 displays the crash rates for each zone using Equation 1, the calculation for segments within a corridor.

TABLE 8
VEHICULAR CRASH RATES BY ZONE

Zone	Limits	Bicycle Crashes	Segment Length	Segment ADT	Crash Rate
1	River to 1st Ave	3	0.47 mi	15,113	8.56
2	1st Ave to 18th Ave	7	1.09 mi	11,729	3.68
3	18th Ave to 27th Ave	15	0.74 mi	13,107	9.20
4	27th Ave to 37th Ave	7	1.30 mi	13,336	2.81
Total		32	3.6 mi	N/A	N/A

The crash rates can be put into further perspective when compared to roadways of similar nature. For instance, Zones 1 & 3 are urban, 4-lane, undivided facilities. As can be seen in **Table 9**, crash rates for these zones are significantly higher than the Metro District[21] average for this type of roadway. Conversely, Zones 2 & 4 exhibit lower crash rates compared to similar roadways.

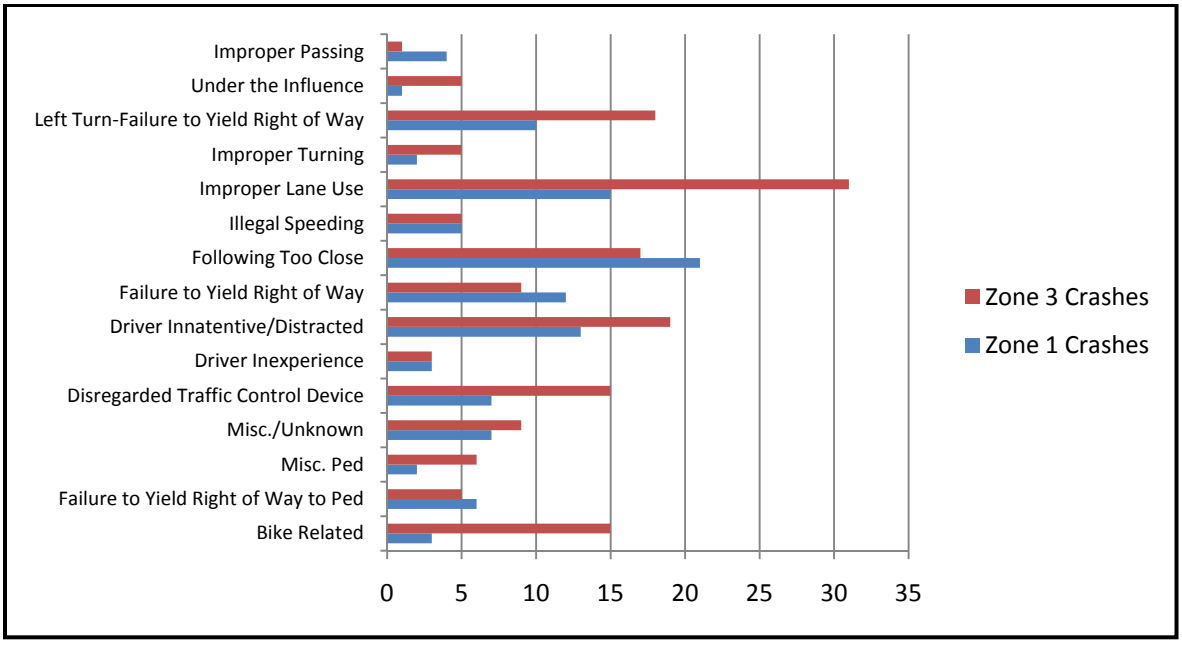
TABLE 9
VEHICULAR CRASH RATES COMPARED TO METRO DISTRICT

Zone	Segment Characteristics	Segment Crash Rate	Average Metro Crash Rate[15]
1	Urban, 4-lane undivided	8.56	5.8
2	Urban, 4-lane divided, non-expressway	3.68	5.0
3	Urban, 4-lane undivided	9.20	5.8
4	Urban, 4-lane divided, non-expressway	2.81	5.0

[21] The Metro District is defined by Mn/DOT as the eight-county Twin Cities Metropolitan Area. Central Avenue is located in this district.

Because the rates were significantly higher than average, additional investigation was completed to determine the cause of the crashes in the Zone 1 & 3. **Figure 7** summarizes the reported causes.

FIGURE 7
CONTRIBUTING FACTORS TO ZONE 1 & 3 CRASHES[22]



It is helpful to revisit the context in which these accidents are happening. Zones 1 & 3 have many similar roadway characteristics, and when compared to the most common contributing factors, may help to explain the nature of some crashes. A summary of these zone's characteristics are shown below.

- Left turn lanes off of Central Avenue are only present at Lowry Avenue
- Predominantly signalized corridor with mast arm indications and signing
- Permissive left turn phasing from Central Ave, except at Lowry & 27th Avenues (protected-permissive phasing).
- On-street parking is common on both sides of the street
- Limited sightlines at corners due to building placement immediately behind sidewalk
- Mid-block driveways

[22] See **Figure 8** in Section 2.10.2 for detail relating to crashes involving bicycles in Zone 3. There were a total of three bicycle-related crashes in Zone 1. It was decided that his relatively low number did not warrant further detailed review.

- In Zone 3, minimal turns from Central Ave (exception: Lowry Ave) and relatively small cross street volumes.
- Very high directional flow in the AM & PM peak hours
- Bus stops on shoulders
- Short blocks are common

Table 10 isolates any contributing factors that represented 10% or more of the total crashes in each zone and identifies possible relationships with the 4-lane undivided roadway.

TABLE 10
CONTRIBUTING FACTORS FOR ZONE 1 & 3 CRASHES

Significant Contributing Factors	Zone 1 Crashes	Zone 3 Crashes	Relationships to Roadway Characteristics
Left turn vehicle fails to yield right of way to another vehicle	10	18	Turning vehicle attempts to turn at the end of yellow phase
			Motorist turns left in front of oncoming traffic in permissive phase
			Turning motorist creeps into nearest opposing lane anticipating gap in furthest lane.
			Sightlines blocked by opposing left turn traffic
A vehicle fails to yield right of way to another vehicle (not involving a left turn)	12	9	Motorist unable to clear intersection due to queuing ahead
			Right turns from driveways
			Conflicts with traffic in parking lane
			Sudden lane changes
			Right turns on red
Following too Close	21	17	Aggressive or inpatient motorists attempting to clear intersection
			Motorists surprised by vehicles ahead slowing to turn
Improper lane use	15	31	Improper passing of vehicle waiting to turn
			Passing slower vehicles on shoulder/parking lane
Driver inattentive or distracted	13	19	Conflicts with vehicles parked on-street
			Sightlines blocked by buses or other vehicles
			Sightlines blocked by buildings
Disregarded a traffic control device	*	15	Entered intersection on red
Bicycle-related crashes	*	15	See Section 2.12.2 for more detail

2.12.2 BICYCLE SAFETY

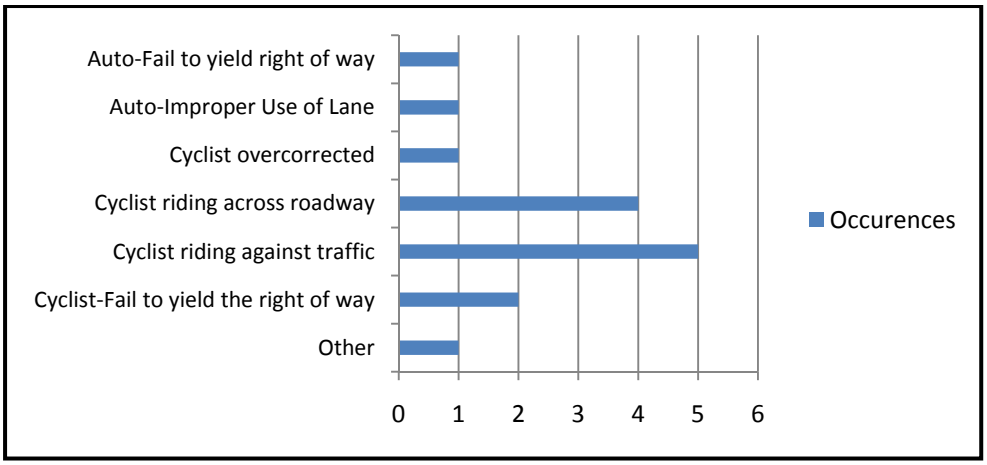
A similar crash rate analysis was conducted focusing on bicycle crash history. To accomplish this, the vehicular crash rate formula was modified to add bicycle ADT and isolate bicycle crashes. Bicycle ADT's were extrapolated from the 13-hour counts by assuming that 80% of the bicycle traffic occurs during the 13-hour time period between 6:00 AM and 7:00 PM. **Table 11** reflects the bicycle crash rates for each zone, utilizing the crash rate calculation for segments within a corridor (**Equation 1**).

TABLE 11
BICYCLE CRASH RATES BY SEGMENT

Zone	Limits	Total Bicycle Crashes	Segment Length	Average Vehicular ADT[19]	Average Bicycle ADT[23]	Combined ADT	Segment Bicycle Crash Rate
1	River to 1st Ave	3	0.47 mi	15,113	284	15,397	0.23
2	1st Ave to 18th Ave	7	1.09 mi	11,729	116	11,845	0.29
3	18th Ave to 27th Ave	15	0.74 mi	13,107	165	13,272	0.84
4	27th Ave to 37th Ave	7	1.30 mi	13,336	130	13,466	0.22
Total		32	3.6 mi	N/A	N/A	N/A	N/A

When looking at the corridor, Zone 3 stands out as a segment with a significantly higher level of both vehicular and bicycle crash rates. Further analysis was conducted to attempt to determine the cause of the unusually high rates. Specifically, the contributing factors involved in each crash involving a bicycle were investigated. The results unveiled an overwhelming trend: Twelve of the 15 crashes cited the cyclist as the cause of the crash. **Figure 8** lists the factors involved with the number of occurrences for each.

FIGURE 8
CONTRIBUTING FACTORS TO ZONE 3 BICYCLE CRASHES



It should be noted that installing dedicated on-street bicycle lanes in this Zone would likely reduce the number of crashes in two of these categories. Pavement markings delineating the bicycle lane would provide an additional visual cue to motorists and decrease the potential for future "Auto-

[23] Does not include cross street bike volumes.

