Highway 23 / Grand Avenue Corridor Study

Analysis & Recommendations for STH 23 in Duluth, Minnesota

Prepared by the Duluth-Superior Metropolitan Interstate Council

December 2013

Executive Summary

This document represents the findings of a corridor study of the segment of MN State Highway 23 between Becks Road and Interstate 35 in Duluth, Minnesota. This roadway, also known as "Grand Avenue" serves as a principal arterial in West Duluth and is both an important regional and local transportation corridor. The study focused on how well the corridor is currently serving multiple modes of transportation, but it also considered the potential for redevelopment and increasing traffic. The findings indicate that the corridor is not sufficiently serving non-motorized forms of transportation, given potential demand. The findings also suggest, however, the possibility for a level of future growth in West Duluth that that could increase traffic and worsen conditions for all users under the existing constraints to expand the roadway.

The findings of this study have led to a series of recommended improvements (found in Section 4 of this document) which have been presented to the Minnesota Department of Transportation (MnDOT) and the City of Duluth. These recommendations represent a menu of short– and mid-term options that could improve the existing corridor for both motorized and non-motorized users. The majority of these improvements can be implemented within the existing public right-of-way and with moderate levels of investment.

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Prepared by the

Duluth-Superior Metropolitan Interstate Council

Duluth and Superior urban area communities cooperating in planning and development through a joint venture of the Arrowhead Regional Development Commission and the Northwest Regional Planning Commission

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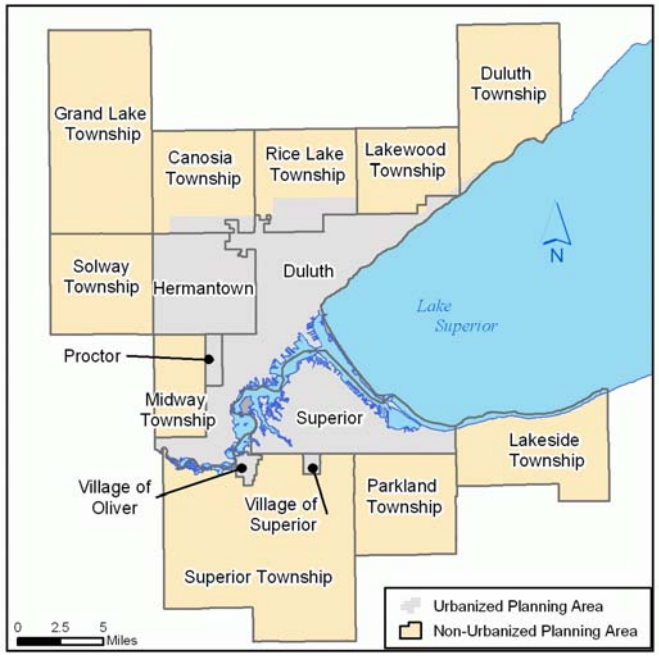
About the Duluth-Superior MIC

The Duluth-Superior Metropolitan Interstate Council (MIC) is the designated bi-state Metropolitan Planning Organization (MPO) for the Duluth-Superior metropolitan planning area (see map below). In 1975, the MIC was created under a joint agreement between the Arrowhead Regional Development Commission (ARDC) in Duluth, Minnesota and the Northwest Regional Planning Commission (NWRPC) in Spooner, Wisconsin. ARDC, in cooperation with NWRPC, is the recipient of metropolitan planning funds made available through federal transportation legislation. MPOs such as the MIC are a forum for discussion and resolution of metropolitan transportation issues.

The MIC's role is to provide guidance and leadership on transportation and land use planning issues in the Duluth-Superior metropolitan planning area. A key goal is to focus the area's limited transportation funding on projects that yield the greatest benefit and that integrate well with the existing transportation system. To this end, the MIC conducts studies, models the transportation system, develops plans, and aids in programing projects for federal funding in the metropolitan area.



The Duluth-Superior Metropolitan Planning Area

The MIC's planning area includes five municipalities and eleven townships in St. Louis County Minnesota and Douglas County, Wisconsin. According to 2004 census estimates, the planning area had a combined population of 146, 365 people.

Duluth-Superior Metropolitan Interstate Council
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Ed Anderson – Superior Common Council
Nick Baker – Douglas County Board *(WI Co-chair)*
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Map Disclaimer

The information contained in the various maps that follow is a compilation of data from different federal, state, county, regional, and municipal sources. Geographic information has limitations due to the scale, resolution, date and interpretation of the original source materials. Users should consult available data documentation (metadata) to determine limitations and the precision to which the data depicts distance, direction, location or other geographic characteristics. These maps and/or data are not legal survey documents to be used for describing land for the purpose of ownership or title.

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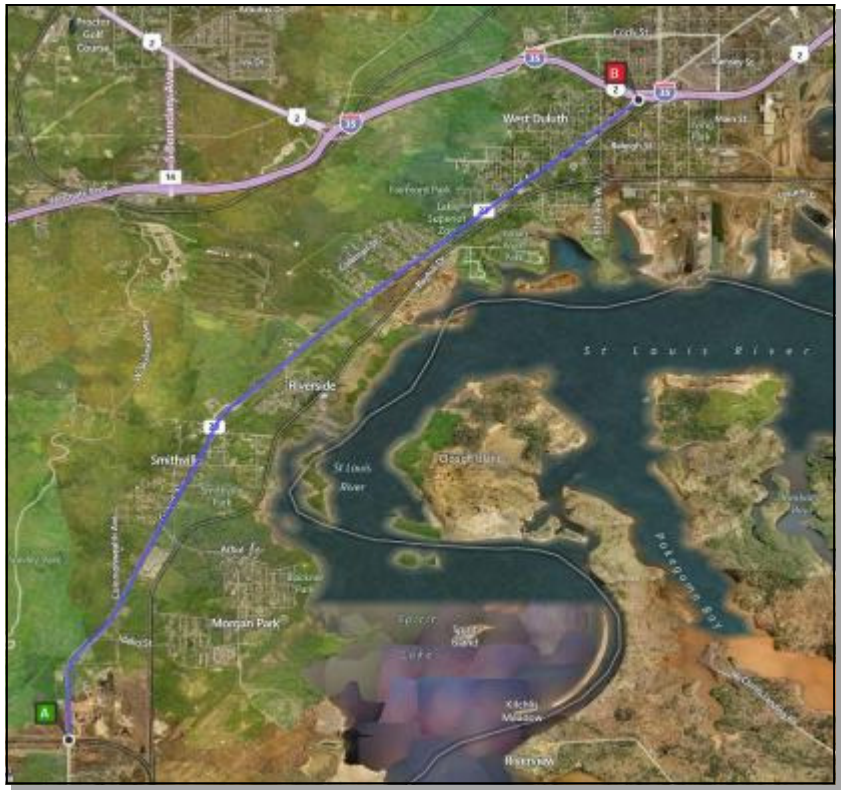


Image source: Bing Maps (2013)

M a p 1.1 | The Highway 23 / Grand Ave Corridor in West Duluth

This plan focuses on a 5-mile section of State Trunk Highway 23 along the St. Louis Rive from Becks Rd (Point A) in the southwest to Interstate 35 (point B) in the northeast. Mn/DOT is planning to resurface this segment of STH 23 in 2015.

1. Introduction & Background

This document represents the results and recommendations of a planning effort conducted prior to the scoping of MnDOT's resurfacing of State Highway 23 (STH 23) from Becks Rd (point "A" in Map 1.1) and Interstate 35 (Point "B"), scheduled to begin in 2015. Although MnDOT's project is programmed as a resurfacing project with no significant alteration or expansion of the roadway, the project does, nonetheless, present an opportunity to study existing conditions in advance, identify specific issues, and work to align other resources to potentially leverage MnDOT's project and include additional improvements to the roadway.

The Duluth-Metropolitan Interstate Council (MIC) assisted MnDOT in the research and outreach efforts associated with the planning and scoping of the 2015 STH 23 project. What follows are an analysis of existing conditions, assessment of future potential, and a synthesis of input received from residents and business owners along the Highway 23 corridor. This study document is organized according to the following sections:

- **INT** *1. Introduction & Background*
- **INP** *2. Stakeholder Input*
- **ANL** *3. Existing Conditions & Analysis*
- **REC** *4. Recommendations*
- **A** *5. Appendices*

INT

Figure 1.1 | Zone 4: 88th Ave W to 72nd Ave W

The section of Highway 23 / Grand Avenue between 88th Ave W and 72nd Ave W is one of the six segments identified as having a set of land-use and transportation patterns unique from the rest of the highway corridor.

Parts of this study document are also organized according to six different "context zones", or segments of distinct character within the 5-mile segment of Highway 23 being studied. Data collection and analysis were done both in scope of the larger corridor as well as these six, smaller segments.

The idea of a context zone comes from the recognition that land use and transportation patterns can change as one travels from one end of a corridor to the other. With such variation often come different issues and opportunities which may be unique to one are but not shared across the adjacent areas. Subsequently, some actions or improvements that are recommended in one area of the corridor will not be appropriate for others. By studying the Highway 23 corridor in this manner, the MIC aimed to identify potential improvements that would be both targeted and potentially more cost-effective for MnDOT and the City of Duluth.

Map 1.2 on the following page shows the location and extent of each of the six context zones relative to the five Duluth neighborhoods in immediate proximity to the highway. Highway 23 has a significant presence in these neighborhoods, and much consideration was therefore given to issues and opportunities as identified by the residents and businesses in these neighborhoods. More information about the involvement of the public and other stakeholders in this study can be found in Section 2, starting on page 11.

Traveling north and eastward from Beck's Rd., the general character of the highway transitions from a more rural environment to a more urban environment. The density of buildings relative to land area gets smaller, and buildings are setback closer to the roadway. Despite this changing character, the cross section of the highway does not vary significantly. With minor deviation in some locations, the roadway is 56

feet wide for most of the 5-mile corridor, and the roadway is marked for four 12-foot driving with 4 feet of paved shoulder, as shown in Figure 1.2.

The general consistency in highway markings and lane widths, however, does not extend to the character beyond the highway edge. The amount of public right-of-way, as well as the topography within that right-of-way undergoes a lot of variation from one end of the corridor to the other. Some sections, therefore, have "tighter", more closed-in edges than others and do not have room for the 5-foot wide sidewalk and 5-foot buffer that is also shown in Figure 1.2. Variation in right-of-way, the presence/absence of sidewalk, and the distance to sidewalk also varies within the individual context zones. The specifics and implications of this variation is explored further in Chapter 3. Suffice it to say for now that this variation also contributes to the changing character of the roadway environment as one travels down the corridor—the table on page 5 provides a summary of characteristics found in each of the six distinct context zones.

Despite the importance of recognizing the changing land-use context along the corridor, it is also important to acknowledge the larger, regional context to Highway 23, as well as the "future" context as it relates to planning for changes within the corridor. There are a set of issues and opportunities pertaining to these broader contexts that also have implications for the land-use and transportation patterns found within the different zones of the study corridor itself. A summary discussion of these issues follows on pages 6 - 9, while data and analyses relevant to these broader contexts is discussed in Section 3.

Source of original image: Google Maps (2013)

Figure 1.2 | Roadway Cross-Section of Grand Ave / Highway 23

Highway 23 is a 4-lane facility between Becks Rd and I-35. With some exception, the cross section is 12-foot travel lanes with 4 feet of shoulder. The presence, width, and position of sidewalk, however, greatly varies.

M a p 1.2 | Hwy 23 Corridor & Context Zones in relation to West Duluth Neighborhoods

This plan recognizes six distinct zones where land use context changes along the roadway. Information about each zone was especially sought from the residents and businesses within the neighborhoods adjacent to these zones.

Zone 1: Becks Rd to Clyde Ave - "Rural highway" context

This section is 34.7% of the corridor. It is primarily rural in character, with some industrial and manufacturing operations set back far from the highway. Much of the highway in this section has wide shoulders without urban curb and gutter. Residential uses are found at the northern end.

- **Bldg-to-Area Density:** 1 sq. ft : 58 sq. ft.
- **Land uses:** industrial, commercial, single-family residential
- **Building Setbacks:** 75 - 220 feet

Zone 2: Clyde Ave to Grand Ave Place - "Parkway" context

Zone 2 accounts for 10.6% of the corridor. Single-family residences are set back slightly closer to the highway, and the center of the roadway is delineated with a grassed median.

- **Bldg-to-Area Density:** 1 sq. ft. : 37 sq. ft.
- **Land uses:** single-family residential
- **Building Setbacks:** 60 - 130 feet

Zone 3: Grand Ave Place to 88th Ave W - "Rural-suburban" context

Much of this section is a continuation of the rural-character found in Zone 1, but it is lined with curb and gutter and, where there is single-family housing, it is significantly closer to the roadway. 17.9% of the corridor.

- **Bldg-to-Area Density:** 1 sq. ft : 53 sq. ft.
- **Land uses:** single-family residential
- **Building Setbacks:** 45 - 170 feet

Zone 4: 88th Ave W to 72nd Ave W - "Suburban neighborhood" context

This section of the corridor is mostly single family residences. Although the density of the neighborhoods are more akin to those closer to the center of the city, their setbacks from the roadway are more suburban in character. 14.5% of the corridor.

- **Bldg-to-Area Density:** 1 sq. ft. : 20 sq. ft.
- **Land uses:** single- and multi-family residential, commercial, institutional
- **Building Setbacks:** 30 - 75 feet

Zone 5: 72nd Ave W to Raleigh St - "Low-density urban" context

There is very little residential development along the highway in this area. A variety of recreational, commercial, and religious uses are predominant, with building setbacks varying significantly. 11.3% of the corridor.

- **Bldg-to-Area Density:** 1 sq. ft. : 15 sq. ft.
- **Land uses:** commercial, single-family residential
- **Building Setbacks:** 10 - 100 feet

Zone 6: Raleigh St to 62nd St - "Higher-density urban" context

The southern side of the roadway is predominately manufacturing facilities, while the north side of the highway is a dense mix of single– and multi-family housing. Buildings are located directly adjacent to the roadway with little variation in setbacks. 11% of the corridor.

- **Bldg-to-Area Density:** 1 sq. ft. : 11 sq. ft.
- **Land uses:** single- and multi-family residential, commercial, industrial
- Building Setbacks: 9 - 15 feet

Image source: America's Byways (2013)

M a p 1.3 | Highway 23 - The Regional Context

The 50-mile stretch of State Highway 23 between Duluth, MN and Askov, MN is designated as the Veteran's Evergreen Memorial Drive. Not only does it provide connection to a number of rural communities, but it provides access to a wealth of outdoor recreational opportunities.

The Regional Context

Highway 23 is an important transportation route, providing access to land uses along the St. Louis River and linking neighborhoods in West Duluth to the rest of the city. Highway 23 also connects the City of Duluth and other rural population centers in Carlton and Pine Counties to the southwest, where the highway is designated as the Veterans Evergreen Memorial Scenic Drive, commemorating the veterans of Carlton, Pine, and St. Louis Counties. The highway also includes a bridge over the St. Louis River in Duluth's Fond du Lac neighborhood that has been dedicated in honor of the service of Native American Veterans (Map 1.3).

Highway 23 is also regionally significant as a recreational corridor. Not only does it provide access to the scenic beauty and variety of recreational opportunities in the St. Louis River Valley, it also provides connection to Jay Cooke State Park in St. Louis County, Banning State Park in Pine County, and the Nemadji State Forest in Carlton County. The route is not only important in terms of the geographic connections to recreation, but also in terms of linking together such recreational activities. Via Highway 23, residents and tourists can access opportunities for boating, fishing, road cycling, mountain biking, cross country and downhill skiing, hiking, horseback riding, camping, etc.

The Functional Context

The section of Highway 23 in the Western portion of Duluth is also important in terms of its functional classification. It is the only through route linking the neighborhoods of Fond du Lac, Gary/New Duluth, Morgan Park, Riverside, Smithville, Norton Park to each other and the

rest of the City of Duluth. The alternative route to the rest of the Duluth metro area is I-35 via Becks road, which is two-times the length of the Highway 23 corridor, and still requires a portion of the trip to be made on Highway 23 itself. This limitation of choice underscores the importance of recognizing the highway's role as a principal arterial with the primary role of facilitating the efficient movement of through traffic.

In addition, Highway 23 in West Duluth facilitates the movement of freight by truck, which is estimated to be 4% of its current daily traffic based on data collected by MnDOT. As shown in Map 1.4 on the following page, the highway provides connection to areas of concentrated commercial and industrial operations.

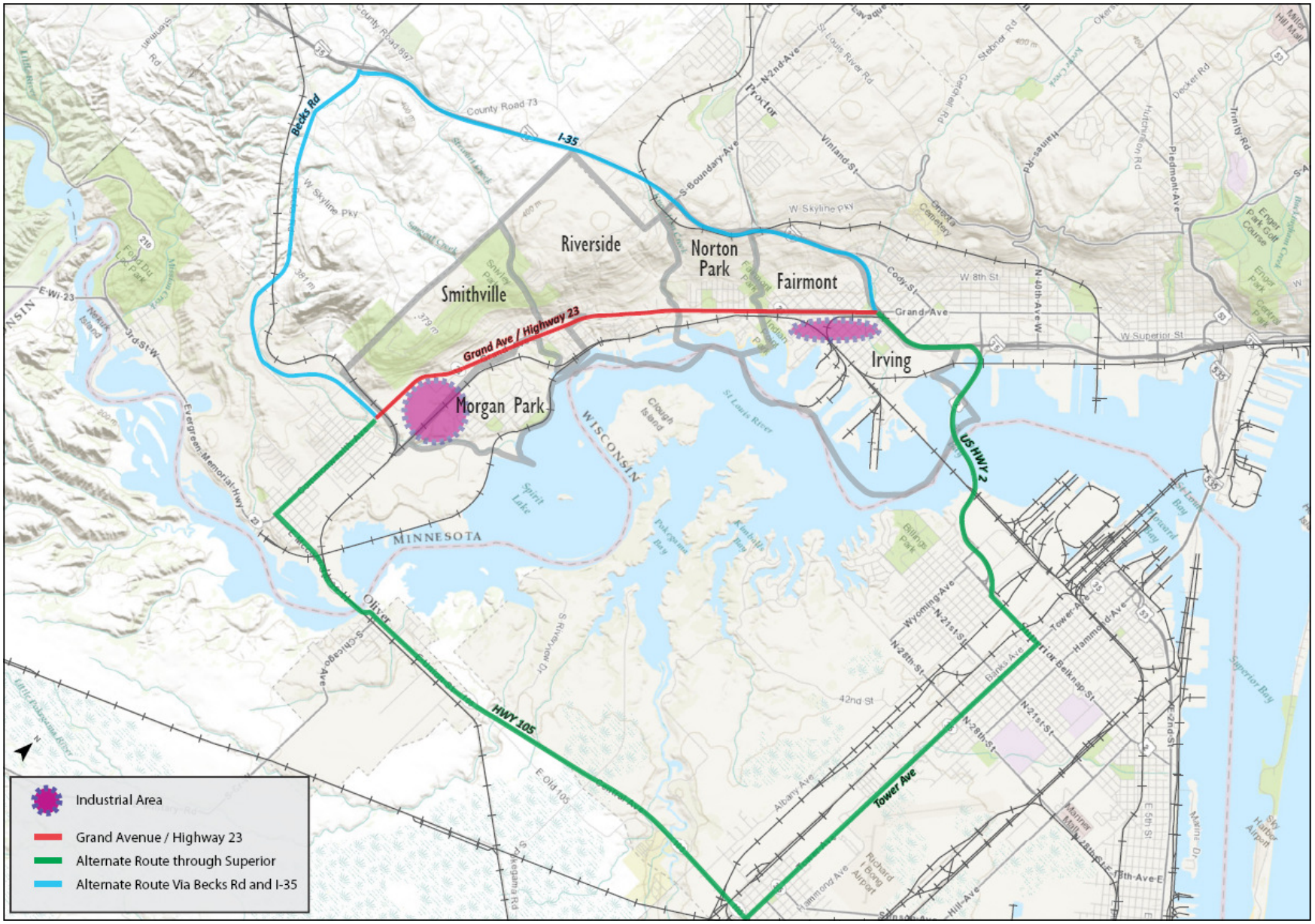
The industrial sites at the south end of the corridor are of particular interest as future centers of intermodal freight transfers due to their proximity to both Highway 23 and the BNSF rail lines. Beyond this, weight restrictions on Highway 23 are less than those on the interstate system, and Grand Avenue is thus part of a bypass route around I-35 for trucks carrying loads in excess of 80,000 lbs (see Map 3.1, page 24). For all the reasons above, the Highway 23 corridor through West Duluth will continue to be an important route for freight for years to come.

Figure 1.3 | Heavy trucks traveling on Highway 23

Highway 23 provides access to commercial and industrial uses in West Duluth, but it also serves as a bypass route for heavy-haul trucks that exceed the weight limits on I-35.

The Future Vision Context

City representatives, planning officials, and interest groups see Highway 23 / Grand Avenue as a leading growth corridor in the coming decades. This is because of the wealth of amenities that exist in this area. The concentration of these amenities has been leading to a vision for the St. Louis River corridor that recognizes the recreational and industrial opportunities already mentioned, but also the availability of



M a p 1.4 | General concentrations of current and future industrial activity relative to alternative through routes

Highway 23 / Grand Avenue provides the most direct route connecting the neighborhoods in the west with the rest of Duluth. Concentrations of industrial activity at either end of the corridor will focus truck trips to the intersections of Becks Road and I-35, but heavy-haul trips rely on Highway 23 in order to bypass weight restrictions on the interstate.

developable lands for future residential, commercial, and industrial growth to occur.

The city's current administration has stated a goal of attracting 5,000 more residents to the city by 2020. Given the beauty of the hillside and the St. Louis River Valley - as well as the access to recreational amenities such as the Munger Trail, the Lake Superior Zoo, or Spirit Mountain Ski hills - it is anticipated that many of these new residents would choose to locate along this corridor.

With the wealth of existing amenities and the anticipation of increases in future commercial, residential, and industrial activities, it is important to protect the vehicle capacity of the highway. On the other hand, with more residential development will also come greater demand for non-motorized access to recreational amenities and other activity centers. The result will be an ongoing effort to balance the needs between regional vehicle travel and localized trips using various modes of transportation.

In addition to assessing the Highway 23 / Grand Avenue corridor based on issues and opportunities in the present, this study also included consideration for needs and opportunities with respect to these corridor's future. Therefore, Section 4, beginning on page 72 also includes recommendations based on projected trends as well as the City of Duluth's future vision for the corridor.

Because significant future growth is anticipated throughout West Duluth, this study also included consideration for future travel demand and mobility needs along the corridor. Thus, Section 4 of this document (beginning on page 72) also includes recommendations based on the interest to maintain sufficient capacity and optimize traffic operations within the existing right-of-way well into the future.

Figure 1.4 | View of Spirit Mountain from the St. Louis River Estuary

The Highway 23 corridor is recognized as a future growth corridor because of its proximity along the St. Louis River Estuary and the access it provides to a variety of recreational activity centers, such as the Spirit Mountain Ski hills.

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2. Stakeholder Input

This section provides a summary of the input received from residents and business owners along the Highway 23 corridor, as well as from other stakeholders who have vested interests in how the corridor develops and operates. Much of this input was gathered through a series of stakeholder outreach meetings that were conducted between March 2013 and June 2013. Comments were also received through the MIC's website and other electronic resources. The information was compiled, shared with MnDOT and the City od Duluth, and ultimately used to develop the recommendations that are identified in Section 4 of this document.

Figure 2.1 | Morgan Park neighborhood meeting

Meetings with neighborhood residents and area businesses were important sources of information that helped inform the study and shape recommendations.

Project Steering Committee

A core group of planners and engineers from the City of Duluth, the MIC, and MnDOT were convened to help define the Highway 23 / Grand Avenue study and scope the MIC's work. This group was also relied upon to vet draft recommendations prior to broader stakeholder review.

Outreach Strategy & Stakeholder Identification

Any MIC study or planning initiative begins with a scoping process that includes formulating a strategy for how to achieve stakeholder outreach objectives.

For this effort, the following objectives were identified:

- Inform stakeholders of MnDOT's upcoming STH 23 project.
- Engage stakeholders in identifying specific issues and

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Figure 2.2 | Stakeholder categories

An effort was made to engage different stakeholder groups equitably. Initial outreach efforts were targeted at 31 initial groups distributed among four categories.

Figure 2.3 | Project webpage

A project page was hosted on the MIC's website. It provided visitors with a variety of ways for users to get information and provide comment.

opportunities.

- Provide and advertise access for input at any time.
- Use stakeholders to vet final recommendations.

The strategy began by identifying four categories of stakeholders: jurisdictional, residential, business-oriented, and special interests. A preliminary list of contacts was compiled with a particular aim at achieving a relative balance of stakeholder interests. This initial outreach was targeted according to the proportions shown in Figure 2.1. The contacts within this original pool were then used to help identify and reach out to additional individuals. A list of stakeholder groups contacted during this study can be found in Appendix B on page, 105.

Web-based Tools

The MIC established a set of web-based tools designed to both distribute information and solicit comments. Principal among these was the agency's website, www.dsmic.org, in which a Hwy 23 / Grand Avenue project page was created. This page provided summary information about the project, as well tools to provide input and receive additional information. These included a calendar that displayed upcoming opportunities for meetings and an interactive map where users could pin comments to specific locations along the highway. The MIC's "OpenMIC" blog and Facebook posts were also used to provide stakeholders with project updates and also refer them back to the website.

Outreach Meetings

Stakeholder outreach meetings were held between March 2013 and June

2013. The meetings were used not only to educate attendees about MnDOT's planned project and the aims of the MIC's study, but also to collect information. Those present were asked to give feedback to MnDOT and MIC officials about specific issues and opportunities that they saw as property owners or regular users of the highway corridor.

Jurisdictional Meetings

The first meeting was held on March 8th and convened a group

- MnDOT
- City of Duluth Planning
- City of Duluth Engineering
- City of Duluth Parks
- Duluth Economic Development Authority (DEDA)
- Duluth Transit Authority (DTA)
- Independent School District 709
- City of Duluth Police Dept.
- US Forest Service
- Dept. of Natural Resources (DNR)

of representatives from the following area jurisdictions:

These participants identified some initial concerns and interests from the perspective of those who manage public resources along the corridor or who use it to deliver public services. During this meeting concerns were raised about traffic speeds and the safety of certain locations along the corridor. Opportunities were also identified with respect to various recreational and economic assets within the corridor and potential future developments.

Neighborhood Meetings

The meeting with the jurisdictions was followed up by three neighborhood meetings located at different locations along the

Figure 2.4 | Outreach Meetings

Jurisdictional representatives, residents and business owners along the corridor, as well as members of the general public were invited to attend a number of meetings. The meetings provided an overview of the project as well as opportunities to inform MIC and MnDOT personnel of specific concerns or interests regarding Highway 23.

Figure 2.5 | Neighborhood Flyer

Posters were distributed in neighborhood businesses and public spaces throughout the study area.

Neighborhood Discussions

Grand Ave Improvement Project

WHAT: Presentation and discussion.

WHY: Learn about Mn/DOT's resurfacing project for 2016 (along Grand Avenue from I-35 to Beck's Road) and inform us about potential issues.

WHEN & WHERE:

- Tuesday, March 12, 6:00 – 8:00pm:
  City Center West - Evergreen Senior Center - 5830 Grand Ave
- Thursday, March 14, 6:00 – 8:00pm:
  Morgan Park Community Recreation Center - 1242 88th Ave W
- Thursday, March 28, 6:00 – 8:00pm:
  Spirit Mountain's new chalet - 8551 Grand Ave

Highway 23 corridor. Meetings were held at City Center West (east end of corridor), Morgan Park Community Center (west end of corridor), and the new Spirit Mountain Chalet (central corridor). The dates, locations, and times of these meetings were advertised to local media as well as with flyers that were displayed in neighborhood businesses and public facilities in West Duluth (Figure 2.5, page 13).

From the information collected at those meetings, as well as comments received through the website and other correspondence, it became apparent that the prevailing concerns centered around the challenges faced by non-motorized users of the corridor. Figure 2.6 below shows percentage of total comments received (pro vs. con) regarding various aspects of the highway or of MnDOT's coming project. Together, these comments indicate a general desire to see the highway corridor become more supportive of multiple

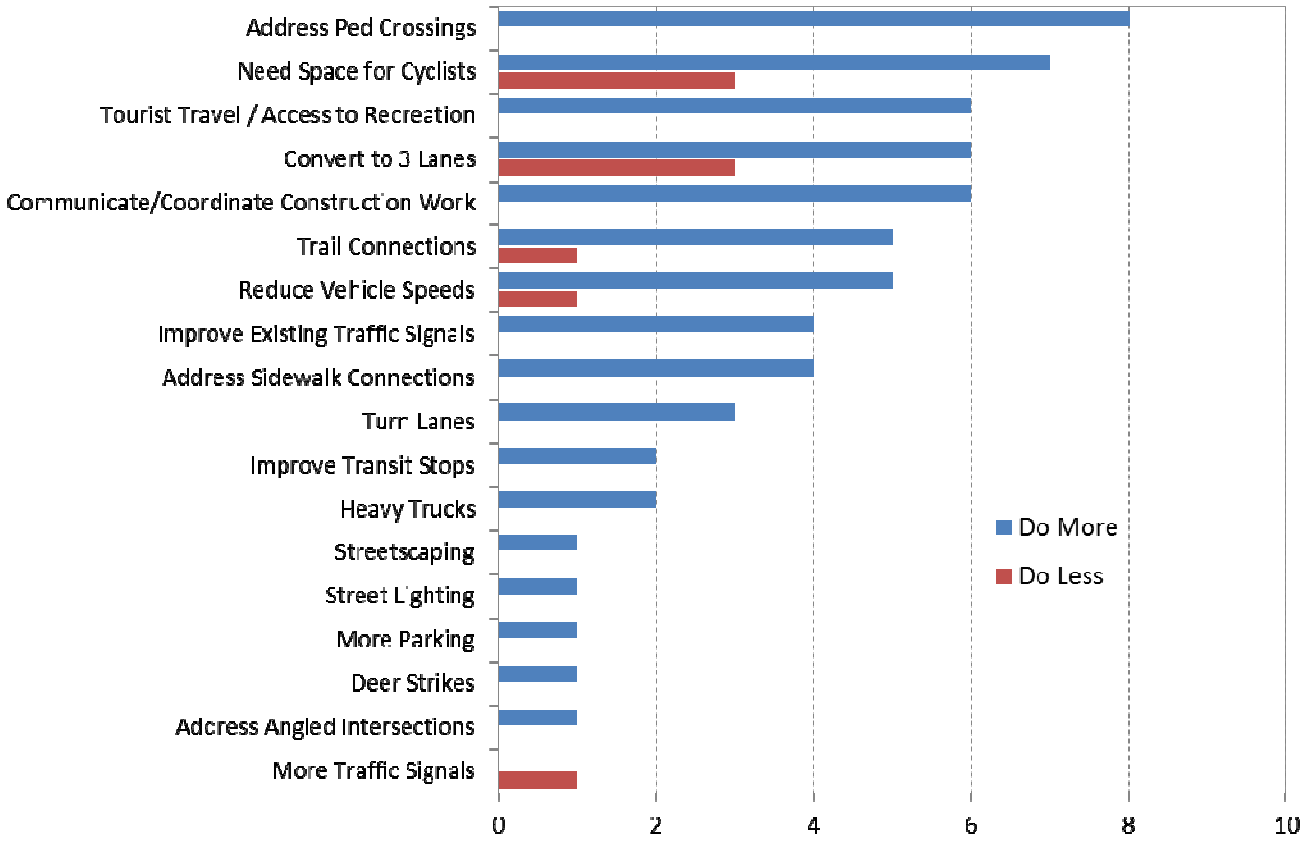

Figure 2.6 | General comments

The majority of comments received throughout the study period were related to improving the corridor for non-motorized users and improving connections to recreational amenities in the area.

modes of transportation, making it safer and easier to cross and travel along, as well as improving trail connections and other recreational amenities in the area.

Mapping the Issues & Opportunities

In addition to the interactive map made available on the MIC's project webpage, large maps of the Highway 23 corridor were brought to each of the neighborhood meetings. Each meeting provided opportunities for attendees to walk around the maps, ask questions, and point out the locations of specific concerns or interest. Participants were asked to post concerns or ideas on the maps using Post-it notes.

The maps corresponded to the six different context zones identified in Section 1 of this study document. Figure 2.8 shows the number of comments received per these zones. Of the six corridor segments, Zone 4 received the greatest number of comments, indicating both problems and opportunities as the attendees saw them.

The comments received outside of the formal outreach meetings, either via the interactive map on the MIC's website, phone calls, or email sent to staff, were also mapped when possible. Maps 2.1 through 2.6 on the following pages show all the comments received both during and outside of the meetings that called out specific issues or opportunities at specific locations. The majority of these comments were related to concerns about the speed of traffic, hazards to pedestrians, and general safety of the corridor.

Synthesizing the Information

An effort was made to synthesize all information received from stakeholders throughout the entire duration of the study. The information was regularly shared with staff from MnDOT District 1

Figure 2.7 | Participants commenting on maps

People at the neighborhood meetings were asked to look at maps of the corridor and point out things they believed were concerns or opportunities.

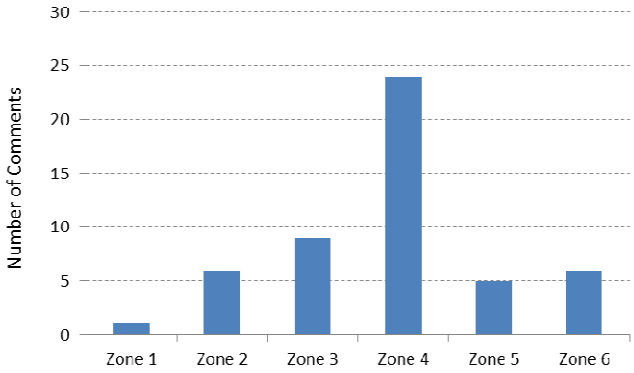

Figure 2.8 | Number of comments received per zone

Between the comments received, either directly or through the website, and those recorded at the stakeholder meetings, Zones 3 and 4 received the greatest focus from stakeholders.

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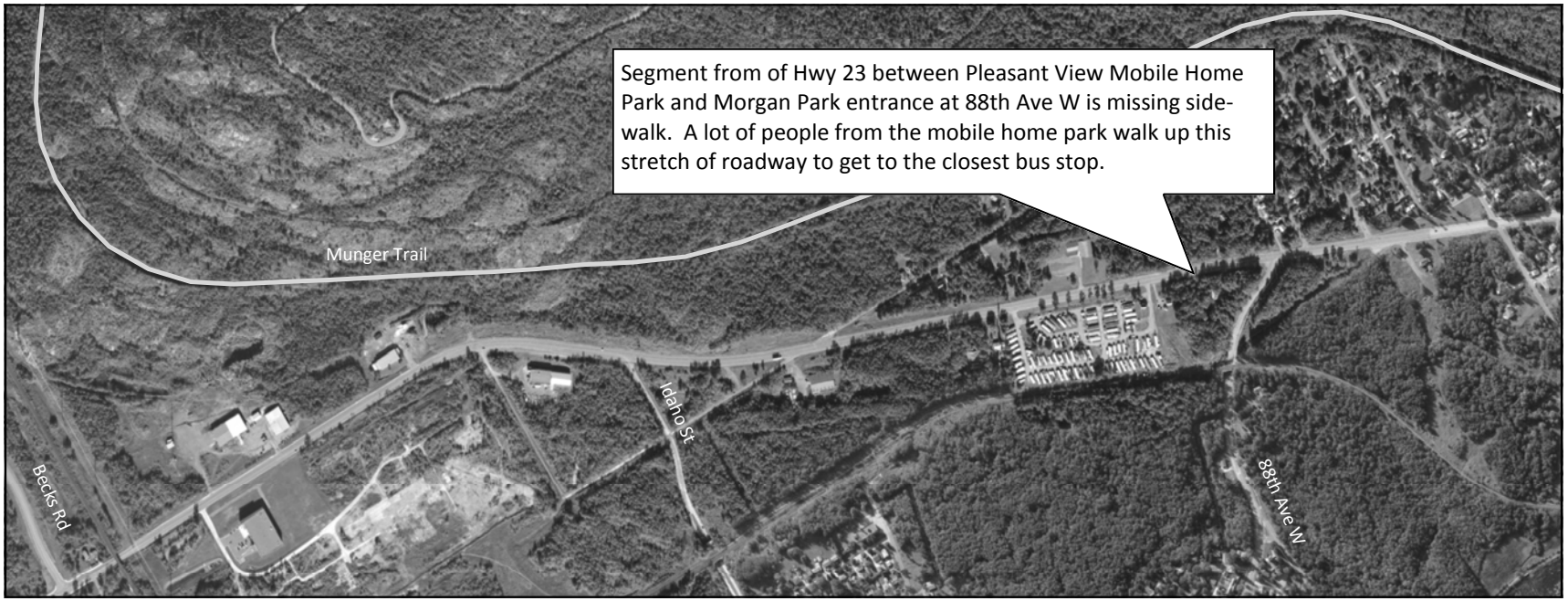
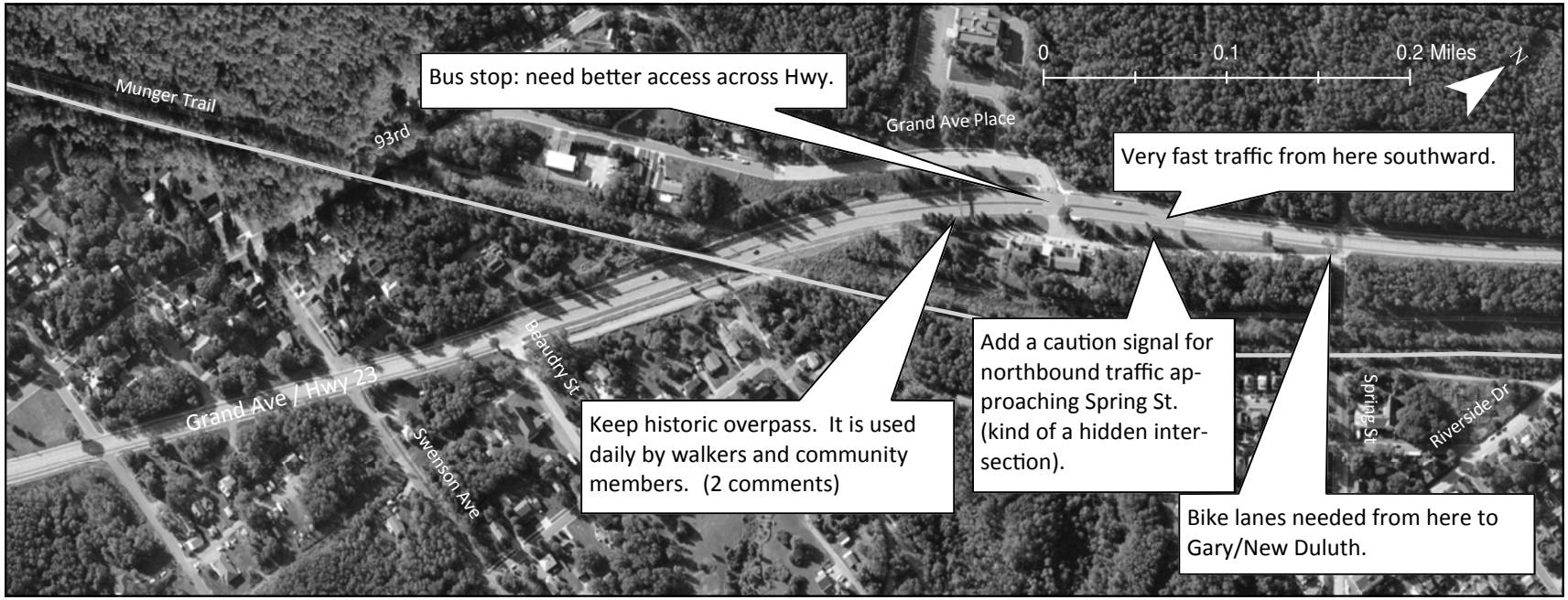
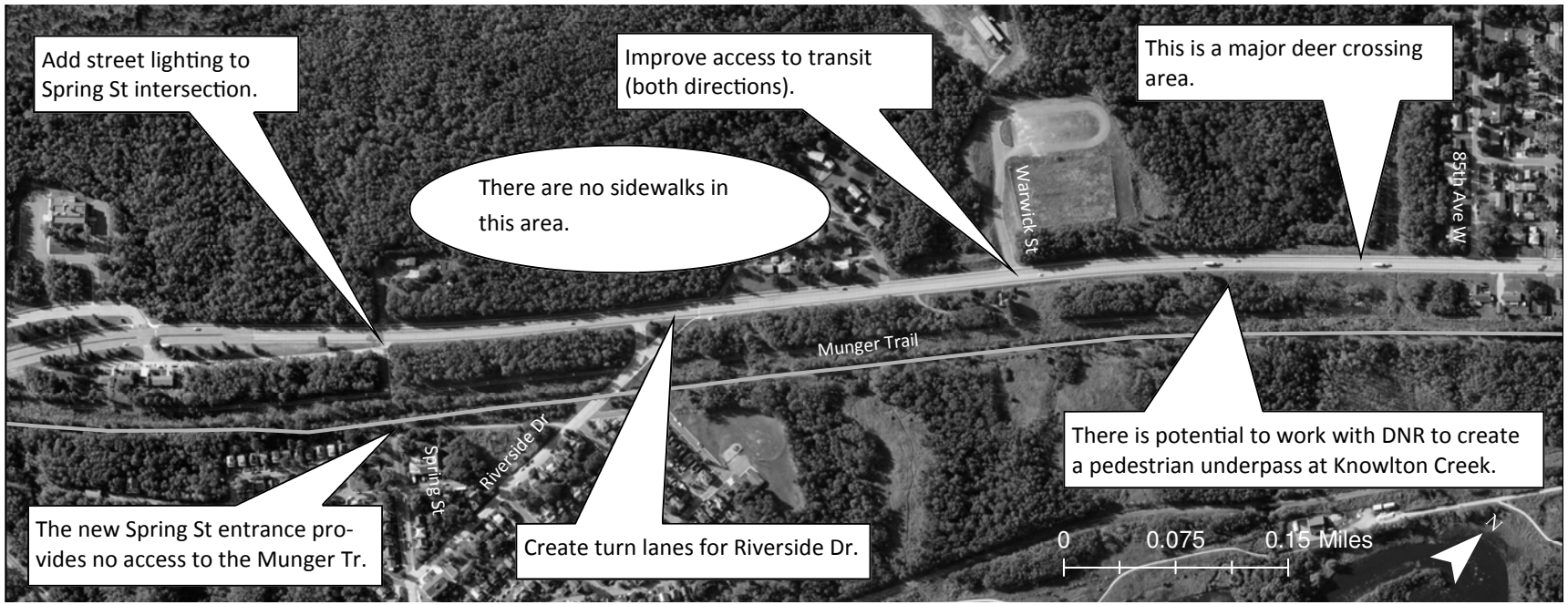
M a p 2.1 | Locational comments received for Context Zone 1 (Becks Rd to Clyde Ave)



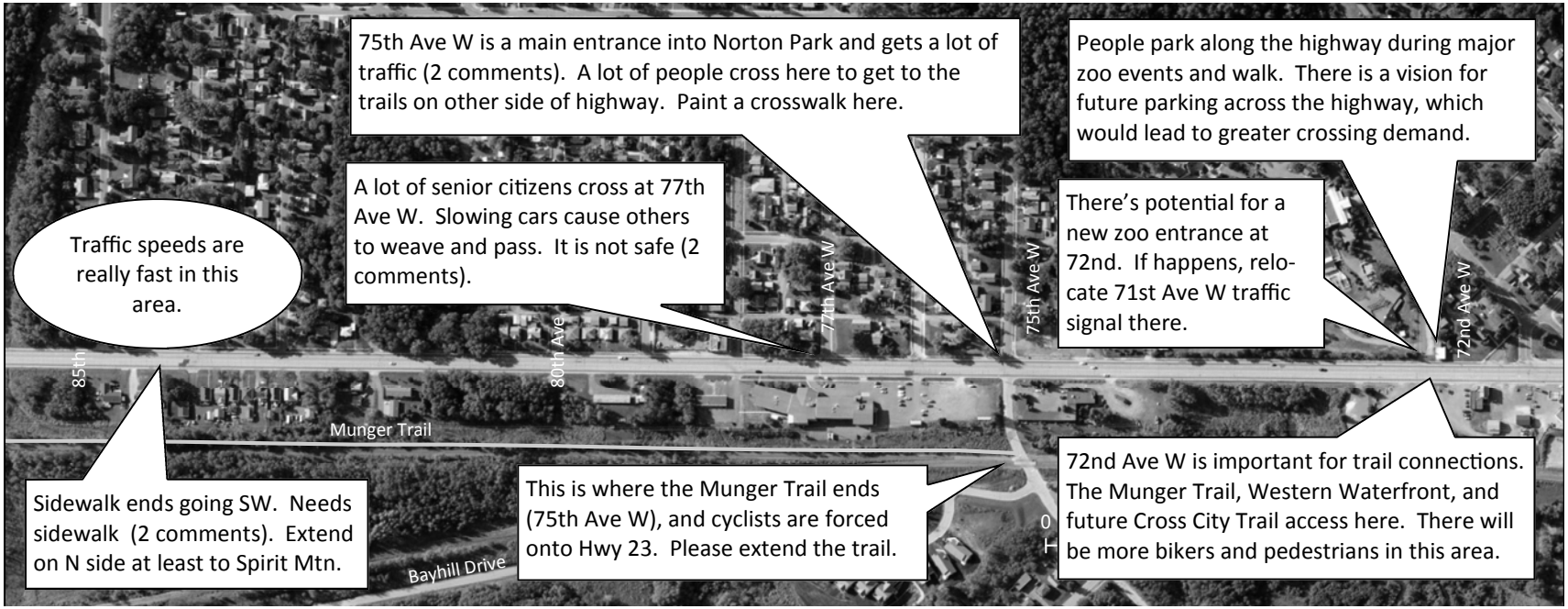
M a p 2.2 | Locational comments received for Context Zone 2 (Clyde Ave to Grand Ave Place)



Map 2.3 | Locational comments received for Context Zone 3 (Grand Ave Place to 85th Ave W)



Map 2.4 | Locational comments received for Context Zone 4 (85th Ave W to 72nd Ave W)