Improper Use of Lane" crashes. Secondly, the directional arrows placed in bicycle lanes would communicate the intended flow of traffic to help diminish the number of crashes related to "Cyclist Riding Against Traffic".

An evaluation of the bicycle crash rate for each intersection using **Equation 2** was completed. This was done to isolate specific intersections of concern. **Table 12** displays the results. Intersections at which turning movement volumes were not available were not included in this part of the analysis. For purposes of comparison, two intersections exhibit a bicycle crash rate greater than one standard deviation above the average for the corridor. These intersections are located at Lowry Avenue and 26th Avenue, both in Zone 3.

TABLE 12
BICYCLE CRASH RATE BY INTERSECTION

Zone	Intersection	Bicycle Crashes	Vehicular ADT	Bicycle ADT	Total Entering Vehicular Volume	Total Entering Bicycle Volume	All Entering Volume	Intersection Bicycle Crash Rate
1	2nd St SE	1	25292	470	46,157,900	856,838	47,014,738	0.02
	Ortman St SE			470	-	856,838	-	N/A
	University Ave		28967	470	52,864,775	856,838	53,721,613	0
	4th St SE	1	26876	470	49,048,700	856,838	49,905,538	0.02
	5th St SE	1	16331	470	29,804,075	856,838	30,660,913	0.03
	Hennepin Ave E		18579	470	33,906,675	856,838	34,763,513	0
	6th St NE			470	-	856,838	-	N/A
	7th St NE/1st		22967	470	41,914,775	856,838	42,771,613	0
2	8th St NE	2		191	-	348,575	-	N/A
	3rd Ave NE			191	-	348,575	-	N/A
	Spring St NE	1	11233	191	20,500,225	348,575	20,848,800	0.05
	Summer St NE			191	-	348,575	-	N/A
	Broadway St NE	1	19706	191	35,963,450	348,575	36,312,025	0.03
	12th Ave NE	1		191	-	348,575	-	N/A
	13th Ave NE	1		191	-	348,575	-	N/A
	14th Ave NE	1	8743	191	15,955,975	348,575	16,304,550	0.06
3	18th Ave NE	2	11272	235	20,571,400	428,875	21,000,275	0.10
	18 1/2 Ave NE		7612	235	13,891,900	428,875	14,320,775	0
	19th Ave NE	1	7723	235	14,094,475	428,875	14,523,350	0.07
	20th Ave NE		9255	235	16,890,375	428,875	17,319,250	0
	22nd Ave NE	1	8425	235	15,375,625	428,875	15,804,500	0.06
	23rd Ave NE	1		235	-	428,875	-	N/A
	24th Ave NE	1	11550	235	21,078,750	428,875	21,507,625	0.05
	Lowry Ave NE	6	14487	235	26,438,775	428,875	26,867,650	0.22
	26th Ave NE	3	9139	235	16,678,675	428,875	17,107,550	0.18
4	27th Ave NE	1	9734	215	17,764,550	391,463	18,156,013	0.06
	28th Ave NE			215	-	391,463	-	N/A
	29th Ave NE	1	11214	215	20,465,550	391,463	20,857,013	0.05
	30th Ave NE	2		215	-	391,463	-	N/A
	31st Ave NE			215	-	391,463	-	N/A
	St. Anthony		16289	215	29,727,425	391,463	30,118,888	0
	33rd Ave NE			215	-	391,463	-	N/A
	34th Ave NE			215	-	391,463	-	N/A
	35th Ave NE	1	8831	215	16,116,575	391,463	16,508,038	0.06
	Columbia Pkwy			215	-	391,463	-	N/A

	37th Ave NE	2	13908	215	25,382,100	391,463	25,773,563	0.08
Total Bicycle Crashes =		32					**Average**	**0.051**

2.13 EXISTING BICYCLE-RELATED ISSUES

The preceding sections illustrate a number of areas of possible concern to cyclists. The following text summarizes issues related to the existing conditions in the context of the relationship between bicycles and the corridor's characteristics. Later in this document, alternatives that help reduce exposure to many of these issues will be introduced. The following bulleted list (A-I) is graphically displayed in **Figure 9**.

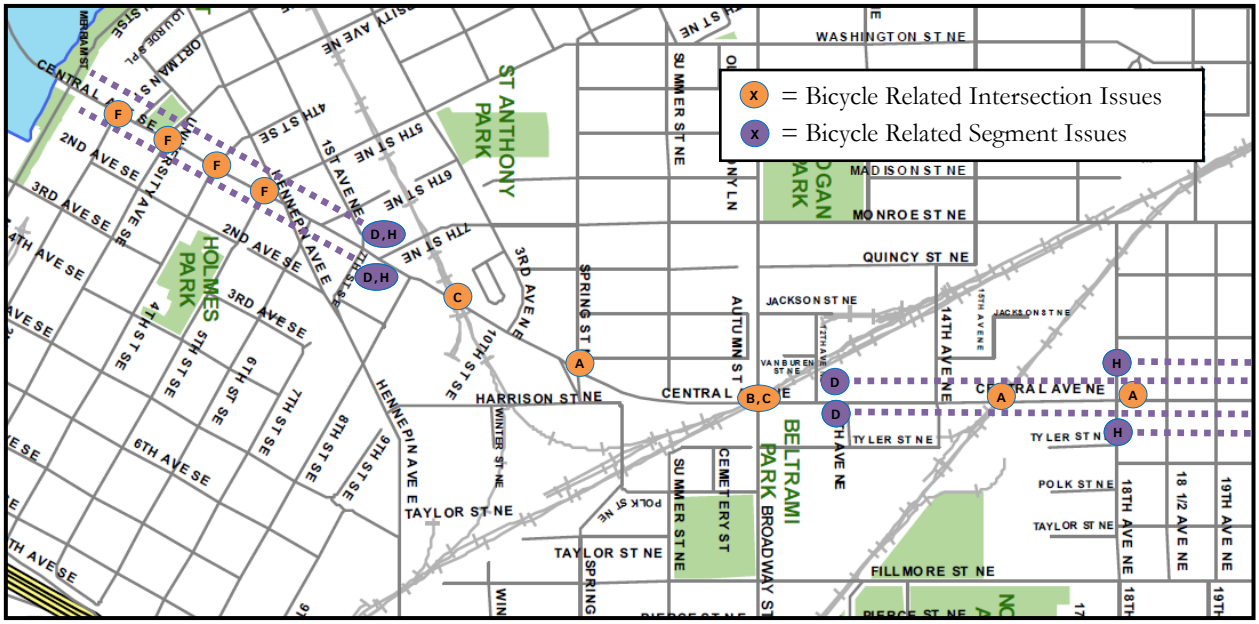
A. There are three locations where the roadway's width changes, adding complexity to the installation of continuous bicycle facilities (Spring Street, BNSF overpass north of 14th Avenue & short medians at 18th Avenue intersection).
B. The elevated intersection at Broadway Street contains expansion joints at 45-degrees to approaching traffic. Concern has been raised that they may catch bicycle tires and knock cyclists off balance. This concern is heightened when cyclists are adjacent to motorized traffic.
C. Central Avenue crosses over two rail lines. The vertical alignment exhibits relatively steep inclines on each approach. These inclines cause additional strain and potentially reduce a cyclists' situational awareness.
D. Much of the corridor exhibits on-street parallel parking. When cyclists travel next to parked cars without giving the vehicles an adequate passing buffer, an additional hazard is presented in the form of opening doors or vehicles pulling into or out of a parking space.
E. Buses provide a challenge to cyclists similar to that of on-street parking. Though transit buses are operated by professional drivers, the combination of larger blind spots, aggressive or inattentive motorists and cyclists sharing the same pavement provides for a segment of pavement containing increased conflict points. See **Figure 4** for a graphical representation of these locations.
F. From a vehicular congestion perspective, several intersections in Zone 1 operate at an LOS of D or worse during the PM Peak hour. Each instance, and the corresponding LOS is listed below:
   - 5th Street SE, E
   - 4th Street SE, D
   - University Avenue SE, F
   - 2nd Street SE, E

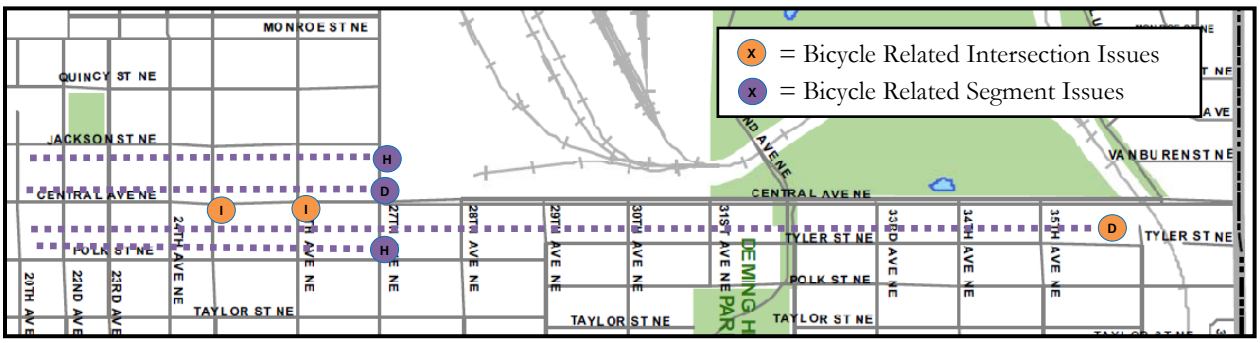
G. Bicycle storage around the corridor was generally sparse. The supply did not appear to be strategically located near bus stops, and large portions of the corridor lacked storage facilities altogether. A need became evident as it was common to find bicycles attached to signposts, fences and trees. **Figure 6** shows current storage locations.

H. Zone 1 (8.56) and Zone 3 (9.20) exhibited high vehicular crash rates when compared to the Metro average of 5.8 for similar types of roadways.

I. Intersections within Zone 3 generally exhibit higher than average bicycle accident rates compared to the rest of the corridor. This is especially true of Lowry Avenue and 26th Avenue, where the bicycle accident rates are more than one standard deviation above the average.