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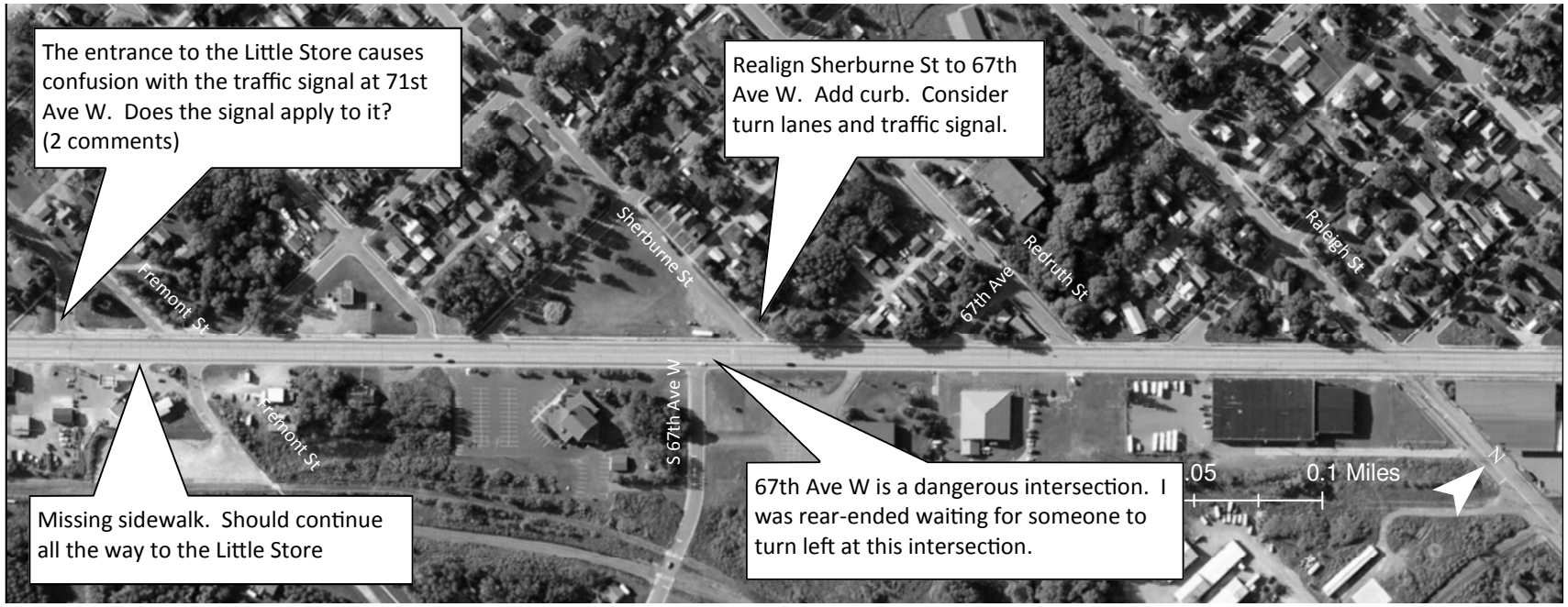
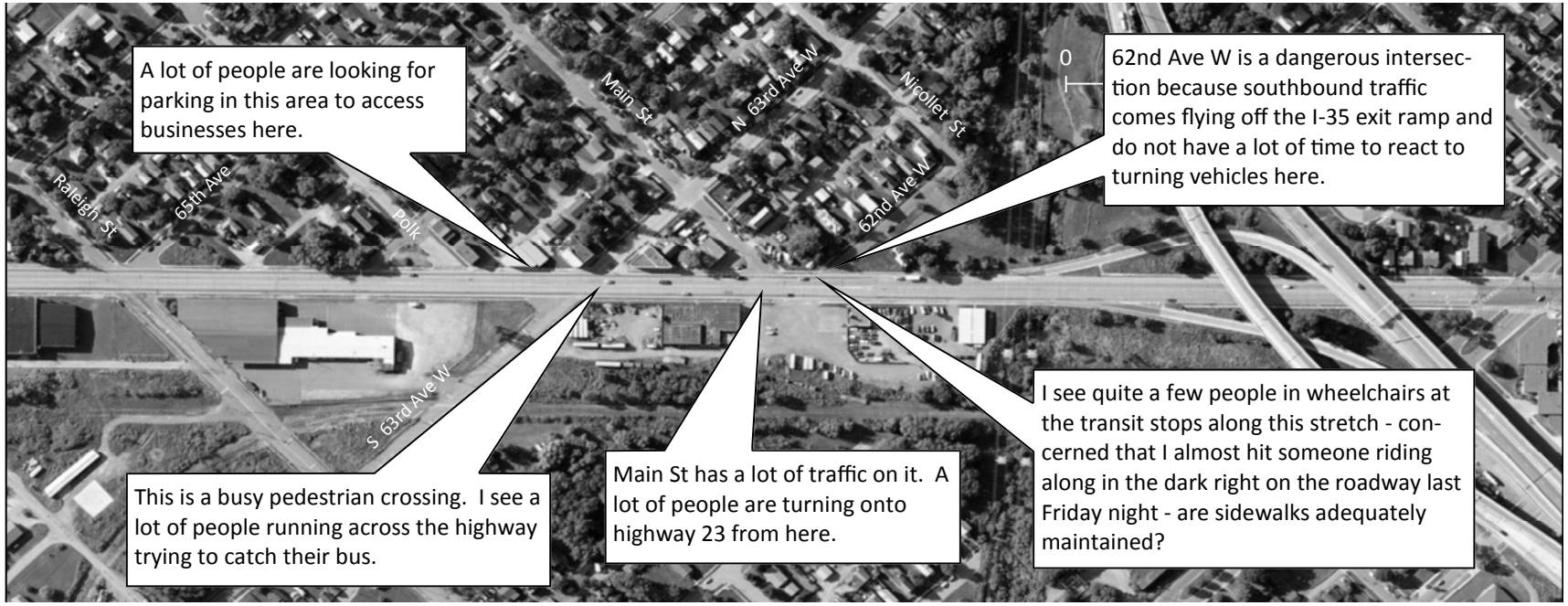
M a p 2.5 | Locational comments received for Context Zone 5 (72nd Ave W to Raleigh St)



M a p 2.6 | Locational comments received for Context Zone 6 (Raleigh St to 62nd Ave W)



and the City of Duluth as they began to initiate various activities related to the scoping and planning of the 2015-2016 resurfacing project. It was also used to further direct the types of analysis that were conducted as part of this study. The issues and opportunities that were identified through the outreach efforts were investigated, often resulting in further efforts to collect data or verify conditions with on-site observations.

The expectations and desires for the Highway 23 corridor, as expressed by the jurisdictions (e.g. MnDOT, City of Duluth), business owners, and area residents, also provided a context from which to assess existing conditions. Issues related to the efficiency, safety, and accessibility of the corridor were examined from the perspective of both present and potential land use patterns, as well as increasing travel demand. A summary of these analyses are provided in the following section.

Figure 2.9 | Field observations

Information gathered through stakeholder outreach were often followed up with site visits and additional data collection.

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3. Existing Conditions & Analysis

This chapter contains descriptions and analysis of a variety of existing conditions found throughout the Highway 23 / Grand Avenue corridor. Issues related to safety, operations, and level of service (LOS) were looked at with respect to the different modes of transportation and the impacts of potential changes in land use patterns and future traffic volumes.

Conditions were assessed both in terms of the entire 5-mile corridor from Becks Road to I-35 and the six individual context zones identified within that corridor (as identified in Section 1, pages 2-5). The purpose of proceeding in this manner was not only to seek ways in which the corridor might better serve its various users, but also help to identify very specific, localized issues and to perhaps develop recommendations that can address those unique issues in a targeted and cost-effective manner. The next 34 pages, therefore, address issues and opportunities in terms of the entire highway corridor, while pages 37 - 69 identify and address issues that are specific to the six distinct context zones.

Land Use and Traffic Patterns

Land use patterns change significantly from one end of the Highway 23 corridor to the other. This is the primary reason for segmenting the corridor into six distinct context zones: conditions and traffic patterns vary accordingly. As one travels the highway from southwest (Becks Rd) to northeast (I-35), the corridor transitions from a rural to an urban environment, and land uses and traffic movements change in number and density (Figure 3.1). This translates into different concerns throughout the corridor. Conditions related to the speed of traffic, for

Image source: Google Maps (2013)

Figure 3.1 | Urban section of Highway 23

The area around the five-legged intersection of Raleigh Avenue represents an urban section of the Highway 23 / Grand Avenue corridor where issues related to turning movements at acute-angle intersections are more prevalent than in the corridor's more rural sections.

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Figure 3.2 | Traffic on Highway 23 / Grand Avenue

The wide roadway, limited signalization, and heavy traffic patterns found on Highway 23 have the potential to create barriers to access, especially for non-motorized users trying to cross the highway.

instance, are more significant in the rural sections to the southwest, while conditions related to turning movements at acute-angle intersections are an issue at the other end of the corridor.

There is a mix of residential, commercial, and industrial activities throughout the corridor, which produce varying traffic patterns. The corridor experiences the typical AM and PM hours of peak travel, but also becomes substantially busier as the day progresses. There are also recreational uses, such as the Lake Superior Zoo and the new Spirit Mountain Chalet that generate higher levels of traffic during certain seasons or events. At these times, different issues related to traffic operations and parking along the corridor can emerge.

In addition, Highway 23 serves as an important regional travel corridor for both daily commuters and heavy trucks hauling freight. As such, the route has been designed as a 4-lane highway to facilitate these movements in addition to local access. But the density of land use and traffic throughout much of the corridor is too low to warrant traffic signalization. This translates into a land use pattern of its own, one which impedes non-motorized movements across the roadway and in a sense separates uses on the northern side of the corridor from activities on the southern side (Figure 3.2).

Local Access and Regional Through Routes

As explained in Section 1, Highway 23 is the only thru-route connecting the neighborhoods in far West Duluth. Even though I-35 lies just to the north, there are no connector routes between it and the neighborhoods to the south. Therefore, the residents in those neighborhoods have only one option, Highway 23, to access I-35 or other destinations in the metro area. Furthermore, anyone wishing to pass through the area is likewise dependent on the highway, as the alternatives (I-35 or through the City of

Superior) are several miles longer. This is apparent in Map 3.1 on the following page, which shows the regional through routes in green.

In addition, Highway 23 is not weight-restricted as the interstate and the Oliver Bridge over the St. Louis River are. So, the highway is also a critical thru-route for heavy freight movements. Map 3.1 (page 24) shows the weight-restricted routes in red, and it is again apparent that Highway 23 is the sole alternative. The highway is also in close proximity to a regional rail corridor, which creates opportunities for the intermodal transfer of goods. All of this underscores the importance of Highway 23 as a principal arterial and the need for MnDOT to protect its capacity into the future.

However, the highway is equally as important for local access as it is for through movements. It serves six neighborhoods (Map 3.2, page 25), each with varying degrees of access to the highway and surrounding facilities. Moving forward, it will be just as important to ensure good access to the residences and business along the highway as it will be to ensure capacity.

The area around the Highway 23 / Grand Avenue corridor is also graced with a number of local and regional trails, most of which come into close proximity to the highway. The Munger Trail, DWP Trail, Western Waterfront Trail, and future Cross City Trail are all important connections for non-motorized commuter and/or recreational travel. However, the connections between these facilities, the highway, and the neighborhoods are limited and thus represent a poorly integrated transportation system.

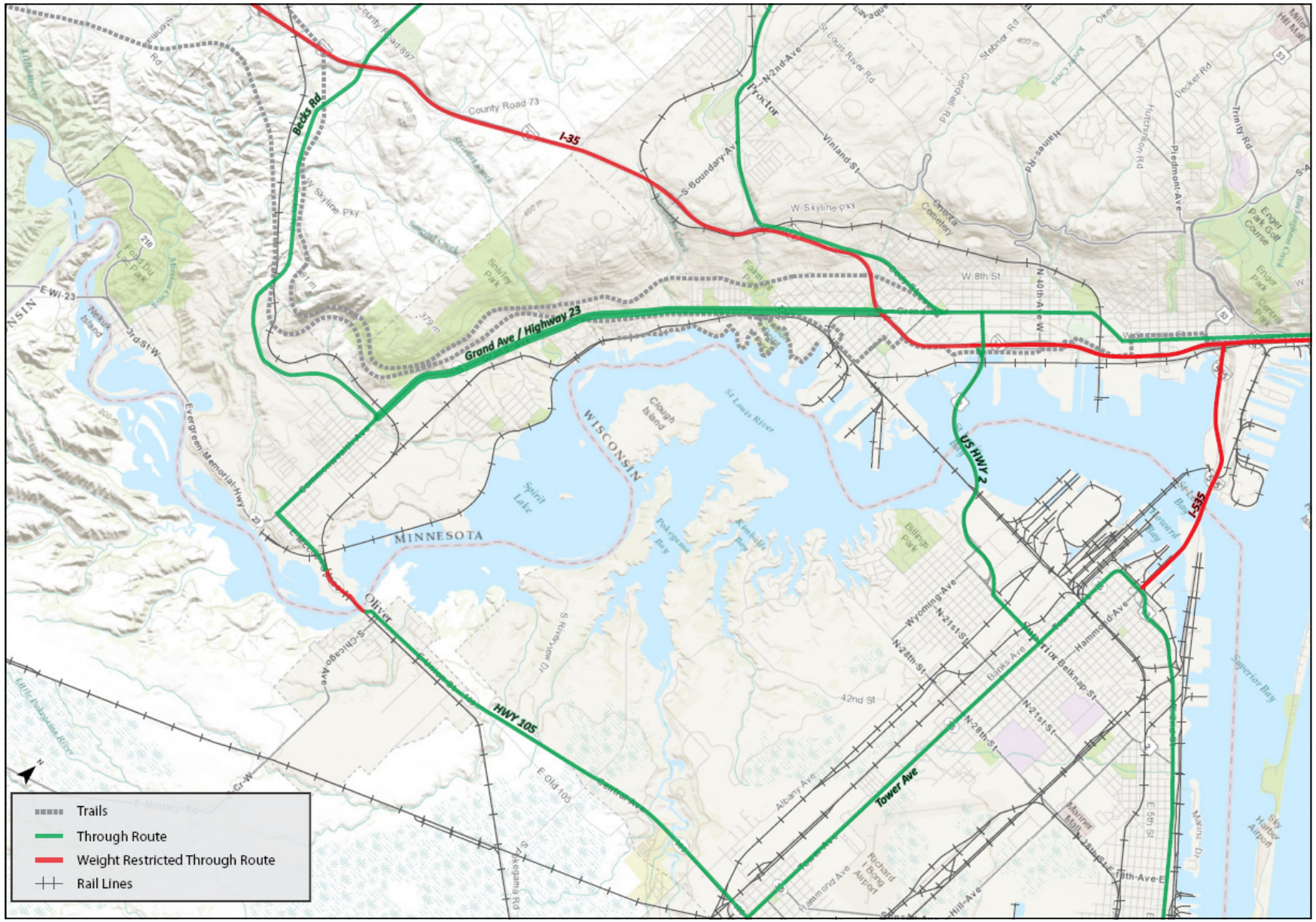
Image source: Google Maps (2013)

Figure 3.3 | Rail crossing and trail head at Pulaski Street

Rail and trail corridors exist in close proximity to Highway 23, creating opportunities for intermodal connections.

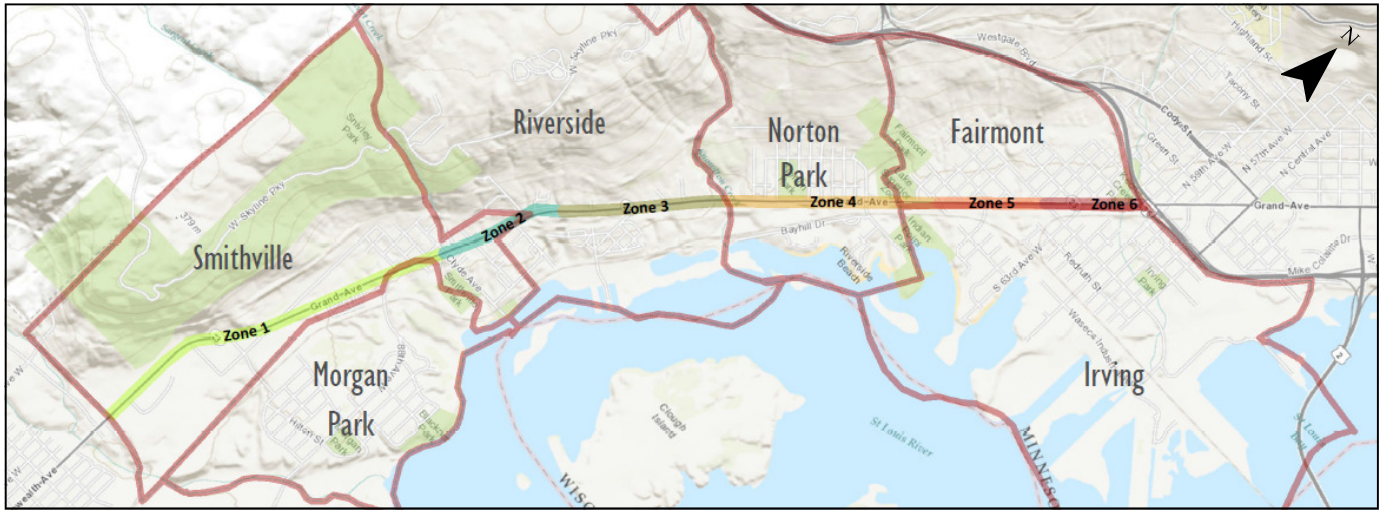
Traffic Volumes

Traffic volumes differ significantly from one end of the Highway 23 corridor to the other. Near Becks Road to the southeast, daily traffic is around 8,400 vehicles per day. Yet, as one moves eastward along the



Map 3.1 | Alternative through routes and regional trails

Highway 23 / Grand Avenue is the most direct arterial route that connects land uses southwest of the I-35 interchange. It is also the only route without weight-restrictions for heavy-haul truck trips. Intermodal opportunities also exist between the highway and area railways and trails systems.



Map 3.2

Highway 23 context zones & West Duluth neighborhoods

This plan identifies six distinct zones where the land use context changes along the roadway. These zones correspond roughly to the locations of the different neighborhoods along the corridor. Data collection and analysis were done according to these zones.

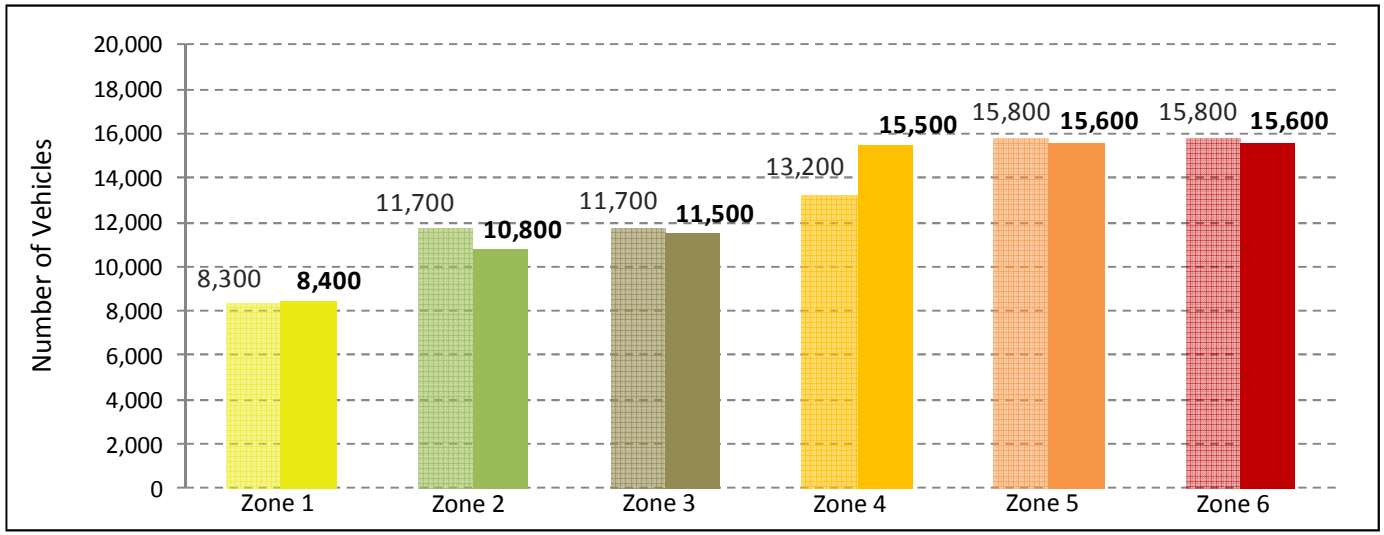


Figure 3.4

Comparison of average annual Daily Traffic: 2002 to 2011

Traffic volumes are heavier in the context zones closest to I-35. There has been a slight decrease in daily traffic over the past decade, with the exception of Zone 4, a residential area which has seen traffic increase by more than 2,000 cars per day.

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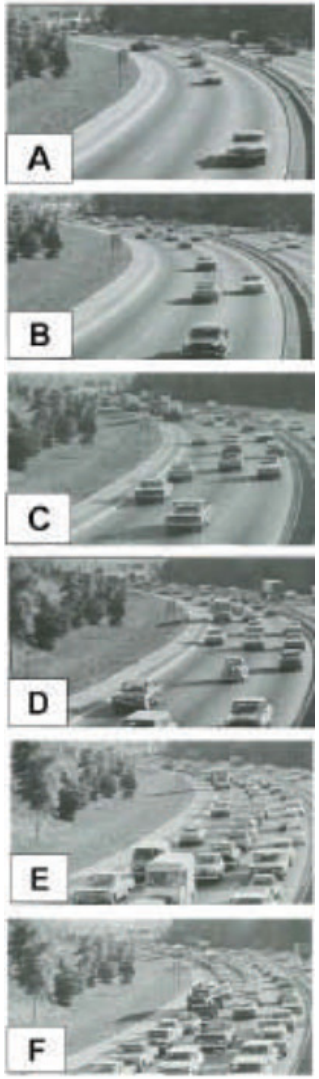

Figure 3.5 | Vehicle level of service (LOS)

LOS is a qualitative statement about the road's operation (A-F), but is based more quantitatively on the measure of number of vehicles present compared to a road's capacity.

highway, volumes continue to increase until in the segments nearest I-35 (zones 5 and 6), traffic is nearly doubled at 15,600 vehicles per day.

Vehicle counts taken since the year 2002 show that traffic has decreased slightly over much of the corridor. This is a pattern consistent with those at the state and national level that show a general flattening in the amount of annual vehicle miles traveled (VMT). The mid-section of the Highway 23 corridor, however, stands out as an exception to this trend. As Figure 3.4 on page 25 shows, traffic has increased in Zone 4 by more than 2,000 vehicles a day over the past decade. This change corresponds with the fact that Zone 4 is also the only zone in the corridor that received new housing developments during the same period.

Turning movement counts that were done at 75th Avenue W in May 2012 showed the peak hour of traffic in Zone 4 to be between 4:30 PM and 5:30 PM. Traffic was 1,470 vehicles (9% of daily traffic), with about 400 vehicles during the most congested 15 minutes within that hour. According to the 2010 Highway Capacity Manual (HCM), at a free-flow speed of 45 mph, this volume of traffic represents a vehicle/capacity (V/C) ratio of 0.21, which equates to a level of service (LOS) of "B" and represents a state of virtually no congestion.

Turning movements that were done at the intersection of Highway 23 and Raleigh Street in Zone 6 in April 2013 showed a slightly higher peak hour volume of 1,556 vehicles (10% of daily traffic), with a peak 15-minute volume of 415 vehicles. This still represents a LOS "B", and indicates there is more than enough capacity to meet current traffic demands.

Despite a trend towards flattening VMT, future development is expected along the Highway 23 corridor. The impacts of this growth on the traffic capacity of the roadway are projected to be significant but still remain better than an LOS D (see Figure 3.5). During this study, the traffic

impacts of a build-out scenario were assessed with regards to the six individual context zones Those impacts are discussed in more detail starting on page 37.

Heavy Truck Volumes

Heavy Commercial Truck AADT (HCAADT) data published by MnDOT shows that daily truck volumes make up about 4% of the total daily traffic on Highway 23. An average volume of 340 trucks per day were reported in Zone 1 in 2011, while an average of 640 trucks per day were reported in Zones 4, 5, and 6.

Heavy trucks were also counted during the April 2012 vehicle counts at Raleigh Street. They represented 2% of traffic at mid-day, but less than 0.05% of traffic during the PM peak. This suggests that there are times throughout the day when heavy trucks represent significantly more than 4% of traffic in the corridor.

It was beyond the resources of this study effort to collect data for a more detailed analysis of daily truck patterns throughout the corridor, but further study in this area may be warranted.

Figure 3.6 | Heavy truck traffic

Heavy trucks make up approximately 4% of the daily traffic in the Highway 23 / Grand Avenue corridor. But there are hours during the mid-day, when trucks represent a significantly greater percentage of the traffic.

Transit Service & Demand

Highway 23 belongs to the Duluth Transit Authority's (DTA) west mainline, which the DTA has identified as the transit corridor that generates the most ridership in the Duluth-Superior metro area. The corridor is actually served by three different bus routes, the characteristics of which are summarized in Table 3.1.

Route No. 1 runs approximately every half-hour between 5:00 AM and Midnight between downtown Duluth to the Lake Superior Zoo, where it turns around at 71st Ave W. Route No. 3 also runs between downtown and the zoo, but does so on more of an hourly basis. Route No. 2, on the other

Route Attribute	I-35 to Zoo (Routes 1 & 3 both ways)	Zoo to Gary/ NewDuluth (Route 2 both ways)
Avg number of bus trips per day	66 westbound 68 eastbound	28 westbound 30 eastbound
Avg bus headway (minutes)	18 minutes	42 minutes
Avg bus occupancy	48% capacity	28% capacity

Table 3.1 | Characteristics of Highway 23 transit service

Bus service is more frequent and more heavily utilized east of the transit turnaround at the Lake Superior Zoo.

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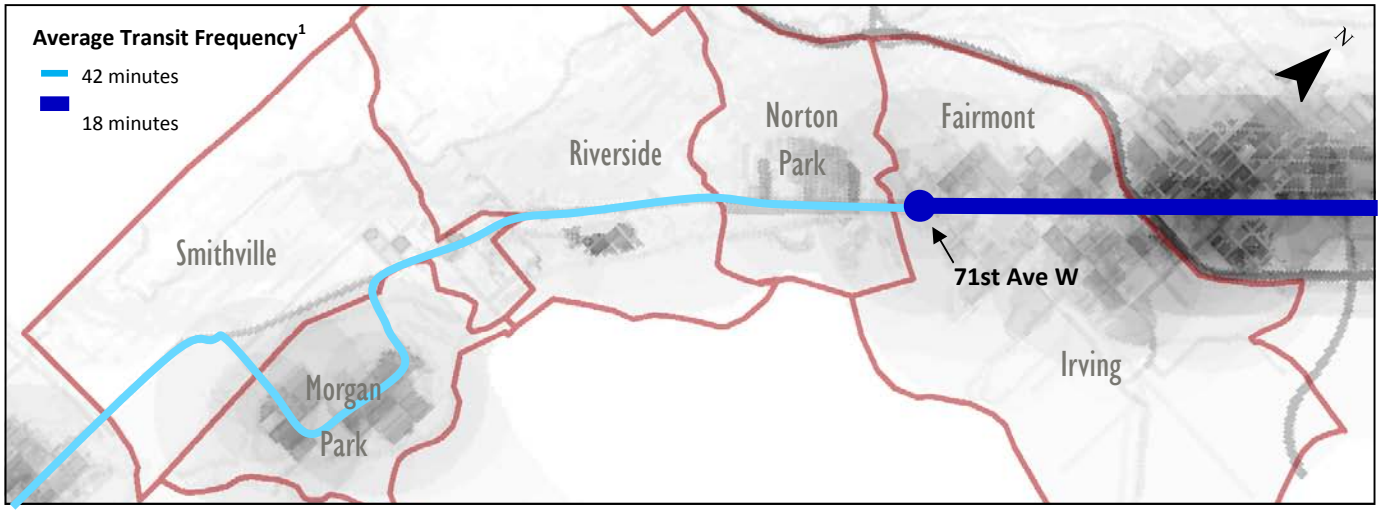
Figure 3.7 | DTA bus service along Highway 23

The Highway 23 / Grand Avenue corridor represents one of Duluth Transit Authority's (DTA) most utilized bus routes.

hand, travels about eight miles further beyond the zoo to Highway 210 in Fond Du Lac and travels the Highway 23 / Grand Avenue corridor approximately every hour. Together, these three routes create a pattern of transit frequency in the corridor that is reflected in Map 3.3 on page 29, in which a bus could be boarded every 15-18 minutes in the 1-mile stretch between the zoo and I-35, while the rest of the corridor experiences a bus roughly every 45 minutes to an hour.

The pattern of transit frequency appears to complement the patterns of residential density (depicted in black on maps 3.3 and 3.4) that are found in the neighborhoods along the highway corridor. With that said, even though buses run less frequently southwest of the zoo, there are still bus stops in that part of the corridor that produce daily ridership levels comparable to the stops northeast of the zoo that get have more frequent transit service. This is shown in Map 3.4 on page 29 and begs the question as to whether transit service under its current configuration is sufficiently meeting demand within that section of the corridor. Although the MIC received no comments to that effect received from the stakeholder engagement during this study, it should be noted that transit riders were not specifically surveyed along the corridor, and thus some further assessment of this on the part of the DTA may be warranted.

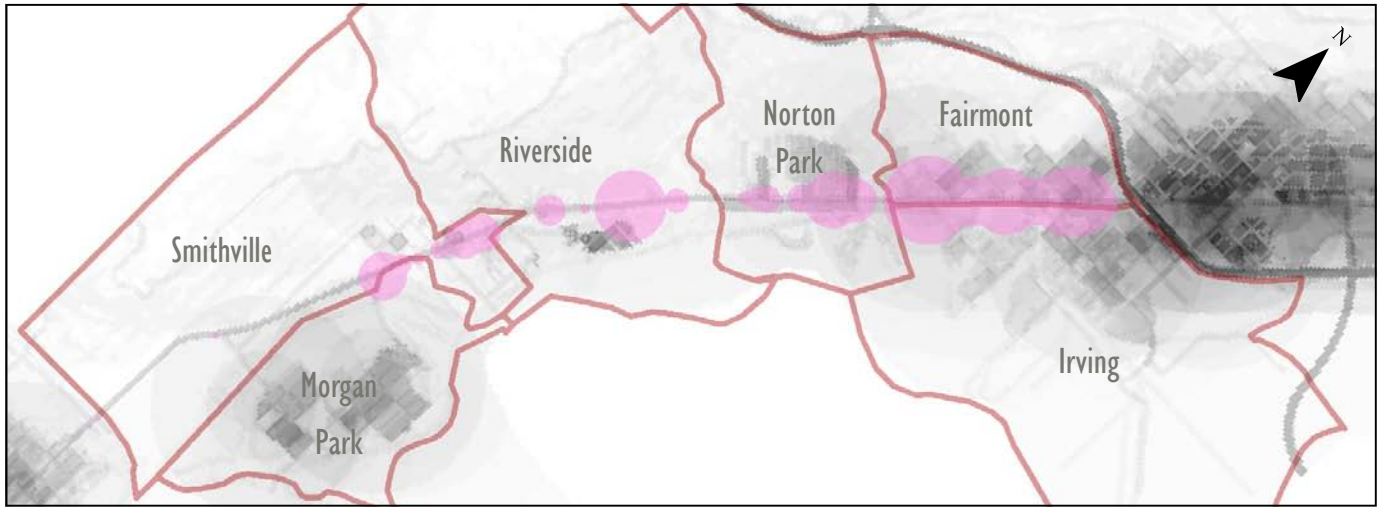
A number of comments were received, however, during the stakeholder outreach efforts for this study that highlighted challenges with respect to accessing a number of the bus stops in the corridor. People reported experiencing or witnessing difficulties in accessing buses either because of poor sidewalk connections or because of the challenge of crossing the highway at busier times. Specific locations that were identified through stakeholder engagement are addressed for each of the context zones discussed in Section 2 of this study (pages 15 -17).



1. Average frequency for service provided between 4:30 AM and 12:00 AM.

M a p 3.3 | Transit frequency

The DTA runs three routes along Highway 23 south of I-35. The section of the highway north of the turnaround point at the zoo (71st Ave W) has buses running approximately every 18 minutes, while the majority of the corridor has buses passing through every 45 -minutes, on average.



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Daily transit boardings & alightings

The majority of transit ridership along Highway 23 comes from the more densely populated area near I-35 (area shown in black). Some transit stops further south, however, also generate large numbers of riders.

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Figure 3.8 | Posted speed limit in Zone 1

The more rural sections of the Highway 23 corridor are posted for a speed limit of 45 mph. The average free-flow speed in these areas, however, is believed to be above 50 mph, due largely to the wide and normally non-congested roadway.

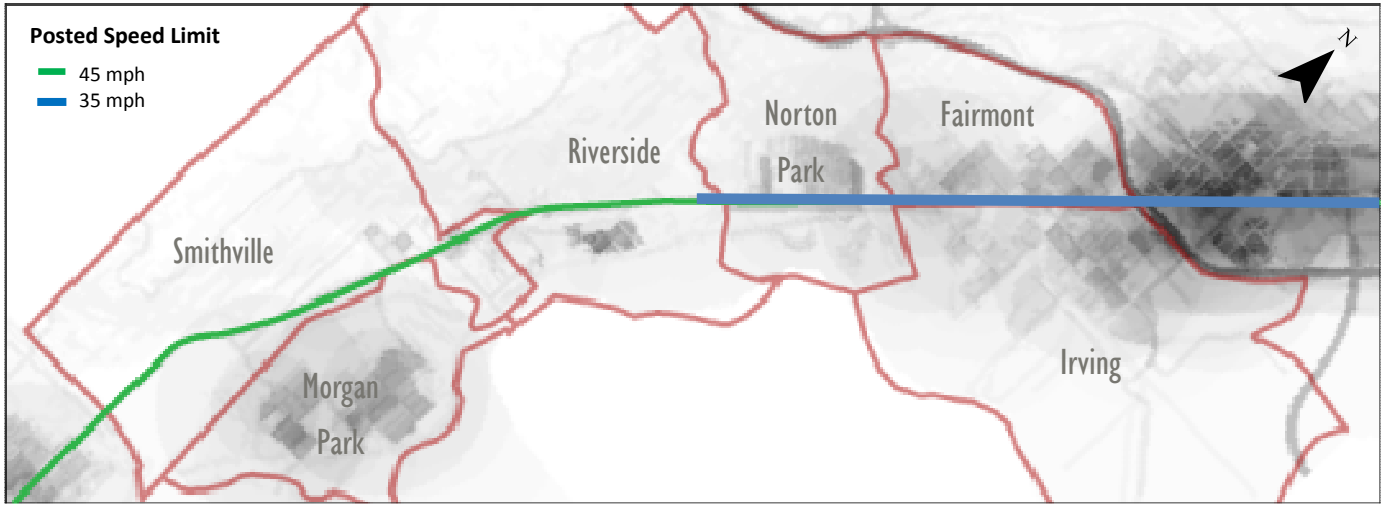
Traffic Speeds

As with traffic volume, the speed of traffic also differs throughout the Highway 23 corridor, depending on the location and time of day. Some of this is due to the fact that different sections of the highway have different speed limits. As Map 3.5 shows on page 31, the southern two-thirds of the corridor have a posted speed limit of 45 mph, while the 2-mile section north of the Riverside neighborhood is posted for 35 mph. It can also be seen in the map that the lower speed limit corresponds with the portion of the corridor with greater residential densities (shown in black) along the highway. In the portion of the corridor posted for 45 mph, the concentrations of residential uses are located away from the highway.

During the mid-day and PM peak hours of travel, the free-flow of traffic becomes more variable the closer one gets to I-35. This is because of a combination of the higher traffic volumes, greater density of driveways, more turning vehicles, and traffic signals at 71st Ave W and Raleigh St. However, outside of these more congested times, the free flow of traffic remains fairly consistent' and this is in large part because of the excess capacity offered by the existing four lanes.

MnDOT District 1 has reported that past speed inventories have shown average free flow speeds of around 52 mph in the section of Highway 23 that is posted for 45 mph and average speeds of 48 mph in the segment posted for 35 mph. This matches observations made the MIC staff while driving the corridor during this study effort and is consistent with the range of LOS - LOS "A" (non-peak) to LOS "B" (peak) - that is estimated to presently exist, based on the current AADT information.

Input gathered through the various stakeholder outreach efforts indicates that users of the highway have few concerns about the efficiency of traffic operations along the corridor. In fact, many said that they



Map 3.5

Posted speeds on Highway 23

The highway is posted for 35 mph in the more densely populated, urban half of the corridor. The speed limit increases to 45 mph west of the neighborhood of Norton Park.

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appreciated the quickness with which they could travel through the corridor and would not want to see any reductions made to the posted speed limits or the number of lanes.

However, there was also a sizable contingency of stakeholders that voiced concerns about the impact that current speeds have on the safety of the corridor. The perspective of many was that current speeds are too fast; they are leading to more crashes and making the corridor unsafe for pedestrians and cyclists who wish to cross or travel along the highway. This concern is addressed with the following discussion of trends found in the historical crash data for the corridor, but is also spoken to in the discussion on pages 36 - 37 that identifies certain aspects of the roadway environment that either support or detract from the safety of non-motorized users.

Traffic Safety

Rates of crashes occurring on Highway 23, and the severity of those crashes, were compared with the average rates for highways of similar type in Northeastern Minnesota. This was done in order to determine if any portions of the corridor were showing higher numbers of traffic collisions or higher rates of injury than would be expected.

Zones 5 and 6, those most urban in character, had the highest crash rates of the six zones studied in the corridor. This was anticipated because higher crash rates tend to be a function of more exposure to higher traffic volumes and greater densities of intersections and driveways. However, none of the six zones had crash rates that exceeded regional averages. Yet, Zone 6 did stand out as having a crash rate that the research literature would suggest to be higher than normal in terms of

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the densities of intersections and driveways found in that segment (see Figure 3.9 on page 32). This is discussed in further detail on pages 66 and 67, which address conditions specific to that context zone.

When looking only at crashes occurring at intersections, those along the Highway 23 corridor generally have crash rates that are lower than would be expected. There are, however, three intersections that have crash rates which are higher than average for intersections of a similar type. These are the intersections of Becks Road, 75th Ave W, and 62nd Ave W (Map 3.6 on page 33). The intersection at 62nd Ave W in particular stands out as a potential concern because it has a lower-than-average crash rate but higher-than-average crash severity. Conditions at these intersections will also be looked at more closely later in this section.

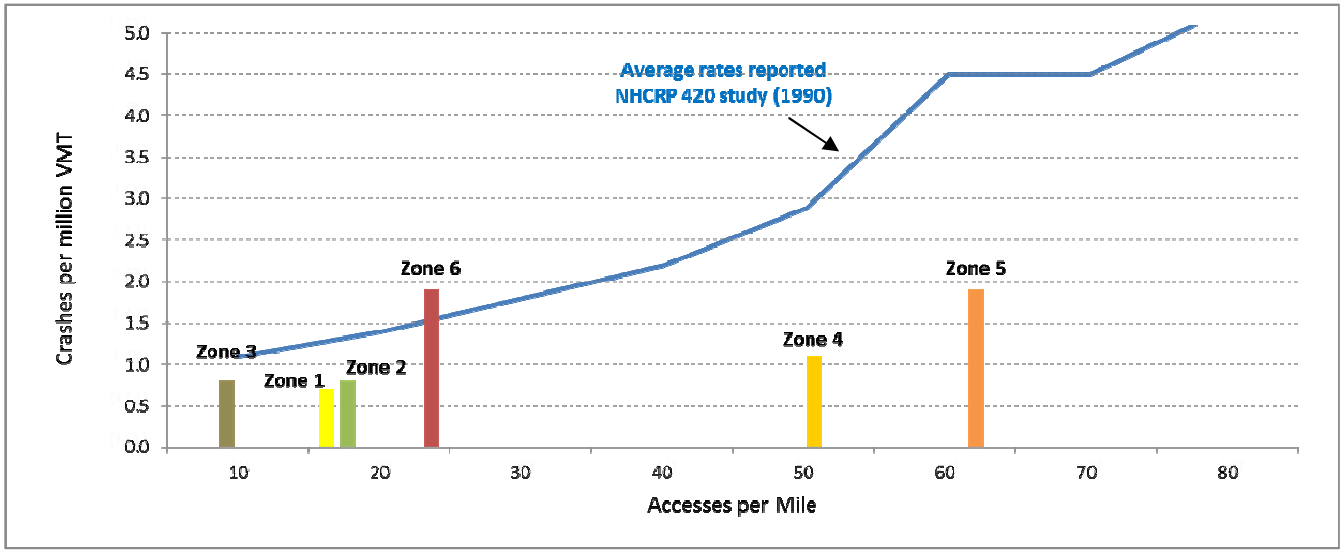
In terms of the types of crashes experienced throughout the Highway 23 corridor, rear-end crashes are the most prevalent, and failure to yield and distracted driving are common causes cited on the crash reports. These things suggest that vehicle speeds may be a predominant contributing factor in traffic incidents on this corridor.

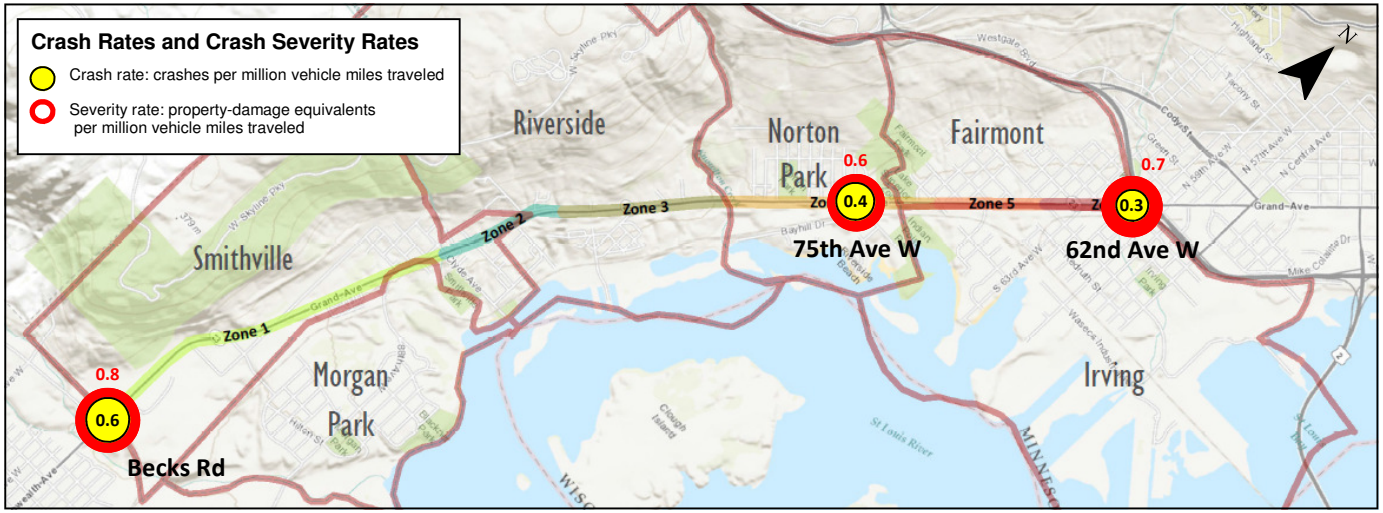
As for the three high-crash intersections identified, crashes at Becks Road were a combination of right-angle and off-road crashes resulting only in property damage; crashes at 62nd Ave W included a high percentage of sideswipes resulting in property damage; and crashes at 75th Ave W were principally

Figure 3.9

Crash rate and access density comparisons

Although none of the context zones studied had crash rates that exceeded the area average, the rates in Zone 6 did exceed what research has indicated to be typical in terms of the densities of intersections and driveways that are found in that zone.





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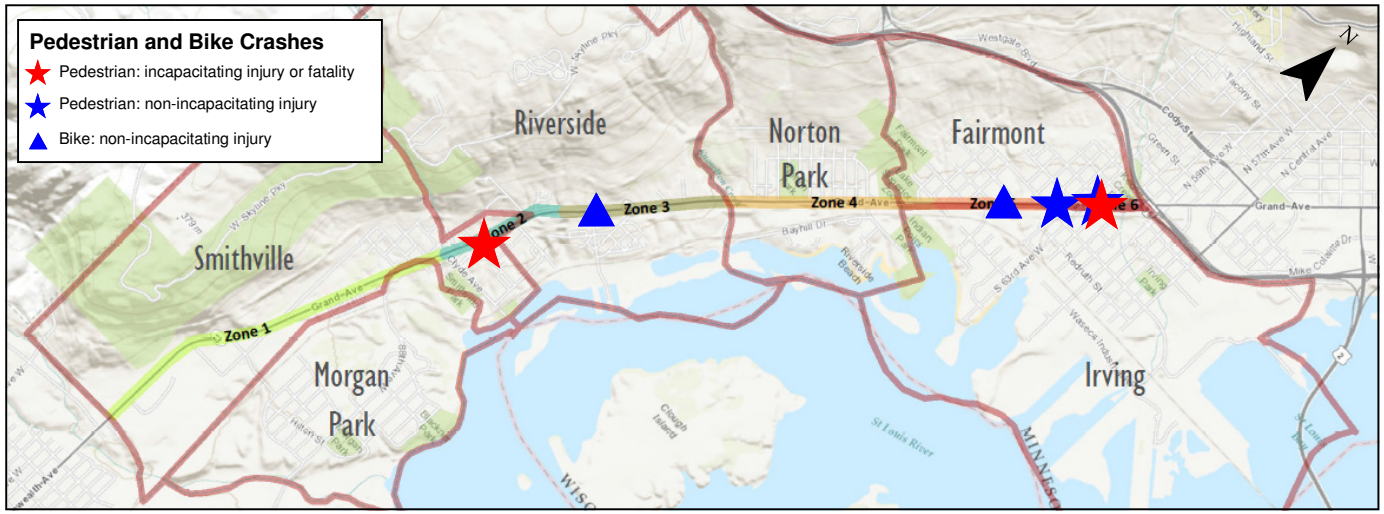
Locations of intersections with above average crash rates

The map at right shows the three intersections in the study area that have had a 3-year average crash rate (yellow dot) that, since 2009, that exceeded the regional average for similar roadways. It is important to note that 62nd Ave E has a higher disparity between its crash rate and its severity rate (red circle).



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Bike & pedestrian crashes from 2003 to 2012

Four pedestrian crashes and two bike crashes occurred in the Highway 23 corridor over the past decade. The pedestrian crashes that resulted in a fatality and incapacitating injury happened in areas where vehicle speeds and potential visibility limitations are concerns.

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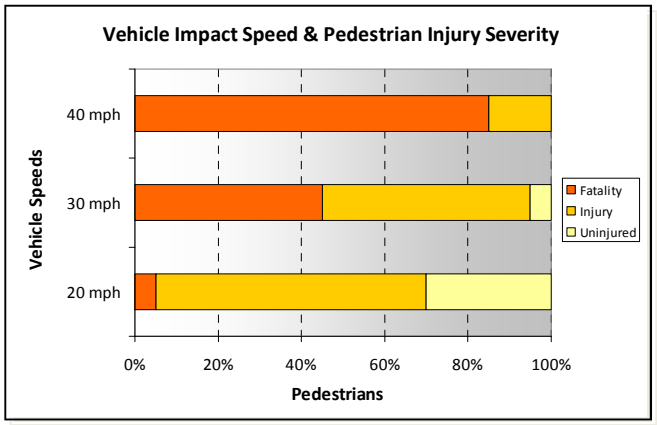


Source: Literature review on Vehicle Travel Speeds and Pedestrian Injuries; U.S. DOT National Highway Traffic Safety Administration, 1999

Figure 3.10 | Vehicle impact speed & Severity of Injury

Research shows that pedestrians being struck by vehicles traveling at or above 40 mph face an 85% probability of being killed.

Figure 3.11 | Poor support for non-motorized users

The Highway 23 corridor is replete with conditions that do not support pedestrian or bicycle safety. The image to the left shows a location in Zone 2 where the sidewalk is crumbling and overgrown and the storm water grates present hazards for bike tires in an already narrow shoulder.

related to left-turn movements - and 50% of which were reported as resulting in possible injury or worse.