FIGURE 9
BICYCLE-RELATED ISSUES MAP





3.0 EVALUATION OF ALTERNATIVES

This section discusses the methodology used in developing scenarios and ultimately the recommended alternative. Emphasis was placed on developing alternatives that accomplish the following project goal:

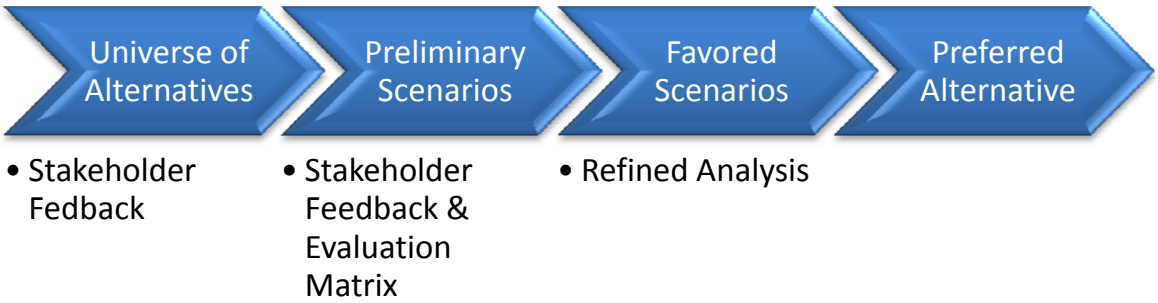
Identify a preferred alternative that can be integrated in the corridor and community that serves all users.

3.1 METHODOLOGY

Early in the study, it was important to develop as complete of an understanding of the corridor as possible. This was accomplished through a combination of field inventories and observations, analysis of relevant data, discussions with city and partnering agency staff, reviews of related studies, and public engagement.

It quickly became clear that the character of the corridor changes many times, and general segments became apparent. Understanding that applying a single design was not the best solution for the corridor, scenarios were developed that applied to a particular zone within the corridor. When presented to stakeholders, each scenario's advantages and disadvantages were discussed. The scenarios were narrowed down until a logical preferred alternative surfaced. **Figure 10** illustrates the steps taken to reach the preferred alternative along with the methods used to reach the next step.

FIGURE 10
ALTERNATIVES ANALYSIS



3.2 SCENARIO DEVELOPMENT

Each distinct segment of the corridor was examined for opportunities to accommodate bicycle facilities that fit each particular segment of the corridor. Once a scenario had been developed, an initial feasibility check was conducted. At this point, various alternatives were eliminated. An example of this includes the option of implementing dedicated bicycle lanes

between the river and 8th Street. Initial analysis showed that the street was not wide enough to install dedicated bicycle lanes while maintaining the existing vehicle lanes and on-street parking. Further complicating matters, the parking density is high in this area, and an analysis of existing traffic operations showed this segment to already be operating at deficient levels at multiple intersections. Evaluation of a 3-lane section also showed failing auto traffic operations. This option was therefore not added to the list of scenarios to be carried forward for additional consideration. Other examples of alternatives that failed the feasibility check include the following:

- A 3-lane section within the segment between 8th Avenue SE and 18th Avenue NE failed because Mn/DOT considers the raised concrete median a valuable element in preserving safety along this portion of the corridor and would not support its removal.
- A 3-lane section north of 27th Avenue NE requested for consideration at the presentation to the Minneapolis Bicycle Advisory Committee (BAC) failed because the removal of one lane in each direction coupled with the relatively short left turn lanes substantially degraded auto traffic operations.
- A shared lane situation between 18th and 27th Avenues. This is similar to the existing conditions, with the difference being the added shared lane pavement marking. This failed because of the significant safety concerns related to bicycle crashes identified in Section 2.12.2 and 2.12.3.I. Additional safety discussion related to the four-lane section in Zone 3 can be found later in this section.

Those scenarios that did pass the feasibility test were further analyzed, and each scenario's advantages and disadvantages (pros & cons) were identified and communicated during presentations to stakeholders. The corridor was divided into five sections, denoted A-E, (later reduced to four Zones in the recommended alternative). It should be noted that the scenario boundaries evolved during the analysis, and those referred to in this section are in some cases different from those identified in the recommended alternative. Throughout these presentations, requests to consider additional scenarios were made and considered. If they passed the initial feasibility review, they were added as scenarios for further consideration. **Table 13** displays all scenarios presented to the East Side Bicycle Task Force, Bicycle Advisory Committee, Mn/DOT staff and the first public engagement meeting. They include those that were added via requests from attendees at earlier meetings. Layouts of each scenario can be found in the **Appendix C**[24].

[24] No layout for Scenario E6 was developed as it was added for consideration after the public comment period.

TABLE 13
PRELIMINARY SCENARIOS

Zone	Scenario	Description	Pros	Cons
Zone 1: River to 8th St SE	No-build	4-lane undivided with on-street parking		
	A1	4-lane undivided with shared outside lanes	Parking retained on both sides	Cyclists travel with traffic
			Increased motorist awareness of cyclists	No dedicated bike lanes
	A2	4-lane undivided with outside bike lanes	Dedicated lanes in both directions	Only possible between Hennepin & 8th Street SE
				Parking removed on east side between Hennepin & 7th St SE
Zone 2a: 8th St SE to 14th Ave	No-build	4-lane divided		
	B1	4-lane divided with outside bike lanes	Dedicated lanes in both directions	5' bike lanes adjacent to 11' travel lanes
	B2	4-lane divided with NB outside bike lane	No impact to SB pavement markings	SB bike traffic to utilize parallel route (Monroe or Fillmore St)
	B3	4-lane divided with shared outside lanes	Increased motorist awareness of cyclists	Cyclists travel with traffic, icluding areas of significant grades
				No dedicated bike lanes
Zone 2b: 14th Ave to 18th Ave	No-build	4-lane divided		
	C1	4-lane divided with outside bike lanes	Dedicated lanes in both directions	Vehicular lanes narrowed to incorporate bike lane
	C2	4-lane divided with outside bike lanes	Dedicated lanes in both directions	Bike lanes require ramps up to sidewalk to maneuver around bridge piers
	C3	4-lane divided with NB outside bike lane	No impact to SB pavement markings	SB bike traffic to utilize parallel route (Monroe or Fillmore St)
Zone 3: 18th Ave to 27th Ave	No-build	4-lane undivided with on-street parking		
	D1	4-lane undivided with outside bike lanes	Dedicated lanes in both directions	Vehicular and parking lanes narrowed to incorporate bike lane
			Parking retained on both sides	5' bike lanes adjacent to 11' travel lanes
	D2	3-lane undivided with outside bike lanes	Dedicated lanes in both directions	Traffic operations slightly degraded
			Parking retained on both sides	
	D3	4-lane undivided with NB outside bike lane	No impact to SB pavement markings	SB bike traffic to utilize parallel route (Monroe or Fillmore St)
			Parking retained on both sides	
Zone 4: 27th Ave to 37th	No-build	4-lane divided with parking on NB side		
	E1	4-lane divided with narrowed median, parking on NB side, and NB bike lane	Parking is retained	Median narrowing is necessary
				SB bike traffic to utilize parallel route (Fillmore St)
	E2	4-lane divided with NB outside bike lane	Median is not disturbed	SB bike traffic to utilize parallel route (Fillmore St)
				Parking is removed
	E3	4-lane undivided with outside bike lanes	Dedicated lanes in both directions	Median is removed
			Parking is retained	
	E4	4-lane divided cycletrack	Median is not disturbed	Significant capital cost to install
			Parking is retained	Requires encroachment of right-of-way
			Dedicated lanes in both directions	
	E5	4-lane divided with shared outside lanes	Median is not disturbed	Cyclists travel with traffic
			Parking is retained	
	E6	2-way cycletrack on west side of Central Avenue	Bicycles are removed from traffic	Significant capital cost to install

3.3 SCENARIO EVALUATION

3.3.1 EVALUATION OF PRELIMINARY SCENARIOS

In addition to feedback from stakeholder meetings and the public comment website, each scenario was evaluated by the seven criteria listed in **Table 14**, using a matrix. These criteria directly support the project goal and helped steer the project towards meeting that goal. Each scenario was assigned a ranking based on how it met each criterion. **Table 15** summarizes the results of the matrix evaluation.

- Meets Criteria (↑)
- Partially Meets Criteria (-)
- Does Not Meet Criteria (↓)

TABLE 14
CRITERIA FOR PRELIMINARY EVALUATION OF SCENARIOS

Criteria Abbreviation	Criteria Description
Safety	Promotes safe bicycle travel
Community	Appropriate for the community
Parking	Avoid Removing on-street parking
Standards	Meets design guidelines[25]
Operations	Should not increase deficient[26] motorized traffic and transit operations
Cost	Relatively inexpensive to implement
Cyclist %	Serve an increased portion of bicycle users

TABLE 15
PRELIMINARY EVALUATION MATRIX[27]

Zone 1	Scenario	Description	Criteria						
			Safety	Community	Parking	Standards	Operations	Cost	Cyclist %
Zone 1: River to 8th St SE	No Build	4-lane undivided with on-street parking	↓	–	↑	↑	↓	↑	↓
	A1	4-lane undivided with shared outside lanes	–	↑	↑	↑	–	↑	↑
	A2	4-lane undivided with outside bike lanes (north of Hennepin Ave)	↑	↑	–	↑	↑	↑	↑
Zone 2a: 8th St SE to 14th	No Build	4-lane divided	↓	–	↑	↑	↑	↑	↓
	B1	4-lane divided with outside bike lanes	↑	–	↑	↓	↑	↑	↑
	B2	4-lane divided with NB outside bike lane	↓	–	↑	–	↑	↑	–
	B3	4-lane divided with shared outside lanes	–	↑	↑	↑	↑	↑	↑
Zone 2b: 14th Ave to 18th Ave	No Build	4-lane divided	↓	–	↑	↑	↑	↑	↓
	C1	4-lane divided with outside bike lanes	↑	↑	–	↑	↑	↑	↑
	C2	4-lane divided with outside bike lanes ramped around bridge piers	–	–	↑	–	↑	↓	↑
	C3	4-lane divided with NB outside bike lane	↓	–	↑	–	↑	↑	–
Zone 3: 18th Ave to 27th	No Build	4-lane undivided with on-street parking	↓	–	↑	↑	↑	↑	↓
	D1	4-lane undivided with outside bike lanes	↓	–	↑	↓	↑	↑	↑
	D2	3-lane undivided with outside bike lanes	↑	↑	↑	↑	–	↑	↑
	D3	4-lane undivided with NB outside bike lane	↓	–	↑	–	↑	↑	–
Zone 4: 27th Ave to 37th	No Build	4-lane divided with parking on NB side	↓	–	↑	↑	↑	↑	↓
	E1	4-lane divided with narrowed median, parking on NB side, and NB bike lane	↓	↓	↑	↑	↑	↓	–
	E2	4-lane divided with NB outside bike lane	↓	–	↓	–	↑	↑	–
	E3	4-lane undivided with outside bike lanes	↑	↓	↑	↑	↑	↓	↑
	E4	4-lane divided cycletrack	↑	↓	↑	↑	↑	↓	↑
	E5	4-lane divided with shared outside lanes	–	↑	↑	↑	↑	↑	↑
	E6	2-way cycletrack on west side of Central Ave	↑	↑	↑	↑	↑	↓	↑

Those scenarios (not including the No-build conditions) that failed to at least partially meet every criteria were considered for elimination. The following provides a listing of those scenarios that merited this consideration, distinguished by those that were kept from those that were eliminated.