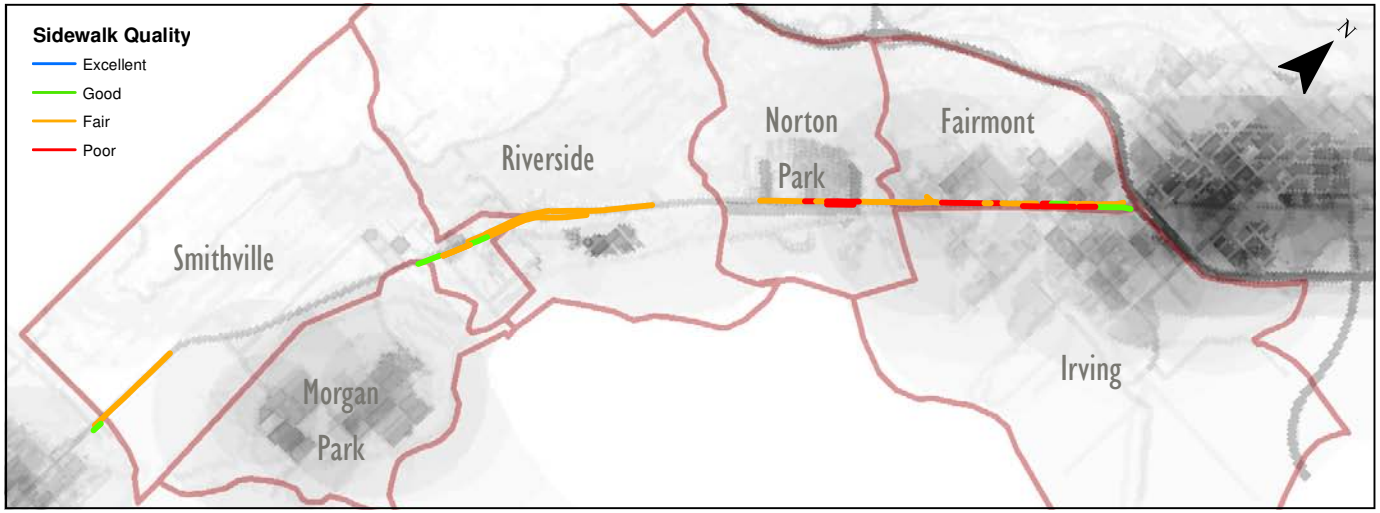
Overall, the corridor appears to be generating no more crashes than similar-type highways, and the crashes that have occurred have not resulted in large numbers of severe injuries.

Non-motorized Transportation & Safety

Six motor vehicle crashes were reported between the years 2003 through 2012 that resulted in either a cyclist or pedestrian being struck (two cyclists and four pedestrians). One of the pedestrian crashes resulted in a severe injury, and another resulted in a fatality. The locations of these crashes are shown in Map 3.7 on the preceding page, where it can be seen that most of the crashes involving either cyclists or pedestrians occurred in the more urban zones 5 and 6, where there are more driveways, more vehicles, and more limited visibility at times. The one pedestrian fatality occurred in Zone 2, more rural in character and where vehicle speeds are higher; and it also occurred at night, when there is limited lighting in the area.

Vehicle speeds are critical when it comes to the safety of non-motorized users of a highway corridor. As Figure 3.10 demonstrates, there is more than a 40% probability a pedestrian will be killed if struck by a vehicle traveling at even just 30mph. This means that Highway 23, with average free-flow speeds estimated to be above 38mph, represents a significant challenge for maintaining a safe environment for non-motorists.

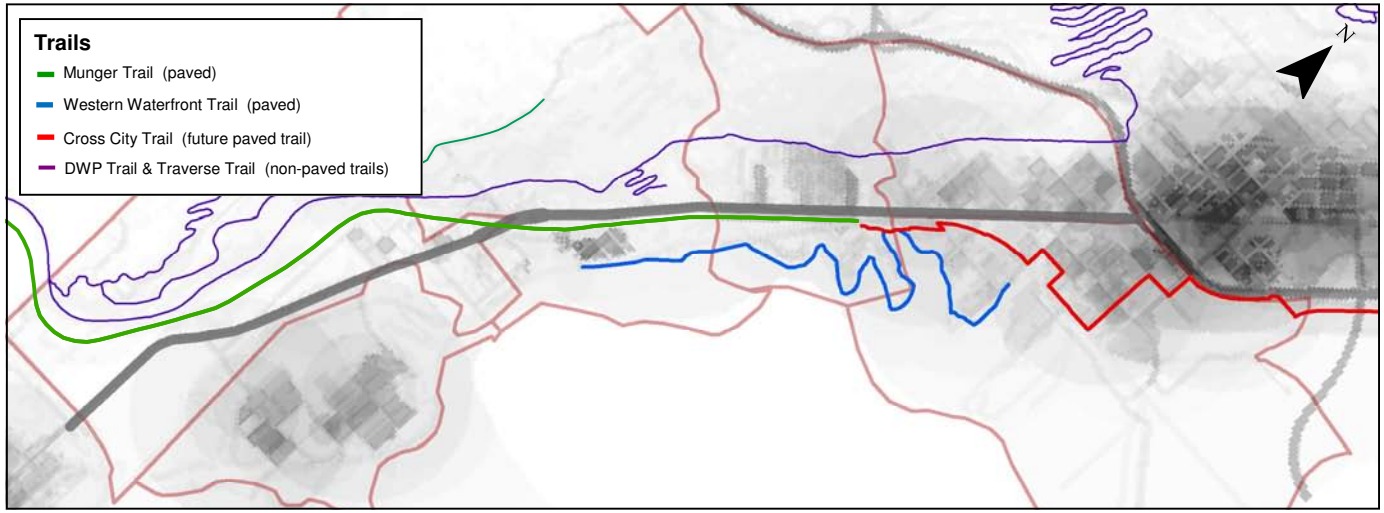
As has already explained, the Highway 23 / Grand Avenue corridor is a route that is equally important for non-motorized as well as motorized movements. Treatments should therefore be sought that provide access and mobility to multiple modes in the least hazardous



Map 3.8

Sidewalk and sidewalk condition

Approximately 1/3 of the corridor has no sidewalk on either side of the highway. A significant amount of the sidewalk in the more densely populated Fairmont and Irving neighborhoods is in poor condition.



Map 3.9

Trail connectivity

The area of West Duluth surrounding the Highway 23 corridor contains a lot of trail amenities and potential non-motorized alternatives to the highway. But these assets lack good connectivity to the highway and the neighborhoods.

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Figure 3.12 | The Munger Trail

The Munger Trail is a regional recreation trail that does not provide a lot of connections to local land uses and therefore does not serve the needs of many local bicycle commuters.

Figure 3.13 | Non-motorized crossings

There is significant non-motorized demand in the areas around Highway 23, but crossing the highway presents the biggest challenge for non-motorized travel in the corridor.

ways feasible. This includes making sure that the sidewalk network is complete and adequately maintained, that safe space is made available for cyclists, and that adequate lighting, visibility, and the necessary signage is provided. Figure 3.11 on page 34 and Map 3.8 on page 35 show how this is presently not the case in terms of the existing sidewalk network along the highway. The map, in fact, indicates that the sidewalks in the worst condition are found in the densest residential zones.

Even less support is being provided for cyclists. At present, a width of only 4 feet is available at the shoulders and even less than that in some locations. Opportunities for bike commuting off of the highway might exist, as Map 3.9 on page 35 would suggest: the existing Munger Trail and future Cross City Trail (both paved facilities), for instance, will provide for a nearly parallel route to the highway. However, connections are lacking between these assets, the neighborhoods, and other uses along the highway. Many people who identified themselves as bike commuters during the stakeholder outreach efforts for this study said that it was for this reason they do not consider the Munger/Cross City connection as a suitable alternative to Highway 23.

It should also be recognized that other trail systems exist in the area, together with a wealth of recreational opportunities around the Highway 23 corridor and the St Louis River. These amenities represent strong generators for more pedestrian and cycling activity throughout the area. This further underscores the importance for seeking ways to transition the current highway corridor into an overall safer and more supportive environment for non-motorized users.

Lastly, even if a continuous network of pedestrian– and bike-designated space was made available, non-motorists still face the challenge of crossing the highway, which is probably the biggest non-motorized travel demand throughout the corridor. It has been shown that

more than 360 transit boardings or alightings occur on any given workday, and it is conceivable that half of these movements involve someone crossing the highway. In light of this, crossing support for pedestrians should be provided throughout the corridor This will become increasingly important as the area's general demographics continue to age and more and more people become potentially mobility challenged.

Analysis of Individual Context Zones

The following pages summarize the findings of analyses specific to the six individual context zones identified as part of this study. They call out issues and opportunities in each of the zones that may not be found in the others. Recommended treatments, therefore, are different for one segment to the next and are presented in Section 4 of this plan, beginning on page 38.

Zone 1: Becks Road to Clyde Avenue

Zone 1 is the least developed segment of the Grand Ave / Highway 23 corridor and carries the least amount of daily traffic compared to the other zones. Almost 63% of the highway in this zone is designed as a rural highway section (from Commonwealth Ave to Hulett Ave), meaning it lacks sidewalks, curb, and gutter. The roadway instead has wide, gravel shoulders like the ones seen in Figure 3.14 at right.

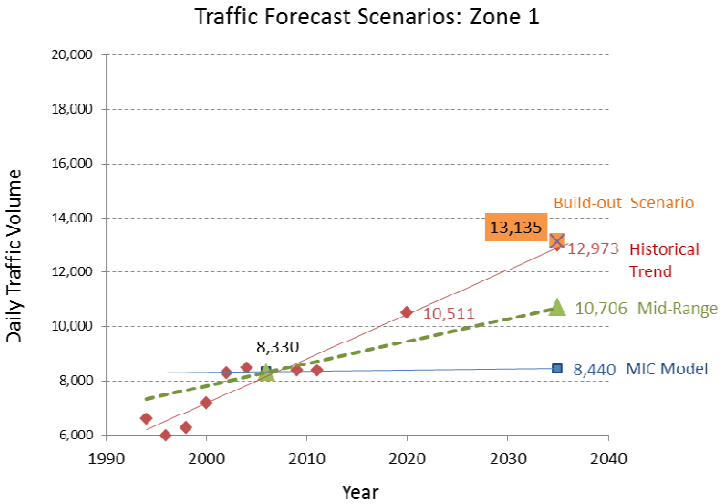
Because of the lower levels of development, the number of driveways along the highway in Zone 1 is minimal and the number turning vehicles is also low. However, this has the potential to change, as the City of Duluth is targeting the former Atlas Cement and U.S. Steele plants for up to 1.2 million ft² of future industrial

Figure 3.14 | Rural-design shoulder found in Zone 1

More than half of the length of highway 23 in Zone 1 is "rural" in design, meaning lacks sidewalk and curb and gutter.

Figure 3.15 | Future Traffic Scenarios for Zone 1

A future build out scenario of zoned industrial areas near Becks Rd suggests the potential for nearly 6,000 more vehicles per day in Zone 1. See Appendix A for explanation of forecasting methodology.



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development and proposals exist to bring up to 75 additional single-family housing units at the north of 88th Avenue W (see Map 3.10). These developments would bring significantly more traffic and turning movements to this segment of the Highway 23 corridor.

Traffic projection based on a full-build scenario for the corridor which include the above proposals is represented by the highest trend line shown in Figure 3.15 (previous page). Under such a scenario, daily traffic could increase to above 13,000 vehicles per day in Zone 1.

The types and levels of development that are being proposed in this area would also likely result in a greater percentage of heavy commercial truck traffic accessing Highway 23 . However, the majority of new truck traffic to this area would be expected to move to and from Becks Road and be primarily limited to the 0.6 mile section between there and Idaho Street.

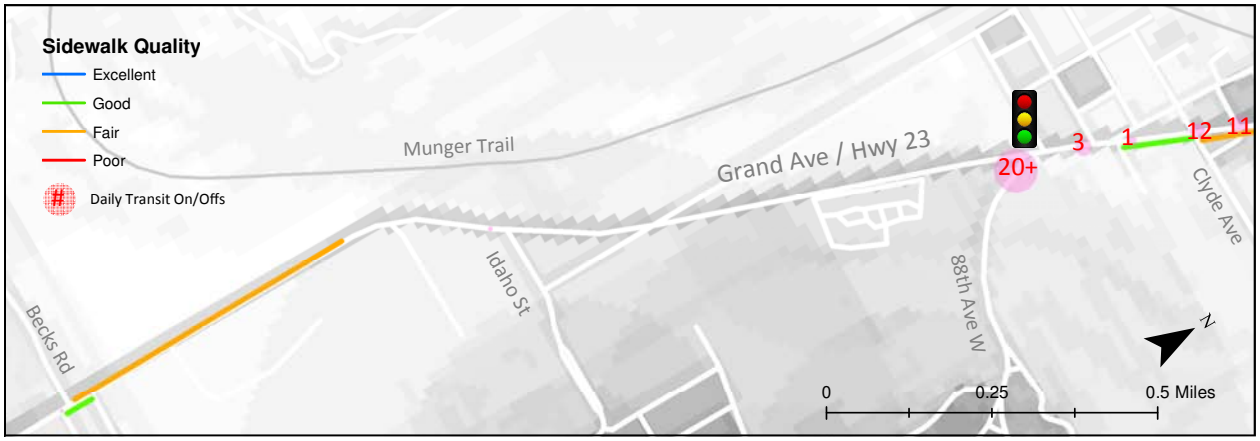
An increase in commuter traffic due to more housing at 88th Avenue W, however, would effect the entire section of highway in Zone, and the intersections of Commonwealth Avenue and 88th Avenue W would likely see significantly more demand for turning movements.

The intersections of Nick Glumac Dr. and Becks Rd. would also experience increased turning movements, including especially those of heavy trucks. These increases would likely necessitate the creation of a right-turn lane at Nick Glumac Drive, one that is designed to accommodate the wider turn movements (see Map 3.10).

The capacity of the highway itself, however, is more than sufficient in Zone 1 to meet future traffic projections - even under the full-build scenario. It is currently operating at 33% capacity (LOS B) and would still be operating under 70% capacity (LOS C). However, as explained on page 22, Highway 23 is the only regional arterial providing connection

M a p 3.10 | Area of future build-out - Zone 1

There are approximately 170 acres of land being targeted for future industrial development (partially shown at right), as well as a residential development proposal for up to 75 units north of 88th Ave W. Based on a "full-build" scenario, this could bring approximately 5,000 more vehicles per day to the area.



M a p 3.11 | Non-motorized aspects - Zone 1

Zone 1 has 4,768 feet of sidewalk, all of which meets conditions to be considered "fair" or better. However, 67% of the 1.7 mile highway segment is lacking sidewalk, and no part of the highway in this zone is served by sidewalk on both sides of the highway.

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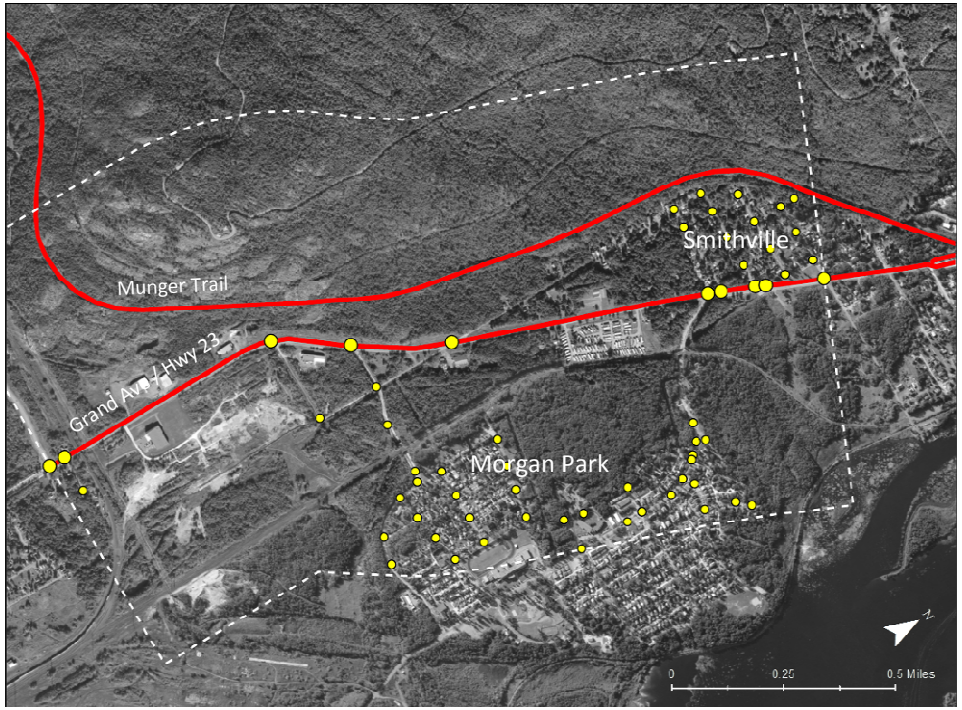

M a p 3.12 | Thru-route connections - Zone 1

Highway 23 and the Munger Trail are the only regional thru-routes within a 2-mile radius that connect to the rest of Duluth. While Highway 23 has twelve connections - or "nodes" - in Zone 1, there are no connections to the Munger Trail. This results in a connectivity ratio of 0.08 compared to the preferred ratio of 0.25 (see Table 3.3).

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Table 3.2: LOS Scores - Zone 1

Mode	LOS	LOS Score*	v/c
Auto	B	2.38	0.33
Transit	E	4.53	-
Bicycle	E	3.73	-
Pedestrian	E	4.50	-

* scores are not comparable across modes

Table 3.3: Access & Connectivity Scores - Zone 1

Measure	Zone 1	Benchmark
Principal connection ratio	0.08	0.15
% sidewalk ("Fair" or better)	14%	100%*
Protected X-ings per mile (Hwy 23)	0.57	3.00

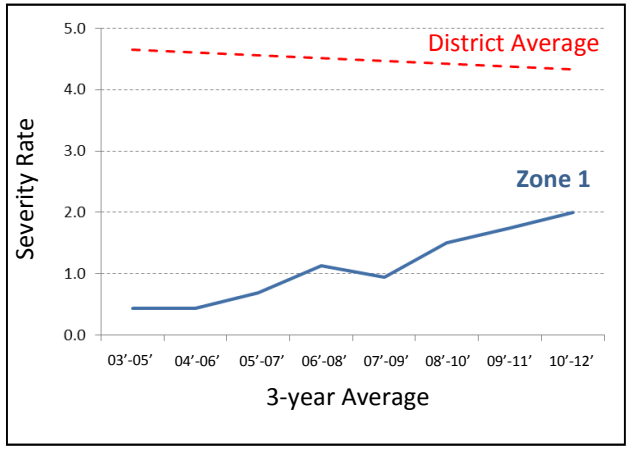
* represents sidewalks on both sides of highway

Table 3.4: Safety Scores - Zone 1

Measure	Zone 1	Regional Avg	Density Avg[1]
Crash Rate [2]	1.12	3.00	1.20
Severity Rate[3]	1.99	4.20	-

1. The crash rate expected for the density of access points (points per mile) present.
2. Number of crashes expected per 1 million vehicle miles traveled.
3. Number of "property damage" equivalent expected per 1 million vehicle miles traveled.

Figure 3.16 | Crash Severity Trend - Zone 1



to the residential, commercial, and industrial lands along the St. Louis River, so it will still important to protect the current capacity of the highway in this area as future development occurs.

It also needs to be recognized that the current roadway lacks amenities for other modes of transportation. More than 1.1 miles (67%) of the corridor is not served by sidewalk on either side of the highway, which also makes access to transit service difficult in the area. Recent on/off counts done by Duluth Transit Authority (DTA) indicate that there is significant pedestrian movement in this zone, at least north of 88th Ave W (Map 3.11, page 39).

In addition to the lack of sidewalk, the shoulders - gravel in some areas and only 4 feet of pavement in others - are insufficient for safe and comfortable cycling on a roadway with vehicle speeds over 40mph and 4% of traffic being heavy trucks. While the Munger Trail, which parallels the corridor, is a potential alternative for bike commuters, there are no connections between it, the highway, and the neighborhoods there (Map 3.12, page 39).

According to the methodology outlined in the 2010 Highway Capacity Manual (HCM 2010) for determining a multimodal level of service (mmLOS), Highway 23 has LOS scores of E for the bike, pedestrian, and transit modes of transportation (Table 3.2).

Zone 1 also falls short with respect to other benchmarks that indicate good connectivity (Table 3.3). Further explanation of these scores can be found in Appendix A, starting on page 90. In general, however, they suggest that Highway 23 in Zone 1 is a transportation facility that is not sufficiently meeting the metropolitan area's multimodal objectives as they are spelled out in the Duluth-Superior long-range transportation plan *Directions*

2035 (2010) and reflected in MnDOT's *Minnesota GO* vision (2011).

In terms of safety, the numbers for Zone 1 look more encouraging: as Table 3.4 shows (previous page), Zone 1 has a segment crash rate below what is average for multi-lane urban highways in the region, as well as what would be expected for urban roadways with similar access densities. The severity rate for Zone 1 is also below what is typical for the region. Yet, when looking at the severity rate in terms of a running, three-year average, it can be seen that crash severity has been trending upward in Zone 1, while the regional average has been trending downward. This may warrant some continued monitoring in coming years (Figure 3.16, previous page).

When looking specifically at the safety of the intersections in this zone, the Becks Road intersection stands out as the only one with a higher-than-average crash rate. As Figure 3.17 shows, it also has a higher-than-average rate for severe crashes. Not only that, but its rate of severe crash occurrences has been trending upward, and this is in contrast to decreasing trend of the regional average for similar thru-stop intersections. Although the vast majority of the crashes that have happened at this intersection have resulted in property damage only, the number of severe crashes is higher than what would be expected for the intersection's low traffic volume.

While no strong trends emerge from the data regarding crash type, the vehicles reported to be "at-fault" in the crashes at Becks Road were predominantly north- or southbound, which might indicate that the speed of traffic on Highway 23 in this area is a contributing factor involved in the higher-than-normal number of crashes happening at the location.

Figure 3.17 | Crash Severity Trend - Hwy23 & Becks Rd

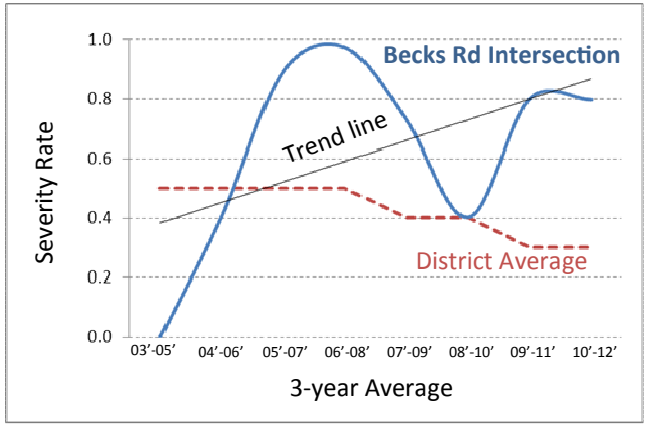


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Figure 3.18 | Divided highway section found in Zone 2

The presence of a grassed median and two bike/pedestrian bridges create a "parkway" context for much of Zone 2.

Zone 2: Clyde Ave to Grand Ave Place

The highway continues to retain a rural feel in Zone 2, but the entire 0.5-mile segment is designed at urban standards. Nearly all of the land use in this section is residential in nature, set way back from the highway, and in most cases is screened by the topography and vegetation. A portion of the highway in this zone is also divided with a grassed median, and has bike and pedestrian bridges that pass over the highway, creating more of a parkway context in that area.

The daily traffic on Highway 23 in Zone 2 is less than 11,000 vehicles. Turning movements are not prominent, and there is no need for traffic control for the highway traffic in this area at present. Thus, traffic on Highway 23 is generally unimpeded. An informal survey of traffic speeds indicate the free flow speed of traffic to be between 48 mph and 50 mph.

Map 3.13 |

Adjacent development patterns - Zone 2

The City of Duluth has received no significant development proposals for lands adjacent to the highway in Zone 2. Uses along the highway are expected to remain principally residential and at current densities.