[25] See Section 1.2

[26] Deficient operations are characterized as having an LOS of E or worse.

[27] Scenarios carried forward for further review are identified with scenario and description text in blue font.

Scenarios considered for elimination but retained

Scenario B1 was retained due to discussion with Mn/DOT's Bicycle and Pedestrian section, considering that a 5' dedicated bicycle lane utilized on a roadway with no on-street parking, but with numerous inclines is safer than traveling in a shared lane.

Scenarios eliminated from short-term consideration

Scenario E4 was eliminated for two reasons. Like others that were eliminated, it required significant capital investments, whose availability is not likely to coincide with the upcoming Mn/DOT overlay project. In addition, this scenario would require encroachment outside of existing right-of-way, adding significant complexity to implementation of this scenario. However, this scenario did provide for safe and efficient travel for all modes of traffic. It is recommended that this scenario be considered for a long-term option when the existing pavement is due for replacement. Scenario E6 should likewise be considered for possible long-term implementation.

Scenarios eliminated from further consideration

Scenario B2 and others that proposed a dedicated bike lane in one direction were eliminated due to a consistent, though not unanimous message that was received opposing this concept. This concern was twofold: First, having no exclusive bicycle lane in the southbound direction and requiring a detour to a parallel roadway to reach an exclusive southbound bicycle lane would reduce the attractiveness of bicycle facilities on Central Avenue. Second, concern was raised regarding the potential of head-on bicycle crashes relating to wrong-way southbound cyclists that might use the northbound bicycle lane since it was the only exclusive bicycle facility available on the corridor (and it should be noted that five of the recent bicycle crashes in Zone 3 were due to wrong-way cycling). Scenarios C3, D3, E1 & E2 were eliminated for the same reason.

Scenario C2 was eliminated for a number of reasons. This scenario requires an increased capital cost associated with the design, construction and maintenance of ramps needed to bypass the bridge piers below the railroad. Secondly, concern was raised regarding the potential for collisions with pedestrians on the narrow sidewalk. Lastly, the railroad bridge is programmed for replacement in the 2014 fiscal year, at which point it is expected that the piers will be relocated out of the shoulders.

Scenario D1 was also eliminated for multiple reasons. First, this is a commercial area heavily dependent on on-street parking (unlike Scenario B2). This area also exhibits many midblock driveways. This combination leads to reduced sightlines for all users, which may help to explain many of the vehicular and bicycle crashes in this segment. Furthermore, pavement

width is already at a premium, and it is not possible to implement dedicated bicycle lanes wide enough to meet design guidelines.

Scenario E3 was eliminated due to the planted median having been recently installed, and is highly valued by the community. Furthermore, modifications to the median would require significant funding and alterations to new pavement, which is not supported by Mn/DOT. This was another reason behind the elimination of Scenario E1.

3.3.2 REFINED ANALYSIS OF FAVORED SCENARIOS

The remaining scenarios were subjected to a more detailed series of analyses to better understand how they might affect the corridor. In each segment, the remaining preferred scenarios are compared to the future No-build scenario from different perspectives.

3.3.2.1 Geometry

Zone 1

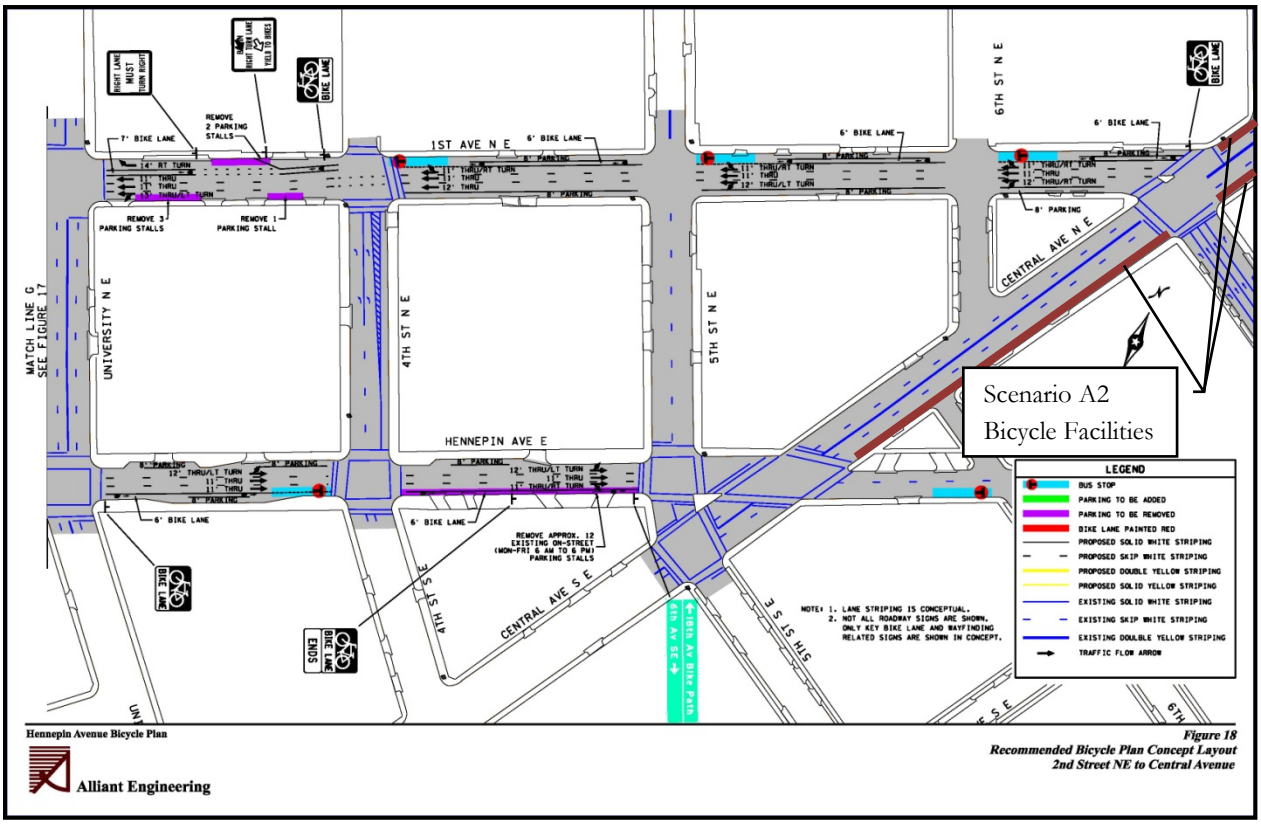
Zone 1 is separated into two segments. Zone 1a is the segment between the river and Hennepin Avenue. Zone 1b is the segment between Hennepin Avenue and the limits of Zone 2a at 8th Street SE.

The results of the evaluation of the preliminary scenarios resulted in two alternatives for Zone 1a. Scenario A1 is identical to the No-build scenario except for the addition of a shared lane (also known as "sharrow") pavement markings added to the outside travel lane to call attention to the presence of cyclists. The placement of these markings also provides guidance to the cyclist on where to position themselves laterally within the lane to minimize their exposure to opening doors from cars parked along the curb. These markings help to reduce wrong-way riding, and have shown to be understood by both cyclists and the motoring public. It is also important to note that these markings, which were previously considered experimental by the FHWA, have now been incorporated into the 2009 Federal Manual on Uniform Traffic Control Devices (MUTCD).

In Zone 1b, north of Hennepin Avenue, a third alternative becomes available in this segment. Scenario A2 introduces dedicated bicycle lanes designed to tie into the bike lanes proposed by Alliant Engineering on the 1st Avenue/Hennepin Avenue one-way pair. These facilities will be implemented in 2010. **Figure 11** shows how the systems would intersect. It is not necessary to carry a southbound dedicated bicycle lane between the one-way pair for three primary reasons. First, no scenarios on Central Avenue south of Hennepin containing dedicated bicycle lanes passed the preliminary evaluation, so cyclists continuing south will do so in the vehicular travel lanes. Second, terminating the southbound bicycle lane at

Hennepin does not provide connectivity in the westbound direction on Hennepin Avenue because Hennepin Avenue is an eastbound one-way street. Lastly, the curb space between 1st and Hennepin provides metered on-street parking, valuable to both the city as revenue and motorists as convenient access to local businesses.

FIGURE 11
PROPOSED BICYCLE FACILITIES ON HENNEPIN AVENUE & 1ST AVENUE[28]



Zone 2

Zone 2 is also split into two segments. Zone 2a is the segment between 8th Street SE and 14th Avenue NE. Zone 2b is the long block between 14th and 18th Avenues over which the BNSF Railway bridge crosses.

In Zone 2a, three scenarios passed the preliminary evaluation. Scenario B3 provides the shared lane concept adopted by Scenario A1, and provides the same advantages over the

[28] Source: Alliant Engineering. Proposed bicycle facilities shown on Central Avenue representing Scenario A2, have been added to the Alliant Figure by this study.