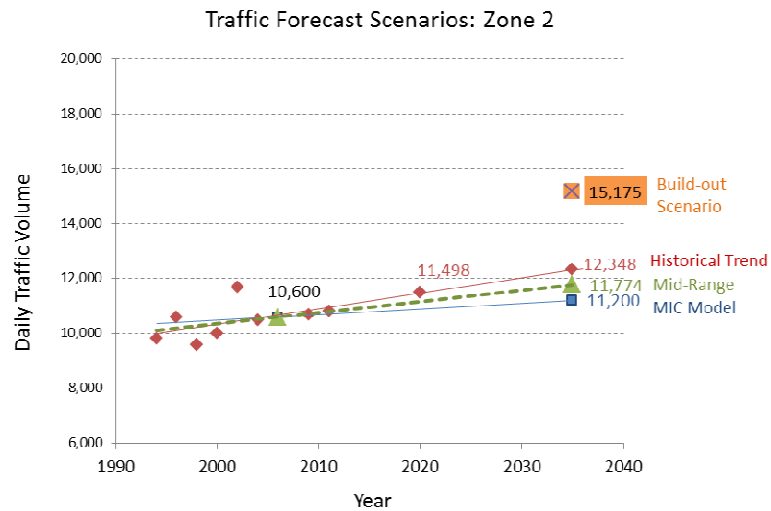
The City of Duluth has not received significant development proposals for lands in Zone 2, and based on a low-growth scenario (identified as "MIC Model" in Figure 3.19 at right) this portion of the Highway 23 corridor would see less than 1,000 additional vehicle trips over the coming decades. On the other hand, any traffic generated from new developments in either Zones 1 and 3 would also cause traffic to increase in this zone. Under the full-build scenario modeled for this study, which was based on actual proposals received by the City of Duluth, there could be an additional 4,500 vehicles traveling through this section on a daily basis. Even at that level of traffic, however, the volumes on the intersecting streets would not be expected to reach levels that would warrant any traffic signals.

Because future signalization is unlikely in this zone, crossing the highway will remain a challenge for pedestrians in the area. Reports received during the stakeholder outreach indicate there is concern for crossing safety at the Grand Avenue intersection in particular. This is due to potential sight-distance problems caused by the combination of a hill and a bend in the highway at that location (Figure 3.20).

Reports from stakeholders also indicate heavy use of the intersection by mobility-limited individuals who regularly access transit there. The mix of sight-distance limitations and vehicle speeds in excess of 40mph put this group of vulnerable users at risk. Furthermore, the 8-foot median at this location is not adequate as a pedestrian refuge, but instead represents a hindrance to the fast and safe crossings of someone with limited mobility or who is in a wheelchair.

Figure 3.19 | Future Traffic Scenarios for Zone 2

A build-out scenario reflecting proposed changes throughout the corridor would be expected to increase daily traffic in this section of the highway to above 15,000 vehicles per day (see Appendix A for methodology).



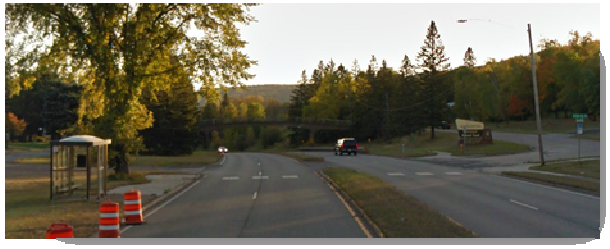


Figure 3.20 | Highway curve at Grand Ave Place

Curvature in the highway near the intersection with Grand Ave Place limits the visibility of the pedestrian crosswalk for northeast-bound traffic, which is believed to average at speeds greater than 45mph.

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Figure 3.21 | Median crossing at Grand Ave Place

The 8-foot median does not provide adequate pedestrian refuge from 45mph traffic. The physical design of the median crossing may even make the crossing less safe for mobility-limited individuals. The bus shelter is not ADA accessible from sidewalk on the southeast side of the highway.

Table 3.5: LOS Scores - Zone 2

Mode	LOS	LOS Score*	v/c
Auto	B	2.17	0.43
Transit	E	4.29	-
Bicycle	E	4.14	-
Pedestrian	D	3.66	-

* scores are not comparable across modes

Table 3.6: Access & Connectivity Scores - Zone 2

Measure	Zone 2	Benchmark
Principal connection ratio	0.07	0.15
% sidewalk ("Fair" or better)	86%	100%*
Protected X-ings per mile (Hwy 23)	1.89	3.00

* represents sidewalks on both sides of highway

Table 3.7: Safety Scores - Zone 2

Measure	Zone 2	Regional Avg	Density Avg[1]
Crash Rate [2]	0.48	3.30	1.30
Severity Rate[3]	1.12	4.20	-

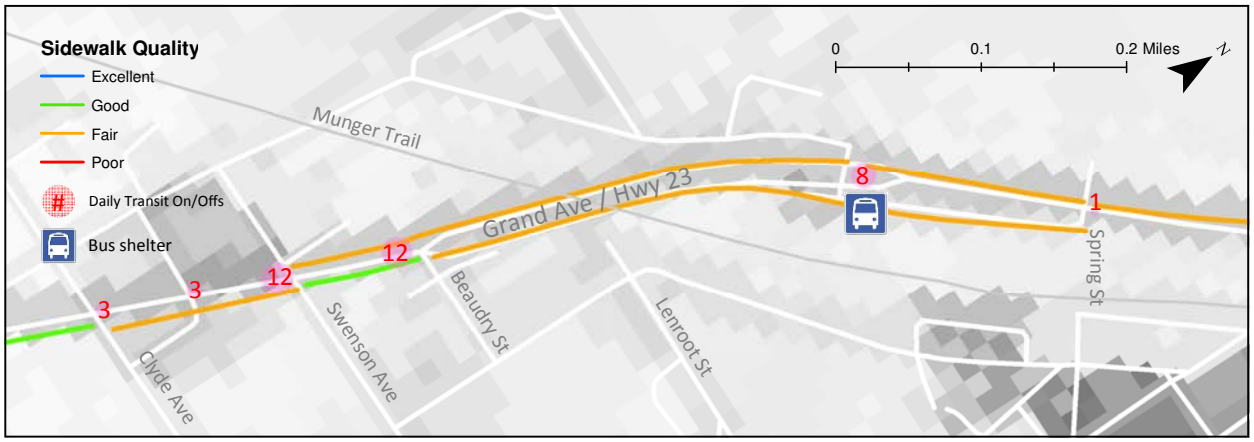
1. The crash rate expected for the density of access points (points per mile) present.
2. Number of crashes expected per 1 million vehicle miles traveled.
3. Number of "property damage" equivalent expected per 1 million vehicle miles traveled.

Most of Zone 2 is lined with sidewalk that is in "Fair" condition or better, as shown in Map 3.14 on page 44. Yet, the sidewalk on the southeast side of the highway runs along a frontage road and does not directly connect to the bus shelter near the intersection of Grand Avenue Place (see Figure 3.21). Even though the shelter has a sizeable concrete pad, there is not an ADA accessible path across the poorly maintained frontage road between the bus shelter and the sidewalk.

In addition, the historic bike/pedestrian bridge near Grand Ave Place (seen in Figure 3.18 on page 42) is reportedly in disrepair and is being planned for removal. This will reduce the opportunities for protected highway crossings in the area. While the bridge today connects to the sidewalks on both sides of the highway, the bike/pedestrian bridge that will be remaining - the Munger Trail overpass - will not be. Transfers between the trail system and the sidewalk on the northern side cannot occur here. So, the trail and the trail overpass cannot be considered a readily accessible substitute for protected pedestrian space for those wishing to traveling along the highway by foot.

Connectivity to the Munger Trail in general is poor in Zone 2. As shown in Map 3.15 on the following page, there is only one connection to the Munger Trail despite the residential density around it. This is the reason for the lower connectivity score shown in Table 3.6.

Zone 2 is not supportive to alternative modes of travel overall. The poor LOS scores displayed in Table 3.5 are the combined result of a wide roadway, high traffic speeds, absence of shoulders, and a lower frequency of bus trips (averaging greater than an hour apart



M a p 3.14

Non-motorized aspects - Zone 2

Most of Zone 2 contains sufficient sidewalk facilities along the highway. However, sidewalk is missing next to the residential density on the north side of the highway between Clyde Ave and Swensen Ave.

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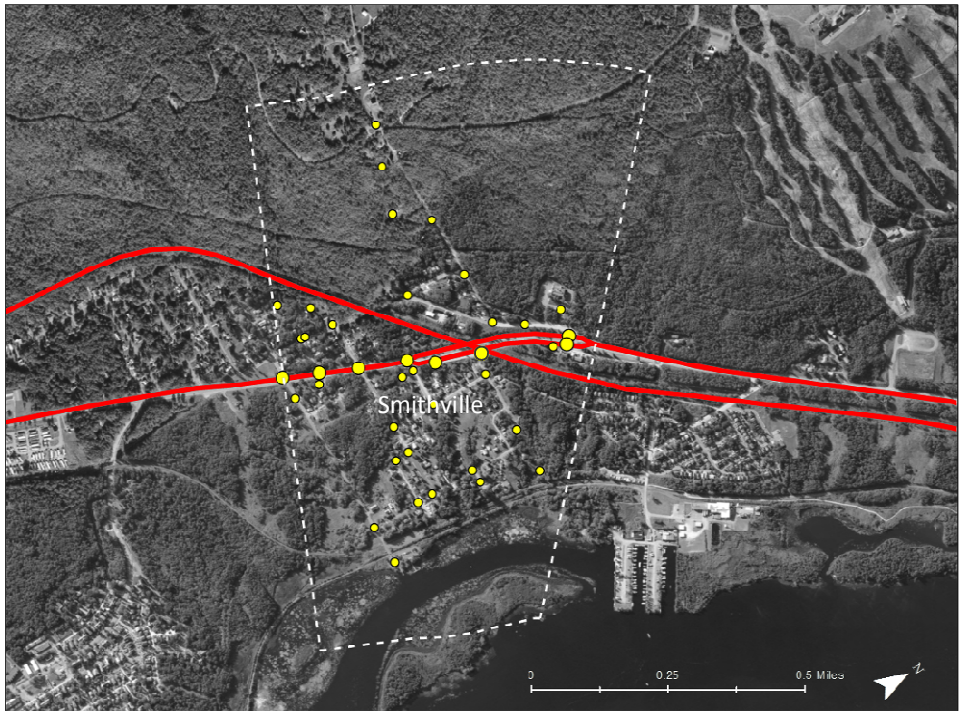

M a p 3.15 | Thru-route connections - Zone 2

There are seven connections to Highway 23 in Zone 2 but just one connection to the Munger Trail. In comparison to the 29 minor connections found within the 3/4 square mile area, the result is a connectivity score of 0.08 compared to the 0.25 benchmark (see Table 3.6 on page 43).

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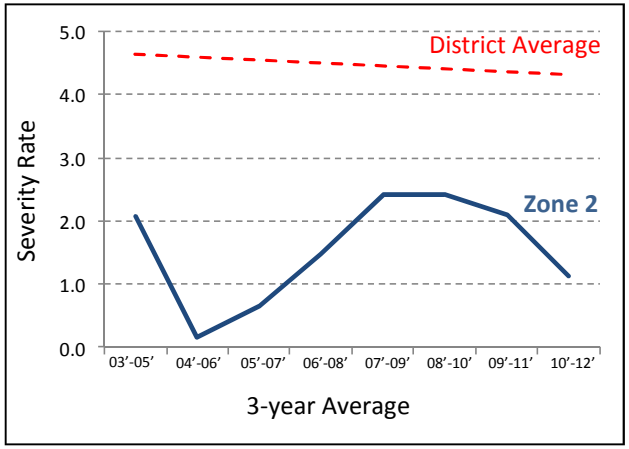
Figure 3.22 | Crash Severity Trend - Zone 2



during the total hours of daily service).

From a statistical perspective, Zone 2 does not appear to have any significant safety issues. The crash and severity rates are well below what is average for similar roadways found in the region (Table 3.7 on page 44), and the trend in crash severity does not appear to be worsening (Figure 3.22).

Despite decent safety numbers and the good condition of its sidewalks, the roadway width and high vehicle speeds nevertheless create challenges for safe and comfortable pedestrian crossings. Even though records show no cyclists or pedestrians were struck in this zone in the past ten years, the risks are still significant.

Zone 3: Grand Ave Place to 85th Ave W

Whereas Zone 2 represents a transition away from the rural character of Zone 1 to more of a suburban context, Zone 3 is in many ways a return to Zone 1. The design of the highway itself is still urban (curb, gutter and storm sewer), but there is little development along the highway and no sidewalk on either side for most of the segment.

Of the six context zones, Zone 3 has the greatest potential for undergoing large transformation. This is because much of the land in this area remains undeveloped and thus presents opportunities for developments of various types and size. The City of Duluth has received some preliminary proposals in recent years for residential and commercial subdivisions along the highway in this zone, all of which would generate substantially more vehicle trips throughout the area.

Figure 3.23 | A mix of contexts found in Zone 3

Despite being mostly rural in context, Zone 3 has curb , gutter, and other elements of urban highway design.

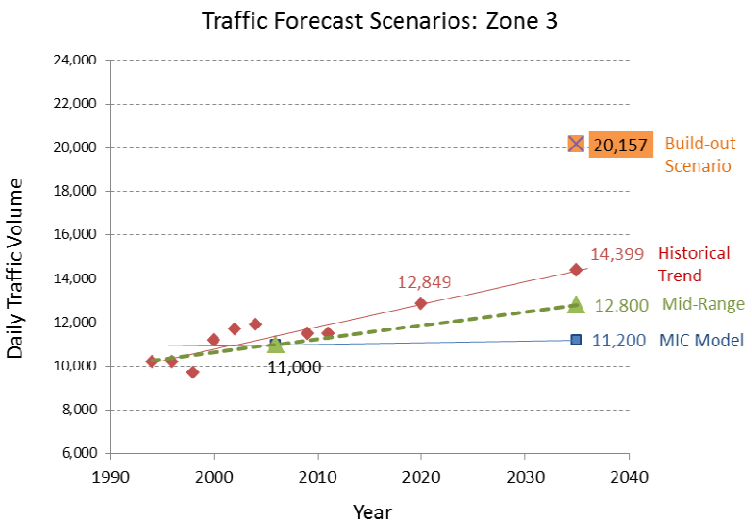
The scale of those preliminary proposals were used to model the full build-out scenario used in this study to estimate the potential travel demand that could occur along Highway 23 in the future. As Figure 3.24 shows, an average daily volume of more than 20,000 vehicles could be expected under such a scenario. Much of that traffic would come from the additional households created in the area, but the new commercial uses would also generate a large number of vehicle trips throughout the day. It is logical to assume that some of these commercial uses would be things like gas stations/convenience stores and fast-food restaurants, which have some of the greatest potential for attracting trips.

Development in this area has already begun to occur. In February 2013, Spirit Mountain opened a new ski chalet with a restaurant, bar, and event-space at Warwick Street. Significant increases in traffic are already being reported by the Duluth Police Department, DTA - and other stakeholders, and there is some community interest in seeing a traffic signal installed at this location. A 12-hour count conducted by MnDOT after the chalet's opening, however, indicated the increased traffic still did not meet the traffic warrants to allow a signal. With that said, the types of development that are being proposed in Zone 3 would likely create the levels of traffic that would require signalization. Map 3.16 on the following page shows three locations that may need signalization, depending on the eventual densities and site layout of future development.

With the Munger Trail, Western Waterfront Trail, and St. Louis River being in close proximity, there is a lot of potential

Figure 3.24 | Future Traffic Scenarios for Zone 3

Zone 3 has received the most interest from developers in recent years. In addition to the increased activity already occurring at the new Spirit Mountain chalet, new development has the potential to generate significant increases in traffic.



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for non-motorized movements in Zone 3, and more residential, commercial, and recreational development would bring even more pedestrians and cyclists to the area. This includes potential demand for crossing the highway by foot, bike, or even mobility-assist devices. While future traffic signals would provide for protected-pedestrian crossings, that level of support does not exist at present.

Based on the transit boarding data alone, there is already significant pedestrian crossing demand at Riverside Drive, the main bus stop for residents of the Riverside neighborhood. As Map 3.17 on page 48 shows, support is already provided at this spot with a set of continuous-flashing ped-crossing signs. The location is not, however, adequately supported with sidewalk.

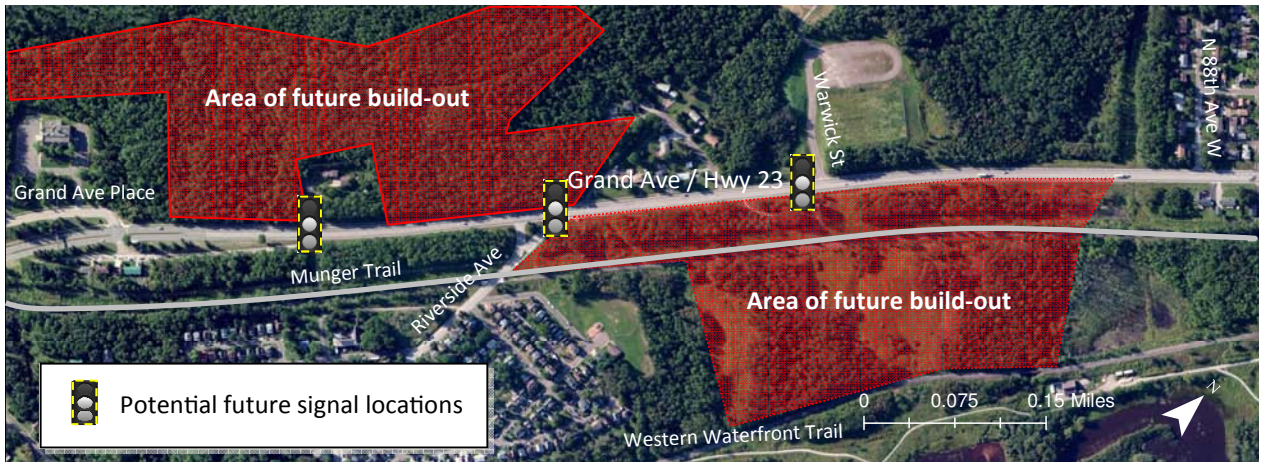
Even though Map 3.17 (page 49) shows that only a small number of bus riders are boarding at Warwick Street, this information is based on 2008 data; the DTA has reported a significant increase in ridership there since the opening of the ski chalet. Bus drivers have also voiced concerns about the lack of sidewalk in this area (Figure 3.25, page 48), especially during the winter months when they've transported a large number of young skiers and snowboarders who have stood waiting for buses in the roadway because snow plowed from the highway was piled up on the side of the road.

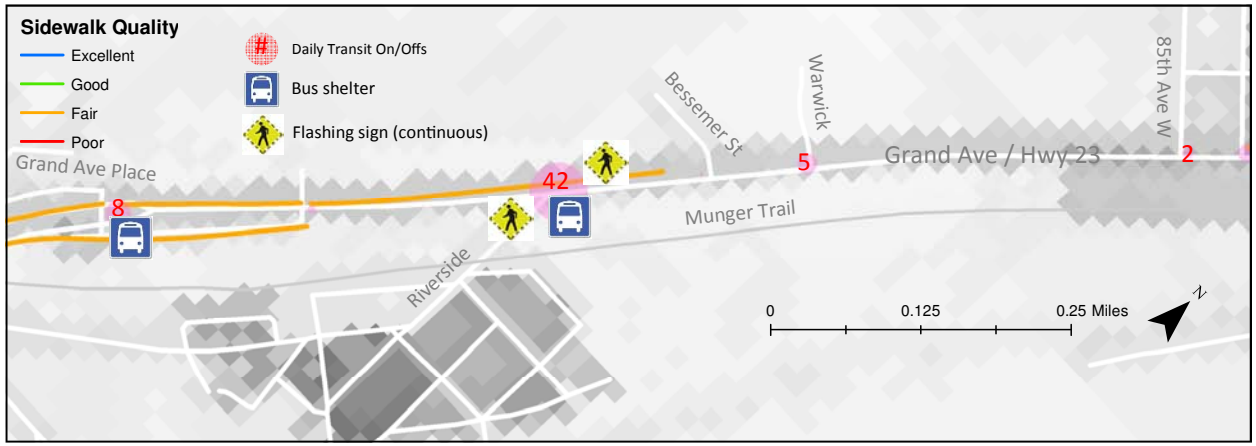
In addition to the lack of sidewalk facilities, there is also insufficient room for cyclists to travel along the corridor. As with the other zones, only four feet of shoulder space exists at the edges of the highway. And while the Munger Trail presents an opportunity for cyclists to travel on a parallel off -street bikeway, there is only one place to access the trail in Zone 3: Riverside Drive (see Map 3.18 on page 49). This is not ideal because not only does the Spirit Mountain chalet

Map 3.16 |

Area of future build-out - Zone 3

Zone 3 contains a large amount of developable land, and there have been proposals for commercial development along the highway. This creates the potential for significant increases in traffic to the area. Depending on the type, density, and layout of future developments, some configuration of traffic signals will likely be needed at one or more of the intersections in this segment in the future.





M a p 3.17 |

Non-motorized aspects - Zone 3

Less than half of Zone 3 has sidewalk. Even the busiest bus stop in the corridor lacks sidewalk connection to its shelter on the southern side of the highway. The Spirit Mountain entrance at Warwick St also lacks sidewalk, as well as connection to the Munger Trail and nearby areas of residential density .

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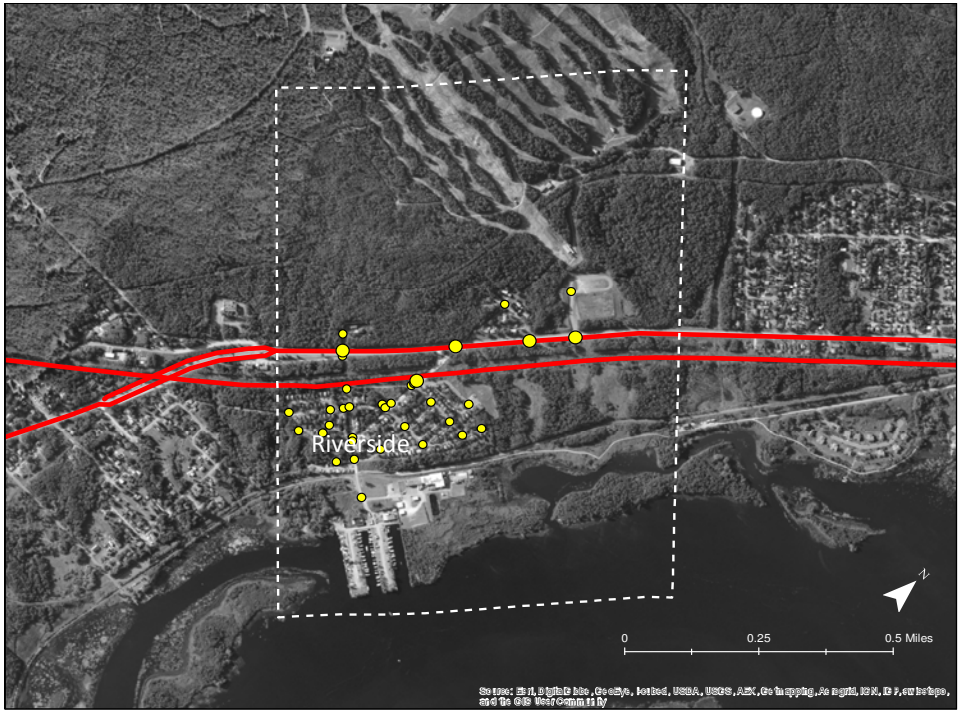

M a p 3.18 | Thru-route connections - Zone 3

Riverside Drive is the only connection between the highway and the Munger Trail. Off-season recreational activities at Spirit Mountain could be better served by a trail access at Warwick St.

Image source: Google Maps (2013)

F I g u r e 3.25 | Spirit Mountain Entrance at Warwick St.

The Spirit Mountain entrance is a bus stop location that is producing increasing numbers of transit riders. Unfortunately, it lacks sidewalk facilities both along the highway and up to the chalet.

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Table 3.8: LOS Scores - Zone 3

Mode	LOS	LOS Score*	v/c
Auto	B	2.38	0.46
Transit	E	4.66	-
Bicycle	E	3.78	-
Pedestrian	E	4.53	-

* scores are not comparable across modes

Table 3.9: Access & Connectivity Scores - Zone 3

Measure	Zone 3	Benchmark
Principal connection ratio	0.09	0.15
% sidewalk ("Fair" or better)	24%	100%*
Protected X-ings per mile (Hwy 23)	0.00	3.00

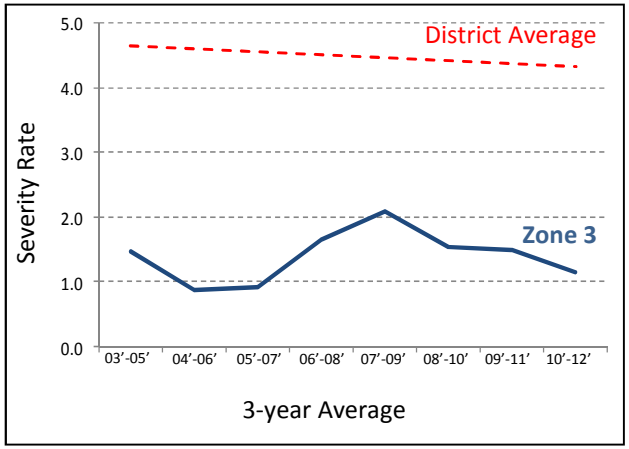
* represents sidewalks on both sides of highway

Table 3.10: Safety Scores - Zone 3

Measure	Zone 3	Regional Avg	Density Avg[1]
Crash Rate [2]	0.79	3.30	1.30
Severity Rate[3]	1.14	4.20	-

1. The crash rate expected for the density of access points (points per mile) present.
2. Number of crashes expected per 1 million vehicle miles traveled.
3. Number of "property damage" equivalent expected per 1 million vehicle miles traveled.

Figure 3.26 | Crash Severity Trend - Zone 3



cater to skiers in the winter, its ski lifts are open to Mountain Bikers during the off-season, and in the near future it will have trail connections to the Duluth Traverse mountain biking trail. Without connections to the Munger Trail or adequate shoulder space along the highway, those users will be inclined to transport their bikes to the facility by automobile, and possibly forego the use of other recreational opportunities along the corridor.

The lack of sidewalk, lack of shoulder width, and low transit frequency (approximately 1 per hour, per direction) all lead to a poor multimodal LOS in Zone 3 (Table 3.8). Because of limited sidewalks, an absence of protected ped-crossings, and minimal connection to the Munger Trail, Zone 3 also has low Accessibility and Connectivity scores (Table 3.9). If/when future residential and commercial development comes this area, the potential exists to exacerbate these conditions or ameliorate them.

In terms of current traffic safety, Zone 3 scores well. It has crash rates and severity rates well below the regional averages (Table 3.10), and the severity rate appears to be relatively stable (Figure 3.26). Nevertheless, average vehicle speeds still exceed 45 mph in this area, and the fact that the majority of crashes (40%) in this segment were rear-end crashes suggests that speeds represents a significant contributing factor for traffic crashes here. As explained earlier, vehicle speeds above 30 mph dramatically increase the probability of pedestrians or cyclists being killed if struck by a vehicle. Although the crash data shows no pedestrian or bike related crashes happened in Zone 3 in the past ten years, three of the crash reports cited maneuvering to avoid a collision with a pedestrian or cyclist as a contributing factor that lead to the eventual crash.

Zone 4: 85th Ave W to 72nd Ave W

Zone 4 represents the portion of Highway 23 that transitions into an urban setting. This zone encompasses much of the Norton Park Neighborhood, and many residential and other types of land uses line the highway there (Figure 3.27).

In the previous decade, Zone 4 was the only section of the Highway 23 corridor that received any significant development. This was in the form of new single-family and duplex-housing units built southeast of the highway along Bayhill Road. Accordingly, Zone 4 was also the only one of the six context zones to experience growth in traffic. Between the years 2002 and 2012, this segment of highway received, on average, an additional 2,000 daily vehicle trips.

At present, Zone 4 has an estimated 14,000 vehicles that travel the corridor on a daily basis. Extending the historical rate of traffic growth out into the future produces traffic levels of around 17,500 vehicles per day by 2035. Yet, under the full-build scenario that was modeled for this study—one which takes into account the growth potential identified in the other zones—future traffic levels could even be in excess of 22,000 per day (Figure 3.28).

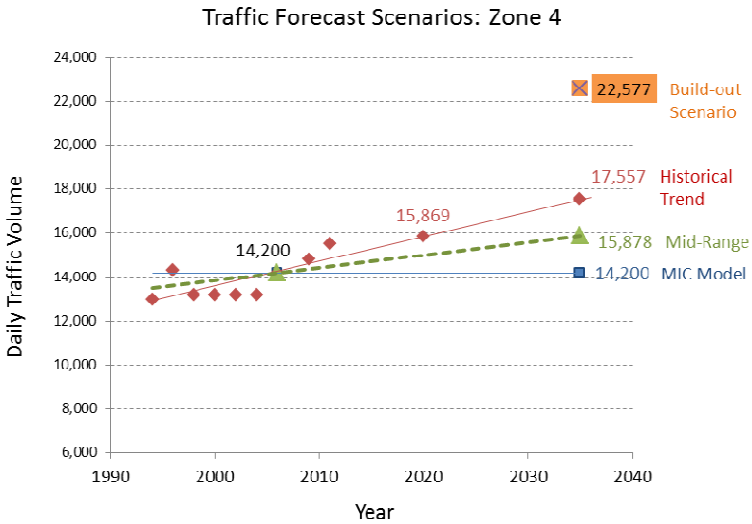
Although Zone 4 does not have the same potential for additional large-scale development like Zone 3 does, there is still the possibility for some additional homes to be built in the area, as well as the arrival of additional commercial activity along the highway. Such increases might trigger a need for additional signalization in Zone 4. If additional residential developments were to happen, they would likely occur along Bayhill Road and/

Figure 3.27 | Land uses next to the highway—Zone 4

Zone 4 is an area of transition along the Highway 23 corridor where many homes and other land uses begin to abut the highway.

Figure 3.28 | Future Traffic Scenarios for Zone 4

Traffic forecasts for Zone 4 reflect additional work-commute trips tied to the development scenarios modeled in zones in 1, 3, and 5.



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or Pulaski Street (Map 3.19).

The highway access to these roads is across from 75th Avenue W, which is a primary entrance into the Norton Park neighborhood. This would then seem like the logical location of a future traffic signal. However, a count conducted there in May of 2012 showed traffic levels on the minor approaches to the intersection to be 1/4 of what they need to be to warrant a signal. As such, one would probably not be warranted until significant growth occurs elsewhere in the corridor.

If a signal were to be located at 75th Avenue W, it could also provide a protected-crossing opportunity for residents of Norton Park to walk or bike across Highway 23 for access to the Munger Trail and other recreational opportunities along the St. Louis River. Beyond this one connection, there is virtually no access to the Munger Trail and Western Waterfront Trail in this highly residential area (Map 3.20, page 53).

There is crossing support for non-motorists at 77th Avenue W in the form of a set of continuous flashing signs (Figure 3.29, page 53). They were installed specifically for the residents of the St. Eligius senior living center, a large contingency of whom utilize the DTA buses and need to cross the highway there. Although these signs are better than no crossing support at all, research indicates that drivers tend to become accustomed to them over time and that they are much less effective than pedestrian-actuated flashing signs[1].

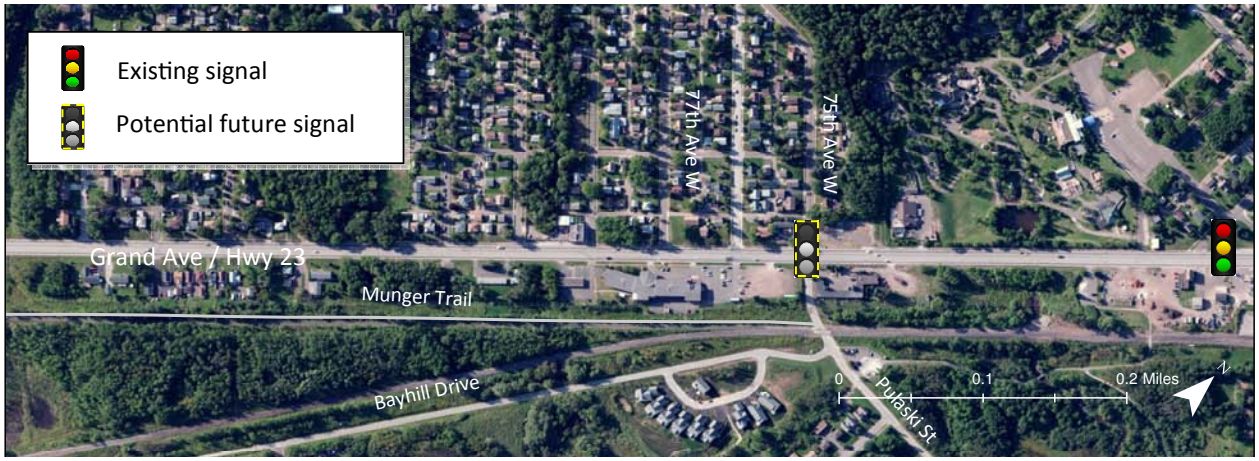
77th Avenue W is also the bus stop with the greatest number of riders in the Zone 4. Yet, despite this, and despite the fact that the only access to the Munger Trail and Western Waterfront Trail is two blocks away, this area has sidewalks

1. Transportation Research Boar, TRCP Report 112/NCHRP Report 562, 2006

Map 3.19 |

Adjacent development patterns - Zone 4

Zone 4 contains significant residential densities. At present, local trips are not focused to any one particular Avenue in Norton Park, and an additional traffic signal is not warranted. If additional residential and commercial activities develop on the southeast of the corridor, however, 75th Avenue W may be a logical place for a future traffic signal.



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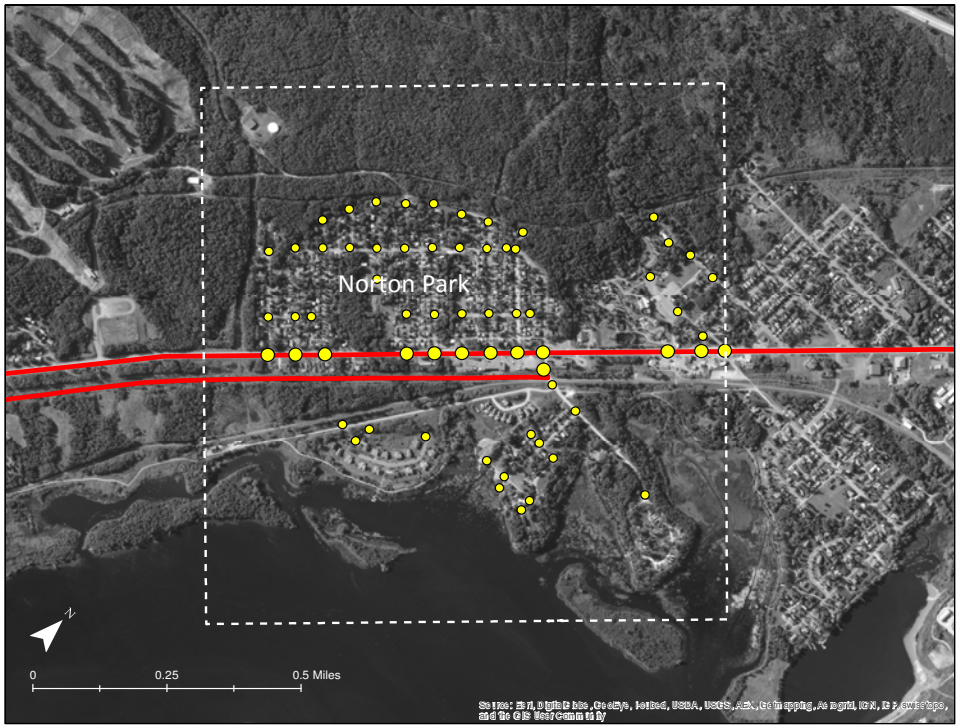
M a p 3.20 | Thru-route connections - Zone 4

Though there are many access points into the Norton Park neighborhood northwest of the highway, there is only one point of access to the Munger Trail.



F I g u r e 3.29 | 77th Ave W pedestrian crossing

The continuous flashing signs and poorly maintained sidewalk at 77th Ave W do not provide the best support for pedestrians at the busiest bus stop in this area.

M a p 3.21

Non-motorized aspects - Zone 4

Only 33% of Zone 4 has adequate sidewalk along the highway (i.e. in "Fair" or better condition and relative to having sidewalk on both sides of the highway). Some of the sidewalk in the poorest condition is in the area with the biggest transit ridership and with the only access point to the Munger Trail.

ANL

Figure 3.30 | Sidewalk gaps and limited bike space

Poor sidewalk connectivity and limited shoulder space along the highway do not support the many recreation-based enterprises found throughout the corridor.

Table 3.11: LOS Scores - Zone 4

Mode	LOS	LOS Score*	v/c
Auto	B	2.38	0.62
Transit	E	4.65	-
Bicycle	F	4.27	-
Pedestrian	E	4.48	-

* scores are not comparable across modes

Table 3.12: Access & Connectivity Scores - Zone 4

Measure	Zone 4	Benchmark
Principal connection ratio	0.14	0.15
% sidewalk ("Fair" or better)	33%	100%*
Protected X-ings per mile (Hwy 23)	0.00	3.00

* represents sidewalks on both sides of highway

Table 3.13: Safety Scores - Zone 4

Measure	Zone 4	Regional Avg	Density Avg[1]
Crash Rate [2]	1.06	3.30	2.80
Severity Rate[3]	1.72	4.20	-

1. The crash rate expected for the density of access points (points per mile) present.
2. Number of crashes expected per 1 million vehicle miles traveled.
3. Number of "property damage" equivalent expected per 1 million vehicle miles traveled.

in some of the poorest condition along Highway 23 (Map 3.21, page 53).

The residential densities in Zone 4 are large enough to produce a significant number of walking and biking trips in the area, and significant demand for crossing the highway. The trailhead to the Munger Trail, nearby Indian point campground, and bike rental at the Munger Inn all add to this potential for non-motorized movements. Nevertheless, the sidewalk gaps and limited shoulder space make the corridor less safe and deter more of those movements from occurring (Figure 3.30).

The many sidewalk gaps and poor sidewalk conditions, as well as the limited shoulder space, result in poor multimodal LOS (Table 3.11) and poor access and connectivity scores (Table 3.12). Because buses are only running hourly and the highway is difficult to cross, transit LOS is also poor.

Zone 4 does, however, score well with respect to vehicle crash rates. Both crash rates and severity rates are well below the expected values (Table 3.13). When assessed as a 3-year running average, the severity rate for Zone 4 shows a moderate increase from 2002, but is still well below the levels experienced elsewhere in the region (Figure 3.31, page 55).

Some of the increase in Zone 4's crash severity is likely the result of crashes that have occurred at the intersection of 75th Ave W. As was shown in Map 3.6 on page 33, that intersection stands out as one of only three within the corridor with rates exceeding district averages for intersections of similar types. As shown in Figure 3.32 on the following page, the crash severity increased significantly between the years 2004 and 2008. Crash records indicate that 57% of the crashes

were rear-end collisions on Highway 23, 88% of which either following too closely, driving distracted , or speed was identified as the primary contributing factor. All suggest that vehicle speeds are likely an important factor in the crashes happening in Zone 4. Speeding traffic also does not bode well for pedestrians and cyclists wishing to cross the highway in this zone.

All together, the trend at 75th Ave W is the opposite of that occurring at most urban stop-controlled intersections throughout the region: it is on the rise, while most others are on the decline. This calls for some continued investigation and regular monitoring of this location in order to identify and implement ways in which the crash trends at this location can be curbed, if not reversed. A suggested first step would be to inventory vehicle speeds to determine to what degree speeding is a problem in the area.

Zone 5: 72nd Ave W to Raleigh St

The half-mile section of Highway 23 in Zone 5 has more commercial and institutional uses along the highway than does Zone 4. It also has a greater number of driveways and uncontrolled access points. The more points of access result in more turning movements at more varied locations that are often spaced unevenly and without traffic control. A consequence of this can be regular disruptions to traffic flow and a more congested state during periods of heavier traffic. This is especially true when right– or left-turn lanes are not present on the major route, as is the case with Highway 23 (Figure 3.33, Page 56).

Current traffic in this zone is estimated to be 16,000 vehicles per day. The MIC-area travel demand model predicts future traffic will

Figure 3.31 | Crash Severity Trend - Zone 4

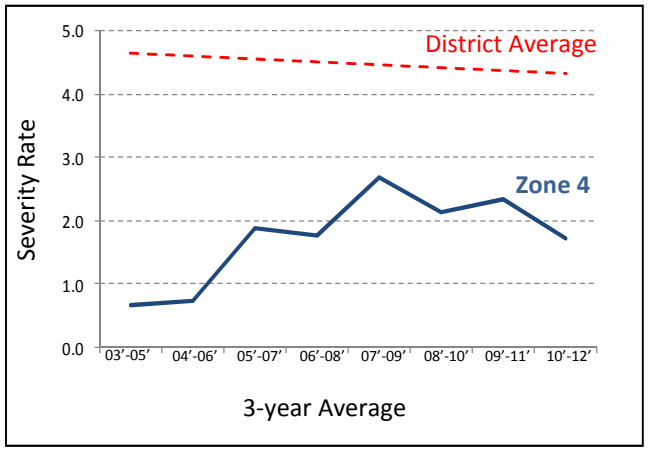


Figure 3.32 | Crash Severity Trend - Hwy23 & 75th Ave W

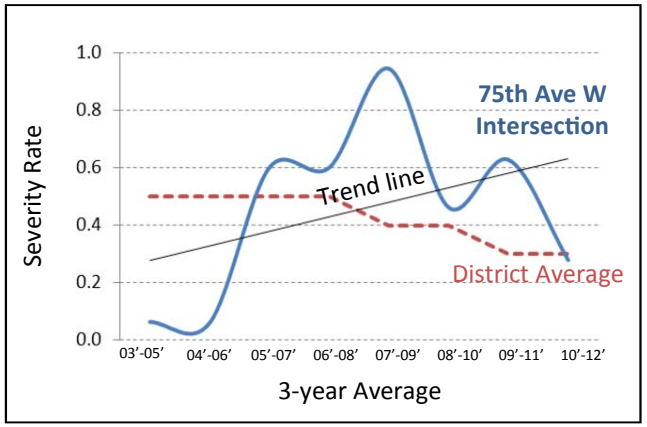


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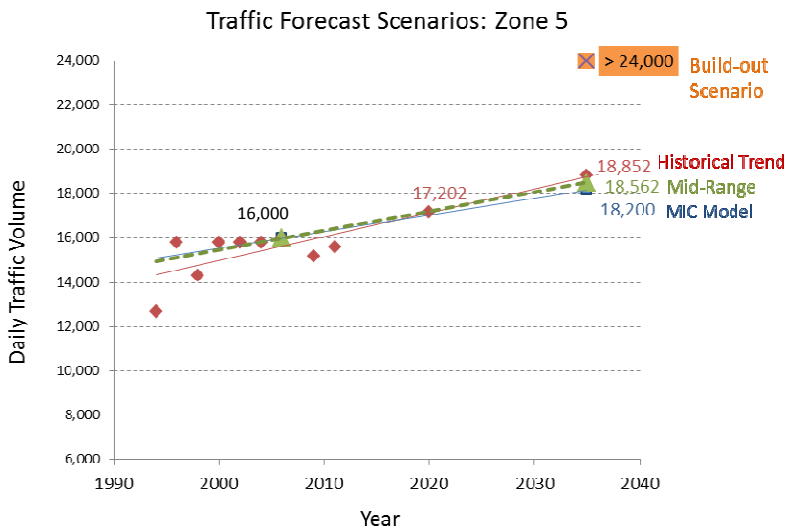
Figure 3.33 | Urban context found in Zone 5

Zone 5 is a higher-volume urban section of Highway 23 with more access points and turning movements. Instances of congestion can occur with the absence of turn lanes.

Figure 3.34 | Future Traffic Scenarios for Zone 5

Traffic is projected to approach 18,000 vehicles per day in the coming decades. Under the "full-build" scenario volumes could exceed 24,000.



continue to grow at a rate similar to what was experienced in previous decades (Figure 3.34). However, under the full build-out scenario considered for this study, daily traffic in Zone 5 could approach 24,000 vehicles per day in the coming decades. This is a level of traffic akin to that on STH 169 north of Downtown Duluth, which currently encounters operational challenges during peak traffic, but - unlike Highway 23 - has a two-way center left-turn lane (TWLTL) to help mitigate those challenges.

Considering the projections in Figure 3.34, traffic congestion would become a challenge in Zone 5 under any of the scenarios, especially since there is no room for lane expansions in this area. At an assumed 10% of AADT and a 40/60 split between incoming and outgoing directions (trends currently observed in the area), a PM peak-hour of traffic in year 2035 would be in the realm of 540 vehicles per lane under the lowest-growth scenario. This would equate to a V/C ratio of 0.81, or LOS "D". And under the full-build scenario, the LOS would be "F", indicating grid-lock.

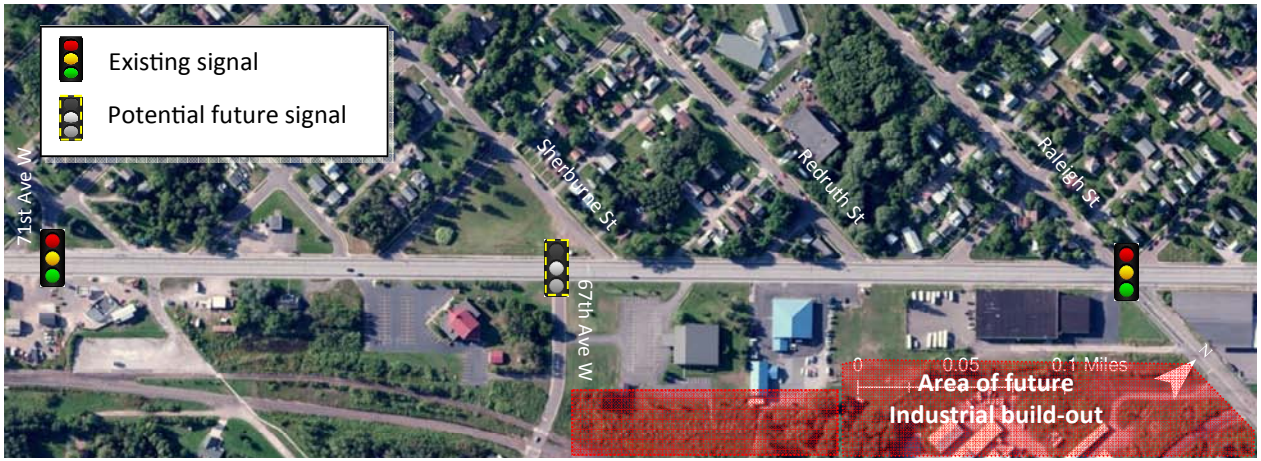
Another challenge for traffic movements in Zone 5 are the acute-angled intersections that result from the layout of the street grid in the area. There are nine such intersections in Zone 5, which can be seen in Map 3.22 on the following page. These intersections make turn movements challenging and can exacerbate instances of traffic congestion. This is especially the case with large commercial vehicles that require larger turn radii.

As a point of access to a number of industrial uses in the

area, the Raleigh Street is especially important for heavy truck movements. Fortunately, it has wide radii and is also signalized. However, the City of Duluth is targeting a site in Zone 5 for locating additional manufacturing or other light industrial uses (Map 3.22). This has the potential to bring even more truck movements to the area. Much of the extra truck traffic would likely occur between Raleigh Street and I-35 and, in fact, use 63rd Avenue W (in Zone 6) to exit onto Highway 23 as it leaves the industrial site. Coming to that site, however, trucks may rely on the traffic signal at Raleigh Street to make their left turns during periods of heavier traffic, and this could lead to increased incidents of congestion there.

If traffic levels do grow substantially in Zone 5 in the coming years, an additional signal may become warranted in this segment, possibly at the intersection of 67th Avenue W (see Map 3.22), since it connects to additional residential and commercial uses in the Irving Park neighborhood. The northern leg of that intersection (Sherburne Street) is currently off-set at an angle and would need to be squared up in order to achieve operational efficiencies and avoid safety conflicts there. Since the land directly next to that intersection is currently vacant and undeveloped, an opportunity exists to correct that alignment prior to, or during any redevelopment of that site.