No-build scenario. Due to the width of the street, it is not possible to provide dedicated bicycle lanes that meet the recommended minimum six-foot width identified in the Mn/DOT Bikeway Facility Manual. However, Scenario B1 does provide five-foot lanes, which exhibit safety benefits identified in Section 2.5. If this scenario is selected for implementation, it is recommended that the Mn/DOT overlay project provide a constant surface across the 5-foot lane to remove the groove between the edge of pavement and gutter. It should be noted that the irregular narrowing of the geometry approaching Spring Street would require that the bike lanes be temporarily ended. This occurs approximately 600 feet in advance of the intersection on each Central Avenue approach, then picked up again on the far side of the intersection.

Two scenarios remain in Zone 2b, the segment between 14th and 18th Avenues. Scenario C1 provides dedicated bike lanes in each direction by narrowing the vehicular travel lanes to 11 feet. Doing this allows all three lanes to travel between the bridge piers supporting the railroad bridge crossing over Central Avenue. On either side of the bridge piers, this lane configuration is modified slightly. The vehicular lanes are maintained at 11-feet for motorist's expectation of a consistent travel path. The extra space gained on the widened shoulder provides a valuable buffer between cyclists and vehicles. An additional requirement of Scenario C1 is that the median extending north from the BNSF's center bridge pier be shortened to accommodate the bicycle lanes while retaining the on-street parking on the west side of Central Avenue. In comparison, the No-build scenario retains the 13-foot vehicular lanes, but requires cyclists to merge into the general travel lanes to pass by the piers.

Zone 3

In Zone 3, between 18th and 27th Avenues, only the No-build and 3-lane scenarios remain. By removing one of the vehicle lanes, the 3-lane section transfers that pavement width to dedicated bicycle lanes, and converts a second vehicle lane to a two-way-center-left-turn lane (TWCLT). Below is a list of typical benefits resulting from a 3-lane section with dedicated bicycle lanes:

- Reduces the number of conflict points between vehicles.
- Reduces the speed variability along the corridor, and typically lowers the prevailing speeds thereby providing a traffic calming effect.
- Improves the sight distance for left turning vehicles, which would help to reduce the number of left turn crashes.

- By moving left-turning vehicles out of the inside through lane, it eliminates lane changes to avoid left turning vehicles, thereby reducing sideswipe and rear end crashes.
- Improves the sight distance at the corners, which would help to reduce right angle crashes.
- Provide dedicated space for bicyclists, which is anticipated to reduce the number of bicycle crashes reported that involve sidewalk riding.
- Typically results in little decrease in vehicle capacity because any vehicles that make left turns and have to wait for a gap in traffic block the inside through lane, which results in only one usable through lane at that point.

Regardless of the scenario, it is recommended that the short medians on either side of 18th Avenue be removed to accommodate the bicycle lanes and retain on-street parking in this area. An additional, possibly more important reason to remove the medians is for safety purposes. These medians are consistently struck by vehicles since they encroach on the width of the approaching lanes.

Zone 4

Lastly, two scenarios remain in Zone 4, between 27th and 37th Avenues. Like the southern segment of Zone 1, they are the No-build scenario and one (Scenario E5) where shared lanes in both directions are provided. The benefits of shared lanes over the No-build condition have been previously identified.

3.3.2.2 Operational analysis

Helpful in determining a scenario's value is understanding how a change to the corridor may affect the progression of motorized traffic. An analysis of motorized traffic operations conducted for the 2029 design year compared the value of a particular scenario with the No-build option. As stated in Section 2.9.1, 2029 traffic volumes were extrapolated using an estimate of a 0.5% annual growth. This is considered a conservative estimate compared to the historic trend of decreasing volumes on Central Avenue shown in **Table 3**. Models of the corridor were constructed in Synchro Version 7 that captured the design year volumes, optimized signal timing and each scenario's geometry, to provide the LOS for each signalized intersection along the corridor. The results of this analysis for the AM, Off and PM peaks are shown in **Table 16 to 18**, respectively. Intersections shaded in red indicate a drop in LOS between the No-Build and proposed scenarios. An intersection shaded in yellow indicates the scenario provides an improvement in LOS.

TABLE 16
PREFERRED SCENARIOS: 2029 AM PEAK LOS

Intersection	2029 AM Peak LOS							
	No-Build	A1	A2	B1	B3	C1	D2	E5
37th Ave	C							C
35th Ave NE	A							A
St. Anthony Pkwy	B							B
29th Ave NE	A							A
27th Ave NE	A						B	
26th Ave NE	A						A	
Lowry Ave NE	B						C	
24th Ave NE	A						A	
22nd Ave NE	A						B	
20th Ave NE	A						A	
19th Ave NE	A						A	
18th ½ Ave NE	A						B	
18th Ave NE	A					A		
14th Ave NE	A			A	A			
Broadway St	C			C	C			
Spring St	A			A	A			
1st Ave NE/7th St SE	D	D	D					
E Hennepin Ave	A	A	B					
5th St SE	A	B						
4th St SE	B	B						
University Ave SE	D	D						
2nd St SE	B	B						

TABLE 17
PREFERRED SCENARIOS: 2029 OFF PEAK LOS

Intersection	2029 Off Peak LOS							
	No-Build	A1	A2	B1	B3	C1	D2	E5
37th Ave	C							C
35th Ave NE	A							A
St. Anthony Pkwy	B							B
29th Ave NE	A							A
27th Ave NE	B						B	
26th Ave NE	A						A	
Lowry Ave NE	B						B	
24th Ave NE	A						A	
22nd Ave NE	B						A	
20th Ave NE	A						A	
19th Ave NE	A						A	
18th ½ Ave NE	A						A	
18th Ave NE	A					B		
14th Ave NE	A			A	A			
Broadway St	C			C	C			
Spring St	A			A	A			
1st Ave NE/7th St SE	B	B	B					
E Hennepin Ave	C	C	C					
5th St SE	B	B						
4th St SE	B	B						
University Ave SE	D	D						
2nd St SE	A	A						

TABLE 18
PREFERRED SCENARIOS: 2029 PM PEAK LOS

Intersection	2029 Off Peak LOS							
	No-Build	A1	A2	B1	B3	C1	D2	E5
37th Ave	C							C
35th Ave NE	A							A
St. Anthony Pkwy	B							B
29th Ave NE	A							A
27th Ave NE	A						B	
26th Ave NE	A						A	
Lowry Ave NE	B						C	
24th Ave NE	A						B	
22nd Ave NE	A						A	
20th Ave NE	A						A	
19th Ave NE	A						A	
18th ½ Ave NE	A						A	
18th Ave NE	B					B		
14th Ave NE	A			A	A			
Broadway St	C			C	C			
Spring St	A			A	A			
1st Ave NE/7th St SE	C	C	C					
E Hennepin Ave	E	E	E					
5th St SE	F	F						
4th St SE	F	F						
University Ave SE	F	F						
2nd St SE	D	D						

Three significant points emerge from the information in the preceding tables:

1. At intersections where it is estimated that the No-build condition will operate at deficient[29] levels, proposed scenarios do not lower the LOS.
2. The proposed conversion to a 3-lane section in Zone 3 does appear to negatively affect the overall LOS at certain intersections, although in all cases only by one letter grade.
3. At intersections where proposed scenarios are expected to lower the LOS, each intersection is anticipated to operate at LOS C or better.

Further analysis was conducted with respect to the second point to more precisely determine how traffic approaching intersections in the northbound (NB) and southbound (SB) directions is affected by the 3-lane configuration. The measures of effectiveness chosen for this analysis were average speed, travel time within this segment of the corridor and LOS of the NB and SB traffic. **Table 19** displays the results.

[29] Deficient operations are characterized as having an LOS of E or worse.

TABLE 19
SCENARIO D3 ARTERIAL EVALUATION

Central Avenue Synchro Arterial LOS Results Summary - 18th Avenue to 27th Avenue																			
NB Direction		AM Peak						Off Peak						PM Peak					
		No-Build			Reco. Alt.			No-Build			Reco. Alt.			No-Build			Reco. Alt.		
Intersection	Dist.	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS
18th Avenue NE & Central Avenue	0.25	42.3	21.3	B	38.6	23.3	B	42.4	21.2	B	39.4	22.9	B	43.4	20.8	B	43.4	20.8	B
18-1/2 Avenue NE & Central Avenu	0.07	19.7	12.6	D	16.6	14.9	C	21.0	11.8	D	17.3	14.3	C	19.6	12.6	D	17.4	14.2	C
19th Avenue NE & Central Avenue	0.07	17.9	13.9	C	16.9	14.8	C	17.5	14.3	C	16.8	14.9	C	20.2	12.4	D	17.3	14.4	C
20th Avenue NE & Central Avenue	0.07	18.0	13.7	C	17.1	14.4	C	19.7	12.5	D	17.5	14.1	C	18.6	13.3	C	18.7	13.2	C
22nd Avenue NE & Central Avenue	0.07	25.9	9.5	D	16.4	15.0	C	28.7	8.6	E	17.3	14.2	C	19.0	13.0	D	17.4	14.1	C
24th Avenue NE & Central Avenue	0.16	27.7	20.5	B	25.0	22.7	B	31.0	18.3	C	31.3	18.1	C	26.9	21.1	B	35.5	16.0	C
Lowry Avenue NE & Central Avenu	0.07	23.2	10.6	D	23.9	10.3	D	24.0	10.3	D	29.0	8.5	E	27.5	9.0	E	32.3	7.6	E
26th Avenue NE & Central Avenue	0.12	25.6	17.4	C	23.4	19.1	B	33.0	13.5	C	24.9	17.9	C	26.8	16.6	C	24.3	18.4	C
27th Avenue NE & Central Avenue	0.12	32.4	13.9	C	27.2	16.5	C	27.7	16.2	C	32.1	14.0	C	26.0	17.3	C	30.8	14.6	C
	1.00	**232.7**	**15.5**	**C**	**205.1**	**17.5**	**C**	**245.0**	**14.7**	**C**	**225.6**	**16.0**	**C**	**228.0**	**15.8**	**C**	**237.1**	**15.2**	**C**
SB Direction		AM Peak						Off Peak						PM Peak					
		No-Build			Reco. Alt.			No-Build			Reco. Alt.			No-Build			Reco. Alt.		
Intersection	Dist.	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS	Travel Time	Speed	LOS
27th Avenue NE & Central Avenue	0.25	39.6	22.8	B	45.2	20.0	B	43.4	20.8	B	43.9	20.6	B	37.5	24.1	B	41.6	21.7	B
26th Avenue NE & Central Avenue	0.12	26.1	17.2	C	24.6	18.3	C	26.6	16.9	C	25.0	18.0	C	28.0	16.1	C	25.1	17.9	C
Lowry Avenue NE & Central Avenu	0.12	34.0	13.1	C	36.7	12.2	D	36.7	12.2	D	36.1	12.4	D	44.1	10.1	D	34.5	12.9	D
24th Avenue NE & Central Avenue	0.07	17.6	14.0	C	16.7	14.7	C	21.4	11.5	D	20.4	12.1	D	20.4	12.1	D	19.9	12.4	D
22nd Avenue NE & Central Avenue	0.16	25.2	22.5	B	25.2	22.5	B	30.6	18.5	C	24.4	23.2	B	31.8	17.8	C	24.7	22.9	B
20th Avenue NE & Central Avenue	0.07	16.8	14.7	C	17.2	14.3	C	18.4	13.4	C	17.5	14.1	C	19.4	12.7	D	17.1	14.4	C
19th Avenue NE & Central Avenue	0.07	16.9	14.6	C	17.0	14.5	C	17.1	14.4	C	16.6	14.9	C	20.8	11.9	D	16.6	14.9	C
18-1/2 Avenue NE & Central Avenu	0.07	19.3	12.9	D	16.8	14.9	C	20.6	12.1	D	17.3	14.4	C	17.6	14.2	C	17.4	14.3	C
18th Avenue NE & Central Avenue	0.07	17.6	14.1	C	18.4	13.5	C	19.2	12.9	D	18.4	13.5	C	20.8	11.9	D	19.2	12.9	D
	1.00	**213.1**	**16.9**	**C**	**217.8**	**16.5**	**C**	**234.0**	**15.4**	**C**	**219.6**	**16.4**	**C**	**240.4**	**15.0**	**C**	**216.1**	**16.7**	**C**

The table shows that while certain movements along Central Avenue will be degraded, many others would be improved. Another finding is that of the seven cases where the overall intersection LOS has been degraded, very little of that burden has been assigned to Central Avenue.

With respect to the travel times along this segment, the only instances where travel time actually increased occurred during the PM peak in the NB direction (an additional nine seconds over the mile-long segment) and the AM peak in the SB direction (an additional five seconds). Adjustments to the amount of green time assigned to the side streets allowed for the remainder of the peak hour directional flows to move through this part of the corridor more efficiently and without causing significant reductions in the overall intersection LOS.

3.3.2.3 Safety Analysis

Zones 1, 2 and 4 have many similarities when it comes to evaluating the remaining scenarios based on safety. In each of these zones, one of the remaining scenarios proposes shared bike lanes as an improvement to the No-build scenario. Shared lanes are likely to provide a safety benefit by increasing cyclist's visibility in the eyes of motorists. Alternative B1 provides a greater potential benefit due to having dedicated bike lanes on significant inclines. While both shared and dedicated bicycle lanes each provide a certain degree of benefit in terms of

bicycle safety, none of the remaining scenarios significantly contribute to the reduction of vehicular crashes. This is not as much of a concern in Zones 2 and 4, which are predominantly divided roadways and exhibited a lower crash rate than the Metro average. This however, is not the case in Zone 1 where the vehicular crash rate was significantly higher than the Metro average. Unfortunately, a low cost, minimally invasive solution to this issue is not apparent.

> The City of Orlando, Florida converted a 1.5-mile long segment of Edgewater Drive (20,000 ADT) to a 3-lane section, producing the following results:
> - Lower crash rates (-34%) and frequencies (1 every 2.5 days before; 1 every 4.2 after)
> - Lower injury rates (-68%) and frequencies (1 injury crash every 8.9 days before; 1 every 30.4 days after)
> - Lower percentage of vehicles traveling 36+ mph
> - Reduction in volumes on parallel and connecting streets
> - Increased pedestrian (23%) and cyclist activity (30%)
> - Increase in on-street parking utilization (12%)
> - Minimal effect on peak period travel times
> - +50 sec in AM
> - +10 sec in dominant direction in PM
> - -10 sec. in opposite direction in PM
> - Positive results from before/after surveys of area merchants and residents for 8 of 9 measures of effectiveness.

The substantial change proposed by Scenario D3 also provides safety-related benefits to incorporating the 3-lane section in Zone 3. Of the 163 crashes that occurred within the five-year study period, rear end crashes were the most frequent type, comprising 21% of all crashes. Other significant crash types included right angle (15%), hitting a parked vehicle (14%) and left turn (11%).

One common reason for rear-end, side-swipe, and left turn collisions on a four-lane undivided roadway without left turn lanes is due to the stoppage of left turning vehicles in the inside through lanes. Right-angle crashes can occur due to inadequate corner sight distance and sight issues caused by stoppage of left turn vehicles in opposing shared left turn/through lanes. Taking into account the left turn lanes provided at the Lowry Avenue intersection, the removal of rear end, side swipe, left turn, and angle crashes at those locations (presumably not tied to the provision of a left turn lane) would result in the elimination of a total of 24 rear end crashes, 8 side swipe crashes, 11 left turn crashes, and 10 right angle crashes.

> The Iowa Department of Transportation conducted a study of 30 four-lane undivided roadways. Half of these roadways were converted to a 3-lane section. The study showed the following safety results:
> - Major injury crashes reduced by 11%; minor crashes by 30%
> - Crash frequency reduced by 24%
> - Fewer people under 25 and over 65 were involved in crashes
> - Significantly fewer crashes related to left turns and stopping

In addition, pedestrian and bicycle crashes constitute a high portion of the total crashes (7 and 9 percent, respectively). The pedestrian crashes typically occur due to sight obstruction, wider streets without pedestrian refuge islands and high speeds. The bicycle crashes could be due to the lack of exclusive bike lanes, particularly as it is typical that many bicycle crashes are the result of the bicyclist riding on the sidewalk (often against

traffic), whereas they might ride in a more visible position on the roadway with traffic if bike lanes were provided.

3.3.2.4 Parking Impact

Great care was taken to avoid impacts to existing parking. In fact, removal of on-street parking was often cause for elimination or modification to a proposed scenario. However, there were a few locations where removal of on-street parking was considered a necessary component of an overall benefit to the corridor. The following list identifies locations where proposed scenarios require the removal of on street parking stalls.

- Zone 1, Scenario A2: Northbound between 6th and 7th Streets
  - 5 stalls: No parking 4-6 PM, Mon. thru Fri; $0.50 per hour, 2 hour limit
- Zone 2, Scenario B1: Northbound between 13th and 14th Avenues
  - 14 stalls: 1 hour parking, 8 AM to 6 PM
- Zone 2, Scenario B1: Southbound between 13th and 14th Avenues
  - 5 stalls: 1 hour parking, 8 AM to 6 PM
- Zone 2, Scenario B1: Northbound between 14th and 18th Avenues
  - 18 stalls, unrestricted parking
  - 2 stalls, 30 minute parking

4.0 RECOMMENDED BICYCLE PLAN

The recommended bicycle plan is a product of stakeholder input and various iterations of analyses and evaluations throughout the course of the study. This section documents the changes recommended to the existing street network. It also provides advice for enhancing the plan to maximize user experience and ridership. **Figure 12 through 15** show each zone's recommended typical section. Refer back to Section 3 for discussion relating to the merits of each recommendation. A Layout of the recommended plan can be found in **Appendix A**.

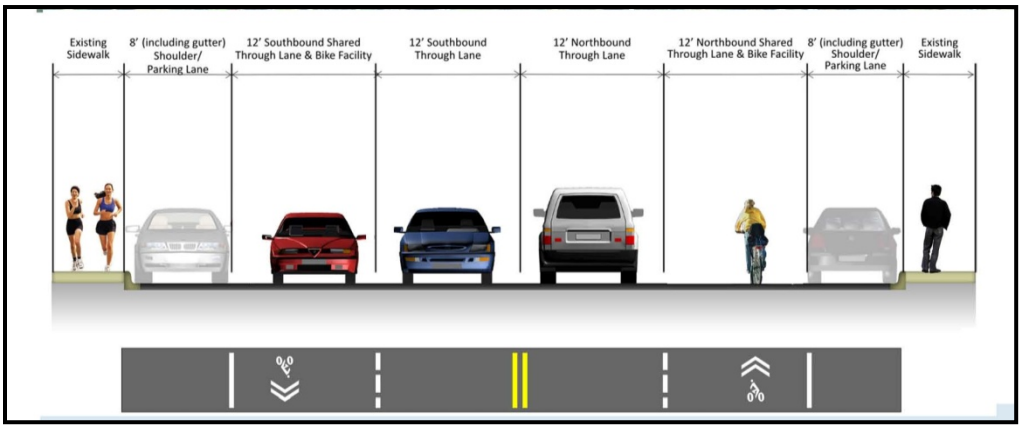
4.1 PROPOSED CHANGES TO STREET NETWORK

4.1.1 ZONE 1

The segment of the corridor between the Mississippi River and 8th Street SE is recommended to take on two distinct layouts, with a transition between Hennepin Avenue and 1st Avenue. Recommendations for this part of the corridor include:

- Between the river and Hennepin Avenue, install sharrow pavement markings in each outside lane. Supplement with complimentary signing.
- Between Hennepin Avenue and 1st Avenue:
    - In the northbound direction, begin a six-foot wide dedicated bicycle lane. Install a two-foot buffer between the outside vehicular lane and the bicycle lane between Hennepin Avenue and 1st Avenue to absorb the extra pavement within this area. This will allow the vehicular lanes to remain along their existing alignment and maintain a constant width.
    - In the southbound direction, maintain the shared outside bicycle lane with sharrow pavement marking.
    - Remove five metered parking stalls (No parking 4-6 PM, Monday – Friday; $0.50 per hour, two-hour limit) along the southeast corner of Central Avenue and 1st Avenue.
- Between 1st Avenue and 8th Street SE:
    - In the NB direction, shift the bicycle lane to retain on street parking between 7th Street and 8th Street.
    - In the SB direction, install a six-foot bicycle lane that feeds into the shared lane on Central Avenue as well as the dedicated lane on 1st Avenue.

FIGURE 12
ZONE 1 TYPICAL SECTION



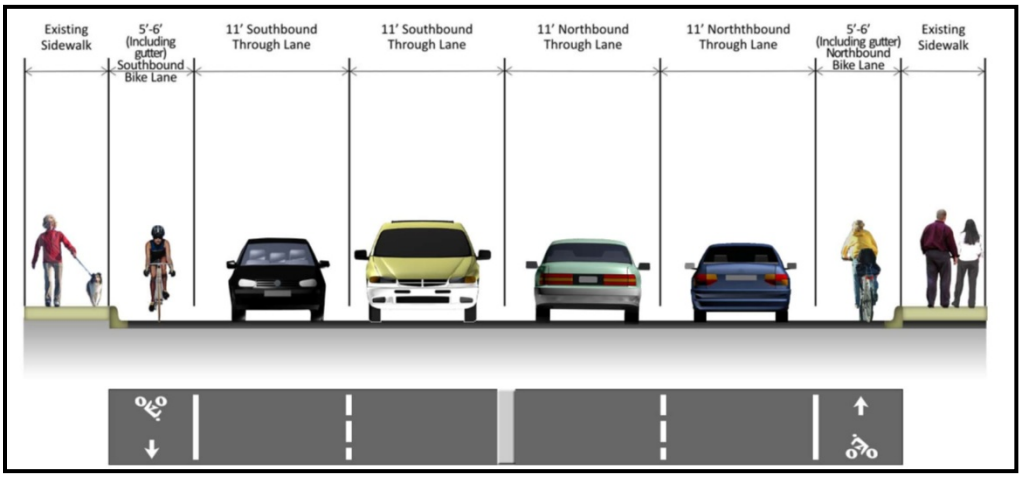
4.1.2 ZONE 2

Most of the segment between 8th Street SE and 18th Avenue NE is divided, with the exception occurring between 13th Avenue and 14th Avenue. This one-block long segment is also the only part of the zone to accommodate on-street parking, which serves small, local businesses. Recommendations for this zone include:

- Maintain the dedicated bicycle lanes developed at the north end of Zone 1.
- Between 8th Street and 13th Avenue, narrow the bicycle lanes to five-feet in width to account for the reduction in roadway width.
    - Coordinate with the Mn/DOT paving project to provide a uniform paved surface across the entire width of the bike lanes, removing the groove between the edge of pavement and the gutter.
- Where the geometry narrows along the approaches to Spring Street, provide a clear indication that the dedicated lane will be transitioning to a shared lane. Resume the dedicated bicycle lanes on the far side of Spring Street, where the roadway width once again will accommodate them.
- Between 13th and 14th Avenues:
    - Remove 14 on-street parking stalls on the east side of Central Avenue, beginning at the south end of the block: 1 hour parking, 8 AM to 6 PM.
    - Remove five on-street parking stalls on the west side of Central Avenue, beginning at the north end of the block: 1 hour parking, 8 AM to 6 PM.
    - Widen the southbound bicycle lane to six feet as it travels adjacent to on-street parking.
- North of 14th Avenue, provide a relatively short-term configuration that consists of six-foot bicycle lanes in each direction, with appropriate buffers between the bicycle lanes and vehicular lanes where the pavement width allows for it.

- Remove six unrestricted on-street parking stalls on the east side of Central Avenue, beginning at the south end of the block.
- Reduce the length of the median extending north from the center bridge pier to retain the on-street parking for businesses on the west side of Central Avenue.
- Monitor progress of the plan to replace the BNSF railway's bridge over Central Avenue. Currently, it is programmed for replacement during Mn/DOT's 2014 fiscal year.

FIGURE 13
ZONE 2 TYPICAL SECTION

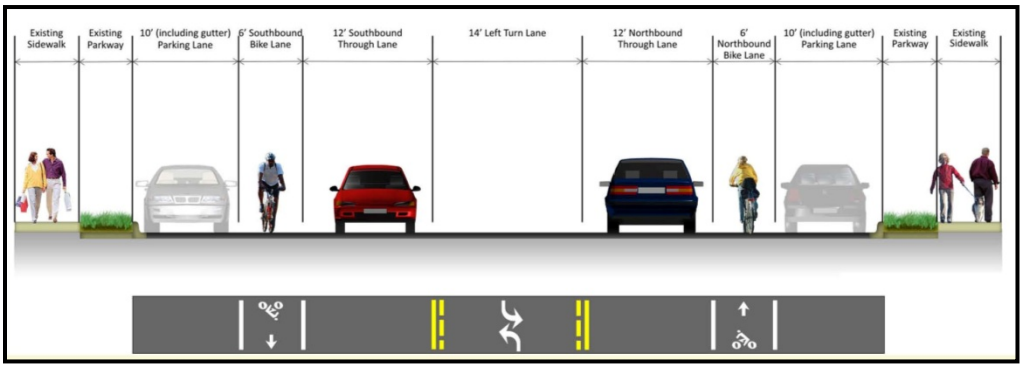


4.1.3 ZONE 3

The commercial segment between 18th Avenue and 27th Avenue is the subject of the most substantial change. The elements of the proposed changes are outlined below.

- Introduce a 3-lane section similar to that on the "Eat Street" segment of Nicollet Avenue between Franklin Avenue and 28th Street:
  - Parking on both sides of the road
  - Six foot bicycle lanes in each direction
  - One thru lane in each direction
  - A two-way center left turn lane to separate left turning vehicles from thru traffic and better accommodate various queue lengths and midblock driveways
- Remove the short center medians and signal poles on either side of 18th Avenue.

FIGURE 14
ZONE 3 TYPICAL SECTION

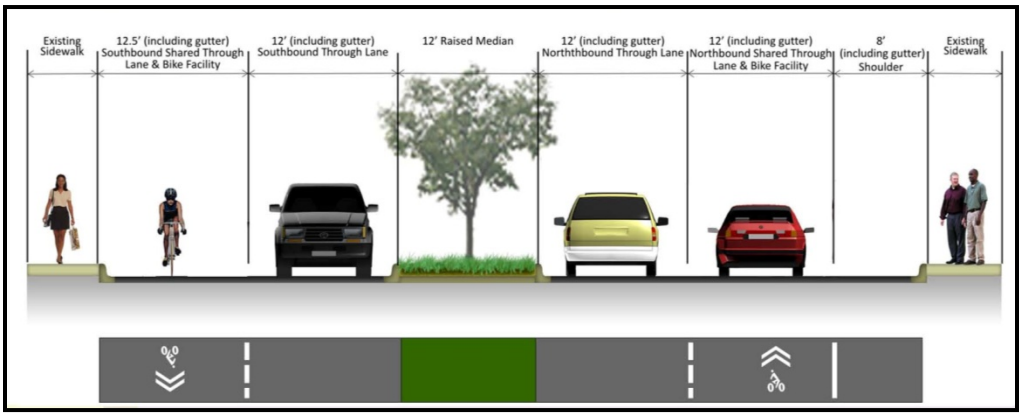


4.1.4 ZONE 4

The northern segment of the corridor, between 27th and 37th Avenues, is the most residential in nature, and has unique redevelopment opportunities in terms of Shoreham Yards. This segment is also unique in that it was recently reconstructed, and consequently, the pavement remains in excellent condition. Recommendations for this segment are below:

- Install shared lanes along the entire segment.
- Encourage the progress of the extension of the multi-use trail on the west side of Central Avenue to provide a separate, dedicated facility for cyclists.

FIGURE 15
ZONE 4 TYPICAL SECTION



4.2 BICYCLE NETWORK

The recommendations in the preceding section provide many opportunities to fill a substantial gap in the bicycle network and expand Minneapolis' goal of a citywide integrated system. The recommended plan would provide the following connections.

The existing off-street multi-use trail along Saint Anthony Parkway is part of the Grand Rounds Scenic Bikeway, offering over fifty miles of bicycle trails throughout the city. The off-street trail along Columbia Boulevard also feeds into this system. Furthermore, an off-street, multi-use trail runs parallel to Central Avenue between Saint Anthony Boulevard and Columbia Boulevard.

As Minneapolis develops the bicycle network, Central Avenue will provide an important north-south corridor from which many routes will be available. The following list summarizes the planned bikeways.

- 37th Avenue NE
- 33rd Avenue NE
- 29th Avenue NE
- 27th Avenue NE
- Lowry Avenue NE
- 22nd Avenue NE
- 18th Avenue NE (Existing)
- Summer Street NE
- 1st Avenue and Hennepin Avenue one-way pair
- 5th Street NE/SE

In addition to the potential system connections to the planned bikeways listed above, a bicycle boulevard is planned on 22nd Avenue NE.

4.3 WAYFINDING

Clear wayfinding assists cyclists who may be unfamiliar with the corridor and the surrounding bicycle network find their destinations. In Minneapolis, wayfinding signing is standardized[30], utilizing signs with white text on green background, and include a bicycle logo and well as the direction of the intersection path, as necessary. These signs may be placed at intersections with connecting bikeways. They are also useful in routing cyclists to nearby bikeways that are not directly connected to their current route. In this situation, the distance to the other bikeway should also be placed on the wayfinding sign.

[30] Source: City of Minneapolis Bicycle Route and Bicycle Destination Signing Standards, 2009. Also conforms to Minnesota MUTCD.

On Central Avenue, it is recommended that wayfinding signing be placed at Saint Anthony Parkway to indicate the connection with the Grand Rounds. In this special case, the city should determine whether to use the sign format indicated above or the format adopted by the Grand Rounds. A second location where wayfinding is recommended is at the intersection with 1st Avenue NE. This signing should be adopted once the portion of the 1st & Hennepin bicycle plan east of the river has been implemented. Due to the skewed grid system in this part of the city, rather than identifying 1st Avenue on the wayfinding sign, it may be more helpful to indicate the direction of Downtown.

4.4 BICYCLE PARKING

Bicycle parking facilities are an important element in developing a vibrant cycling corridor. These facilities serve important roles in the community – more than simply a place to safely store a bicycle. They may be used to attract an undiscovered sector of the market to a business, and may also be used as aesthetic enhancements to the corridor. To be most effective, parking facilities should be properly sized and located at desired destinations along the corridor.

One should also consider the level of security appropriate for the parking facility. At locations where storage is necessary for greater lengths of time, such as overnight, bike lockers should be considered. Bike lockers offer fully enclosed, lockable compartments that give no indication of the actual presence of a bicycle. Common applications of these devices are apartments, condominiums, employment centers and transit hubs. A customer-oriented storage facility is more likely to take the form of a bike rack, which allows the cyclist to apply the desired level of security for their property, and generally caters to shorter-term stays.

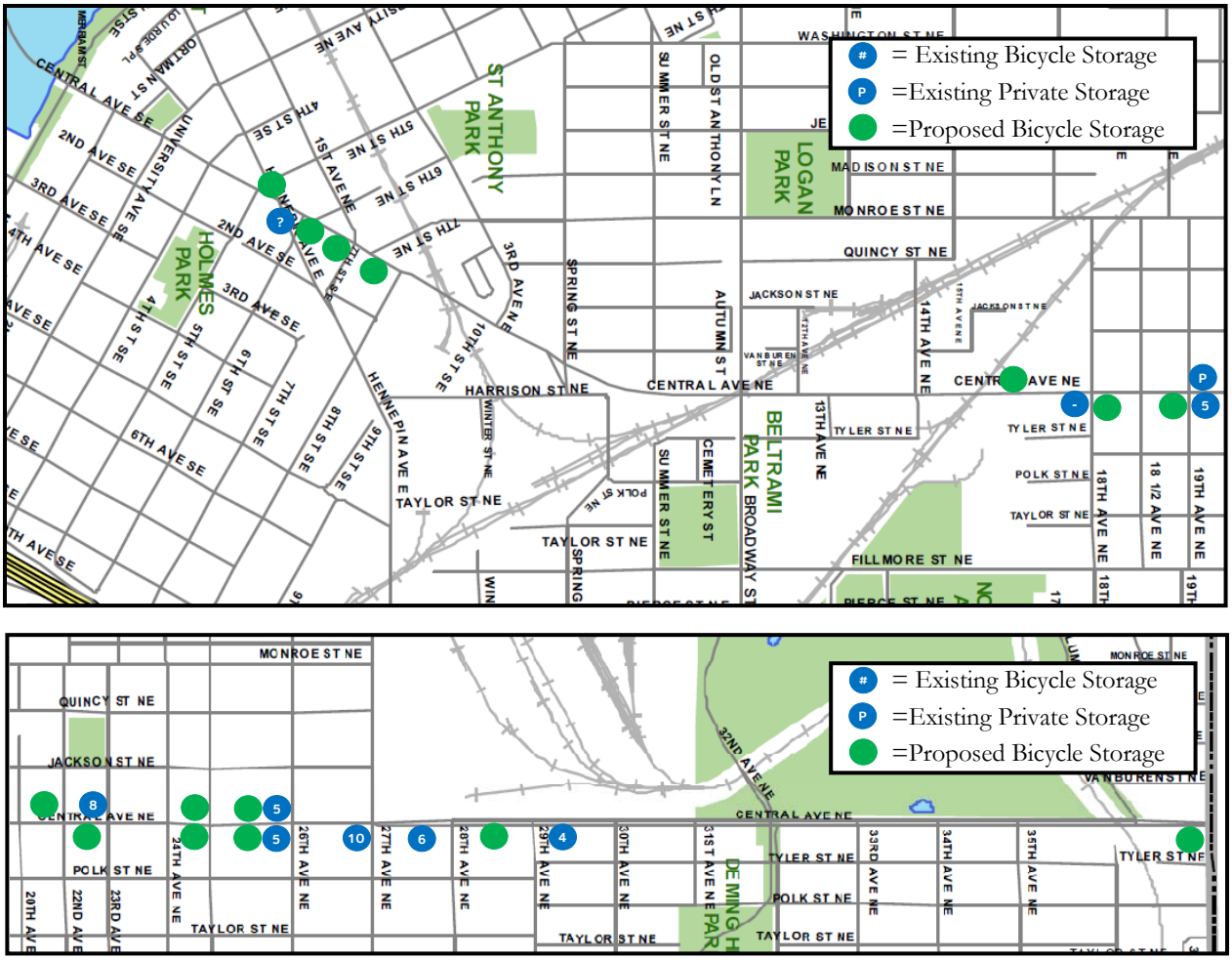
This study recommends that the amount of available bicycle storage be significantly increased. It was apparent that the parking demand greatly outweighed the supply, as a significant number of bicycles were observed being locked to fences, trees, signposts and meters. When considering the addition of storage facilities, location and placement is an important factor to consider. Storage facilities should not be installed in situations that cause parked bicycles to encroach onto the sidewalk, which is the case for some of the existing facilities. Bus stops may cater to cyclists with diverse storage needs. It was observed on multiple occasions that a bicycle was locked to a tree, fence or signpost adjacent to a bus stop, indicating a comfort level that

could be supported through the use of bicycle racks. However, it is also conceivable that cyclists might also desire a more secure method of storing their property as they may be away for a longer period of time, such as a traditional workday. In this case, a combination of bicycle racks and lockers should be considered, taking into account available space.

No specific recommendations will be made for residential parcels. However, it is generally recommended that dense residential developments provide adequate storage for their tenants.

Recommended locations for consideration of bicycle facilities are shown in **Figure 16.**

FIGURE 16
RECOMMENDED BICYCLE STORAGE FACILITIES



4.5 BICYCLE PROMOTION AWARENESS AND MAINTENANCE PLAN

Cycling throughout Minneapolis already has a strong ridership base. This is true of Central Avenue as well. Cyclists of varying abilities have been observed on trips diverse in nature, though it is the more experienced cyclist that is common throughout the corridor. The recommended plan aims at not only increasing the number of experienced cyclists along the corridor, but also intends to attract other, more casual riders, to help decrease the demand for auto-based trips.

The recommended plan's design elements, consisting of durable pavement markings, wayfinding signage, and selected minor modifications to medians will provide a clear portrayal of where cyclists should be expected. However, for the corridor to be truly successful in attracting additional cyclists, a holistic effort should be embraced. The community should play as big of a part in the success of this corridor as the city's government and Public Works staff.

One of the fundamental elements of success will simply be public awareness. In this effort, the city should continue to provide up-to-date information regarding its bicycle network through the use of online maps as well as hardcopy versions available throughout the city at locations such as bus stops, schools, parks, libraries and other public spaces. Similarly, continuing to utilize the NTP coordinator and Bike/Walk ambassadors for outreach programming actively reaches large portions of the city's population. Another method of increasing the visibility of a cycling corridor is through the use of the public/private cost participation program for bicycle racks. Bicycle racks not only address a practical need for temporary storage, but also advertise the corridor as a bicycle-friendly one.

Another fundamental element of success is continued development of the bicycle network.

The city should continue its ambitious plans for expanding the network to reach a greater portion of the population. In doing so focus should continue to be on providing safe and convenient infrastructure for all potential bicycle-related facilities. These not only include the bicycle facilities themselves, but also transit stations, bus stops and buses, bicycle storage facilities, etc… Should any of these elements become undesirable to use, it will have a negative impact on the amount of people choosing a bicycle as a mode of travel. Furthermore, the city should continue to support transit-oriented development,

and partnerships with like-minded organizations like Transit for Livable Communities, and Metropolitan Transit, Hennepin County and the National Park Service.

Maintaining a functional and visible corridor is another fundamental element of success. This not only consists of maintaining bikeway identification and wayfinding signing and pavement markings, but also requires that a smooth, clean and structurally stable surface be sustained. Finally, it is recommended that roadway elements such as bridge expansion joints, catch basins, pavement seams and the like utilize bicycle-friendly designs to maximize the cyclist's experience.

The community's role in the success of the bicycle corridor lies not only in promoting it by word of mouth, but also by local businesses including cyclists as a target market, participating in the cost participation program for bicycle racks, and by attracting businesses that cater to and support cycling and active lifestyles.

4.6 IMPLEMENTATION PLAN

The short-term implementation of the recommended bicycle plan is heavily dependent on a significant opportunity. Mn/DOT has programmed pavement rehabilitation of the project corridor, excluding the recently constructed Zone 4. This work may occur as early as the 2011 fiscal year. With this opportunity, it is anticipated that the cost of pavement markings will be absorbed by the rehabilitation project. In preparation for the rehabilitation project, the following tasks should be completed:

- Perform median shortening/removal work north of the bridge pier between 14th and 18th Avenues and at the 18th Avenue intersection. It may be possible for this work to be transferred to Mn/DOT as part of the maintenance agreement with the state.
- Secure funding related to the capital costs of required signing for the entire project corridor as well as pavement markings in Zone 4.
- Coordinate with Mn/DOT on the final lane configuration of the corridor.
- Coordinate the installation of signing and pavement marking in Zone 4 with the timing of the rehabilitation project.
- Monitor the replacement of the BNSF bridge over Central Avenue between 14th and 18th Avenues.

4.7 COST ESTIMATE

Based on the elements in the recommended plan, as well as assumptions regarding cost savings, a cost estimate has been developed for the project corridor. It should be noted that the estimate assumes that the median shortening/removal work cannot be transferred to the state. This estimate also does not include a cost associated with bicycle parking, as it is not required for the recommended bicycle plan to be implemented. Furthermore, the cost participation agreement related to bicycle storage requires commitments from local businesses, and there is not enough information known about interest in these devices to make an educated recommendation. Lastly, the estimate assumes that the cost of poly-preformed pavement markings in Zones 1 2 & 3 would be incorporated into the Mn/DOT overlay project.

TABLE 20
COST ESTIMATE

Item	Estimated Cost[31]
Ground-in, Poly Preformed Pavement Markings	$6,000
Roadway Signing	$15,000
Median alternation north of RR overpass	$50,000
Removal of medians at 18th Avenue intersection	$50,000
Final Design (10%)	$12,000
Miscellaneous (5%)	$6,000
Total	$139,000

[31] Costs rounded to nearest $1000