There are also alignment related issues at the two existing traffic signals in the area. Traffic operations at the Raleigh Street signal are complicated by the 5-legged intersection there (discussed further in the following section). The traffic signal at 71st Avenue W, on the other hand, is at a 3-legged intersection, but traffic operations are made complicated there by the off-set access to the Little Store; some drivers exiting the Little Store are confused by the orientation of the signal heads across the street



Map 3.22 |

Area of future build-out - Zone 5

The City of Duluth has targeted land near Raleigh St for the purpose of encouraging additional light industry to the area. Generating more freight movements, however, has the potential to make traffic operations more challenging in the area.

ANL

Figure 3.35 | View of signal heads from Little Store access

The orientation of the signal heads at the 71st Ave W traffic light are potentially confusing to vehicles exiting the Little Store parking lot.

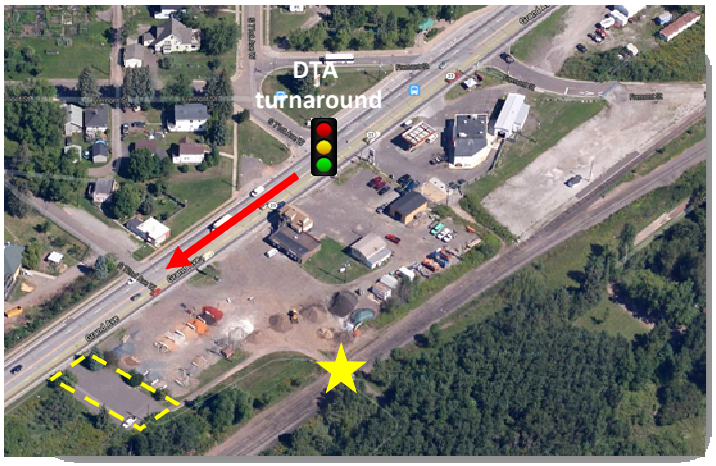


Image source: Google Maps (2013)

Figure 3.36 | Opportunities near the Zoo entrance

Relocating the existing traffic signal to 72nd Ave W may reduce confusion at the Little Store. It would also help pedestrian crossings to the public parking lot (yellow box) and trail head (star).

and have mistaken the green lights for the cross-traffic to be directed at them (Figure 3.35).

Some stakeholders have expressed interest in seeing traffic signal at 71st Avenue W be moved down to 72nd Avenue W. Management at the Lake Superior Zoo, for instance, is interested in relocating the zoo's main entrance to 72nd Avenue W and believe the signal would better serve their needs there. Moving the signal to 72nd Avenue W would also create a protected crossing opportunity for pedestrian traffic between the zoo and the public parking area that serves the shared trailhead to the Munger Trail and Western Waterfront Trail. Bus operations at the existing DTA turnaround, however, may be negatively impacted by a signal relocation, and other accommodations may be needed (Figure 3.36).

Whether located at 71st Avenue W or 72nd Avenue W, a traffic signal will benefit non-motorized crossings in the area. However, comments heard from residents - and subsequent observations - indicate that crossing times at the existing signals in Zone 5 are too short to allow for a comfortable and safe crossing of the four highway lanes. This is especially the case for users who are elderly, have limited mobility, or who may attempt to cross the highway in larger groups or with small children (Figure 3.37 on page 59).

Currently, the signal programming is different for the two signals in Zone 5. In response to a pedestrian pressing the button, the signal at Raleigh Street will provide a "walk" time of 10 seconds, followed by a flashing "walk" time of 16 seconds, creating a total crossing time of 26 seconds. The traffic signal at 71st Street offers a shorter crossing time for pedestrians. With an 8-second "walk" time, 15 seconds of flashing "walk", the crossing time is 3 seconds

shorter.

The Highway Capacity Manual (HCM 2010) recommends a crossing speed of 3.5 feet/sec be used in designing for highway crossings and even recommends using a rate of 3 feet/sec in areas where higher percentages of elderly individuals are present. Given Highway 23's 56-foot width, approximately 19 seconds would be needed to cross at that speed. It is less than the 23 seconds of crossing time provided by the signal at 71st Avenue W, but a more in-depth study of conditions at this location might indicate that the time should be lengthened nevertheless.

Even though pedestrians in Zone 5 have the crossing support at the two signals, crossing demand may be significant throughout the segment. For example, Map 3.23 on page 60 shows higher numbers of transit boardings/alightings occurring at the 67th Avenue W and Redruth Street intersections than at Raleigh Street. While some research has shown that , in general, pedestrians prefer to cross at signals when they are available, there is a significant potential for jaywalking in this area, especially in situations where people are rushing to catch a bus.

But it is not just the challenge of crossing the busy, four-lane highway that makes Zone 5 difficult for pedestrians. Conditions are made worse by the fact that the majority of sidewalk in this area is in poor condition and that sidewalk is even non-existent along much of the southern side (Map 3.23 on page 60). This contributes significantly to the poor LOS score for pedestrians, while the high traffic volumes, limited shoulder space, and abundance of driveways and accesses produce a poor LOS for cyclists (Table 3.14 page 61).

Figure 3.37 | Pedestrian crossing at traffic signal

Some pedestrians were observed to have troubles making it across the highway at 71st Avenue W before the signal changed to green.

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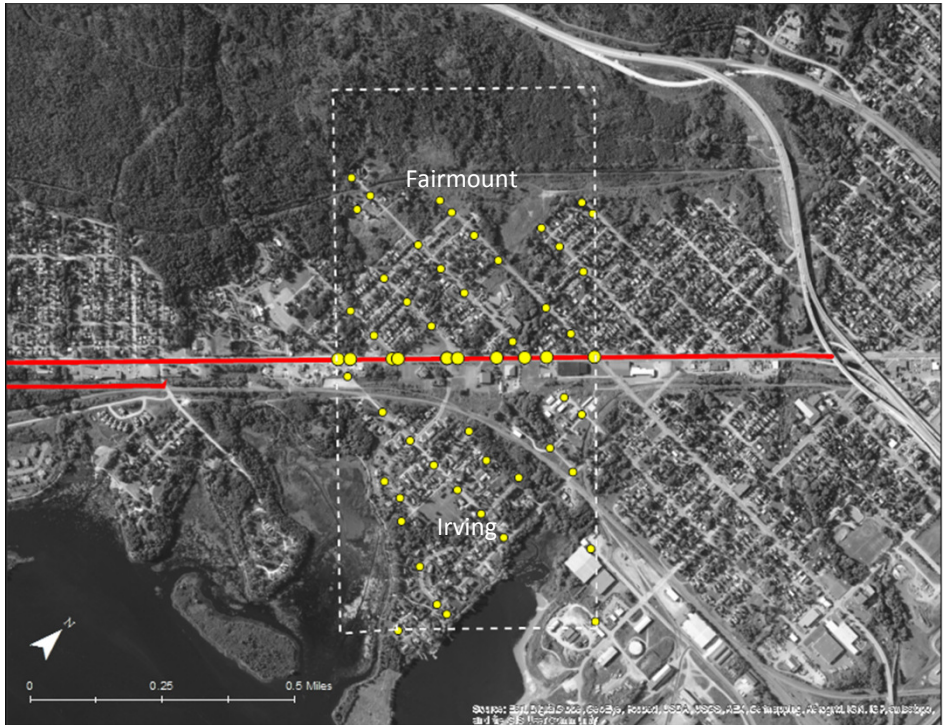
M a p 3.23

Non-motorized aspects - Zone 5

Zone 5 has significantly more traffic than zones to the west. Based on transit numbers, there is also significant pedestrian activity in the area. The gaps in (and conditions of) the sidewalks do not support this level of demand.

M a p 3.24 | Thru-route connections - Zone 5

Zone 5 scored well in terms of the connectivity benchmark set for this study (see Table 3. 15). Unfortunately, this reflects an overabundance of accesses along the northern side of the highway, while a large swath of industrial lands creates significantly less connectivity with the Irving neighborhood to the south.



The lack of adequate sidewalk in Zone 5 does not suit the residential densities found on either side of the highway. Past decisions to forego sidewalk on the southern side may have had to do with the fact that a large swath of light-industry sits between the highway and the Irving neighborhood, limiting the number of street connections there (Map 3.24 on page 60). At present, only two streets connect the neighborhood to the highway: 67th Avenue W and Redruth Street. Despite earning a good connectivity score overall (Table 3.15) based on the benchmarking method used for this study (see Appendix A, page 101), connectivity between Irving and Highway 23 is not particularly good.

Connectivity to Irving is a limitation for both motorists and non-motorists alike. From the perspective of a pedestrian accessing the highway at 67th Avenue W in order to use transit, for example, that person is then met with a quarter-mile of missing sidewalk to either signalized crossing. And while Freemont Street has the potential to be a direct route to the signalized crossing at 71st Street, it currently ends in a cul-de-sac, and sidewalk does not extend all the way through to the highway.

It would be beneficial to eventually extend Fremont Street through to Highway 23 and create an additional road access to the Irving neighborhood. In the short term, opportunities could be sought to extend the existing sidewalk, or even pave a multi-use trail across the gravel lot near the highway (Figure 3.38). This would also have the benefit of creating a direct connection between the Lake Superior Zoo and the waterfront at the Indian Point Campground in addition to being an access point to the future Cross City Trail from both the highway and the neighborhood.

Table 3.14: LOS Scores - Zone 5

Mode	LOS	LOS Score*	v/c
Auto	B	2.38	0.66
Transit	A	0.54	-
Bicycle	F	4.81	-
Pedestrian	E	4.35	-

* scores are not comparable across modes

Table 3.15: Access & Connectivity Scores - Zone 5

Measure	Zone 5	Benchmark
Principal connection ratio	0.26	0.15
% sidewalk ("Fair" or better)	38%	100%*
Protected X-ings per mile (Hwy 23)	3.50	3.00

* represents sidewalks on both sides of highway

Image source: Google Maps (2013)

Figure 3.38 | Lack of connection at Fremont Street

The Irving neighborhood could be benefited from completing the connection of Fremont Street to Highway 23. At minimum, a sidewalk or paved trail could be extended across the gravel lot near the highway.

ANL

Table 3.16: Safety Scores - Zone 5

Measure	Zone 5	Regional Avg	Density Avg[1]
Crash Rate [2]	1.87	3.30	4.40
Severity Rate[3]	3.54	4.20	-

1. The crash rate expected for the density of access points (points per mile) present.
2. Number of crashes expected per 1 million vehicle miles traveled.
3. Number of "property damage" equivalent expected per 1 million vehicle miles traveled.

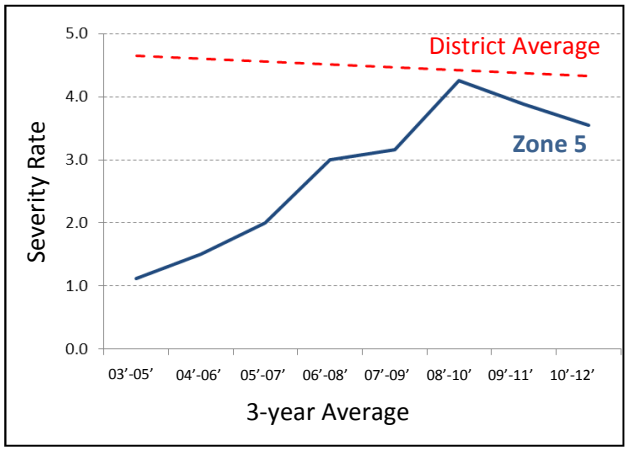


Figure 3.39 | Crash Severity Trend - Zone 5

Zone 5 has a crash severity rate that has been increasing rapidly in recent years. Contrary to trends in the rest of the corridor, the crash severity rate in Zone 5 threatens to exceed the regional average.

There is no doubt that better sidewalk and trail connections would also improve safety for non-motorized movements in Zone 5. Even though the crash records show only one bike collision and no pedestrian related crashes in the past ten years, the records do indicate that four vehicle crashes resulted from sudden stopping or maneuvers to avoid striking peds.

Because of the high residential densities, higher traffic volumes, and large number of intersections and driveways, traffic safety is of concern for all user groups in Zone 5. Pedestrians, cyclists, and drivers alike are exposed to greater chances for collisions when there are more turn movements.

Compared to regional averages, the crash and severity rates for Zone 5 do not look alarming (Table 3.16). Unlike the other zones in the corridor, however, the severity of crashes in has trended upward significantly and has approached the regional average (Figure 3.39). This is in strong contrast to a general decline in average crash severity for the region as a whole and is concerning enough to justify further monitoring and evaluation.

Two characteristics of Zone 5 are likely contributors to the higher severity rate found there: a high access density and the fact that zone contains two traffic signals within half a mile. As mentioned earlier, Zone 5 has the highest access density of the six zones that were studied (Figure 3.40 on page 63), and many points of access can contribute to unanticipated vehicle movements that result in dangerous angled crashes. Traffic signals, on the other hand, often invite higher speeds and "run-on-reds" as drivers try to pass through an intersection before the signal changes to red. This increases the risk for higher-speed collisions that result in the more

severe angled, or "T-bone" crashes.

The crash data for Zone 5 suggests that some of this has been occurring, yet the most prevalent crash type in the zone has been rear-end crashes. A large number of these were reported to have resulted from distracted drivers or drivers following other vehicles too closely, a pattern that is also consistent with a higher frequency of turning movements in this segment of Highway 23.

Zone 5 has an access density equivalent to 65 points of access per mile. Having this many locations where vehicles enter and exit the roadway will continue to lead to higher levels of both crashes and congestion, especially in the absence of excess space in the shoulders or in the center of the roadway. Seeking opportunities to close or consolidate unnecessary accesses may be able help to reverse crash trends, reduce crash severities, and improve traffic flow during more congested hours of traffic.

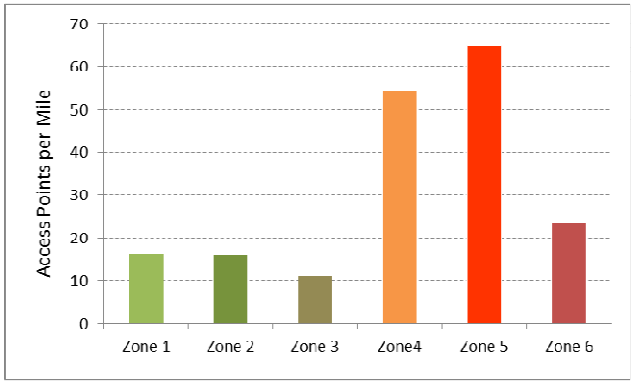


Figure 3.40 | Access densities along Highway 23

Zone 5 has a high access density of 65 access points per mile. This may be a significant contributing factor to the high crash severity in Zone 5 relative to the other segments of the corridor.

Zone 6: Raleigh St to I-35

The Zone 6 represents the most urbanized segment of the Highway 23/Grand Avenue corridor. It has the highest densities of both residential and commercial uses. It also has the greatest density of driveways and access points. Subsequently, Zone 6 has the greatest potential for both crashes and congestion.

It is also assumed that Zone 6 has daily traffic volumes higher than Zone 5. However, none of the standard, ongoing traffic count locations for the Duluth-Superior metro area reside in Zone 6, and so there is no annual average daily traffic (AADT) data specific to this segment of Highway 23. The closest such location is in Zone 5, just southwest of Raleigh Street, and so it has been assumed, for this

Figure 3.41 | Urban context found in Zone 6

Residential, commercial, and light-industrial uses become much more densely spaced in Zone 6.

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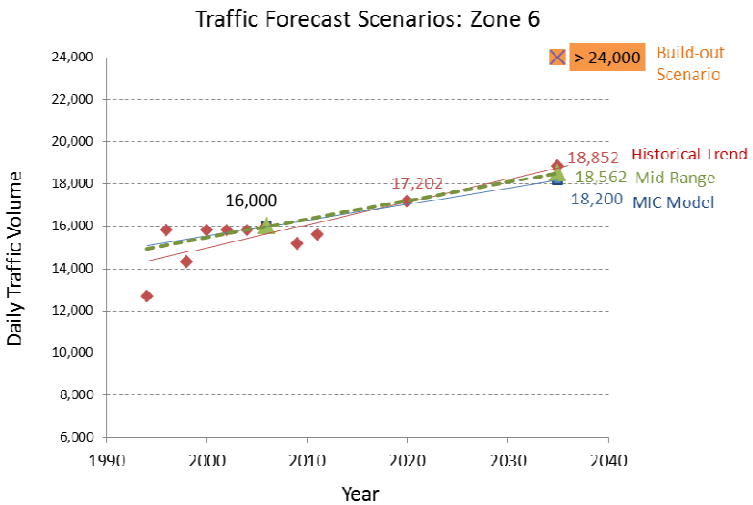
Figure 3.42 | Future Traffic Scenarios for Zone 6

Traffic projections are the same in Zone 6 are assumed to be the same as in Zone 5. At historic rates of growth, daily traffic would approach 18,000 vehicles by 2025.



study, that the AADT for Zone 6 is equal to that of Zone 5.

Working with the data available, current traffic levels are estimated to be 16,500 vehicles per day on Highway 23 here. As with Zone 5, daily volumes are expected to grow by roughly 2,000 vehicle trips over the coming decades. If, however, development levels approach the full build-out scenario modeled for this study, future traffic could approach 24,000 vehicles per day (Figure 3.42) and would result in LOS "F" during the hours of peak traffic flow.

Much of the buildable land area in Zone 6 is already developed, but there is the potential for redevelopment to occur at higher densities that currently exists. The area just south of Raleigh Street, for instance, is being considered for additional light-industrial uses by the City of Duluth (Map 3.25). Such development would bring more traffic to the Raleigh Street intersection, including a greater percentage of heavy commercial vehicles.

Map 3.25 |

Adjacent land use patterns - Zone 6

The land use densities and proximity to I-35 make Zone 6 the segment of the Highway 23 with the most activity. The intersecting street grid is oriented at a 45 degree angle to the highway , creating odd intersections and an overabundance of access points.

Existing industrial uses in this area already generate significant truck traffic, which moves primarily between Raleigh Street and I-35. However, the number of these trucks that actually travel along Highway 23 in Zone 6 is unknown and depends on their direction of travel. The interchange between Highway 23 and I-35 has just one set of ramps; only traffic entering from - or exiting to - northbound I-35 has a direct connection between the highway and the interstate. As is illustrated in Map 3.26 on the following page, any trucks accessing markets south of Duluth via I-35 are required to travel through the Irving neighborhood to access the ramps at Central Avenue. And any future increase in commercial truck traffic from the area will also likely occur along these routes.

For those trucks that are accessing/departing Highway 23 from its existing ramp connections and traveling to/from the industrial and commercial uses in zones 5 and 6, the intersections of Raleigh Street and 63rd Avenue W are the major points of access. Because of the angled orientation of the local street network, 63rd Avenue W provides truckers with the easiest turning radii, but during higher traffic periods they may rely on the traffic signal at Raleigh Street to provide them sufficient gaps in traffic. This will become more of the case if future traffic growth follows the projections shown on the previous page. With increased traffic and an increased percentage of trucks, operations at the Raleigh Street intersection will become more challenging.

Because of how the local street network is oriented, Raleigh Street is a five-legged intersection. The resulting geometry both complicates traffic operations and produces atypical turning movements. In addition, the approaches to the intersection are designed with wide

Figure 3.43 | Traffic in Zone 6

Current traffic levels are heavy in Zone 6during peak hours of travel. The presence of light industry along the highway and to the south also bring a significant amount of truck traffic to the area.

ANL

M a p 3.26 | Required truck movements for accessing southbound I-35

The Highway 23 interchange with I-35 only has one set of ramps. Heavy trucks heading to markets using southbound I-35 are required to access the interstate at Central Ave. Conversely, trucks traveling north to access sites along Grand Ave. are required to exit I-35 at Central Ave.

radii and lack strong lane delineation. This creates further potential for confusion and vehicle conflicts (Figure 3.44).

Although Zone 6 has only about half as many acute intersections as does Zone 5, they are spaced much closer together and create clusters of accesses that are oriented in different directions. The most extreme example of this is found in the vicinity of the 64th Avenue W and Polk Street intersections (Figure 3.45). This type of spacing and alignment is not ideal from an access management perspective. It increases the potential for both collisions and congestion. To make matters worse, there are also a number of driveways and alleyways present, which increases the overall access density of the highway segment.

Research[3] shows there is a strong correlation between access densities and higher rates of crashes. Even though the access density in Zone 6 is not as high as elsewhere in the corridor, its accesses are more densely clustered, which may help to explain why Zone 6 has a significantly higher crash rate than other roadways with similar access densities (see Figure 3.9 on page 32). Despite this, both the crash rate and severity rate are still lower-than-average when compared to the larger region (Table 3.16, page 67), and the severity rate appears to be relatively stable (Figure 3.46, page 68).

Nonetheless, Zone 6 contains the intersection of 62nd Avenue W, which has severity rate in excess of the regional average for similar intersections. The intersection has a relatively low crash rate, but its severity rate is high and appears to be on the rise (Figure 3.47, page 68).

3 Transportation Research Board, NCHRP Report 420, 1999

Image source: Google Maps (2013)

Figure 3.44 | Geometry of Raleigh St. intersection

The five-legged intersection at the Raleigh St. complicates signal operations and produces atypical turning movements.

Figure 3.45 | Intersection spacing at Polk St.

The cluster of uncontrolled, angled intersections and accesses in the vicinity of Polk St. increases the potential for conflicting vehicle movements and collisions.

Image source: Google Maps (2013)

ANL

Table 3.17: Safety Scores - Zone 6

Measure	Zone 4	Regional Avg	Density Avg[1]
Crash Rate [2]	1.51	3.30	1.30
Severity Rate[3]	2.15	4.20	-

1. The crash rate expected for the density of access points (points per mile) present.
2. Number of crashes expected per 1 million vehicle miles traveled.
3. Number of "property damage" equivalent expected per 1 million vehicle miles traveled.

Figure 3.46 | Crash Severity Trend - Zone 6

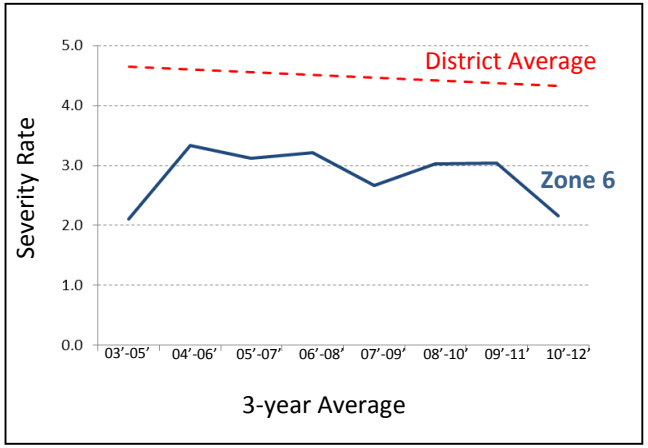
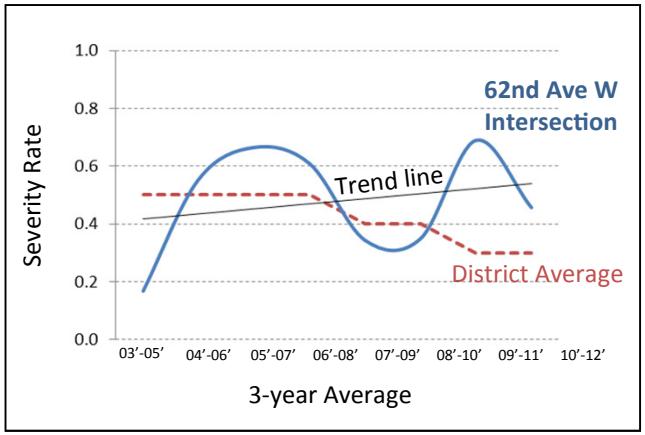


Figure 3.47 | Crash Severity Trend - Hwy23 & 62nd Ave W

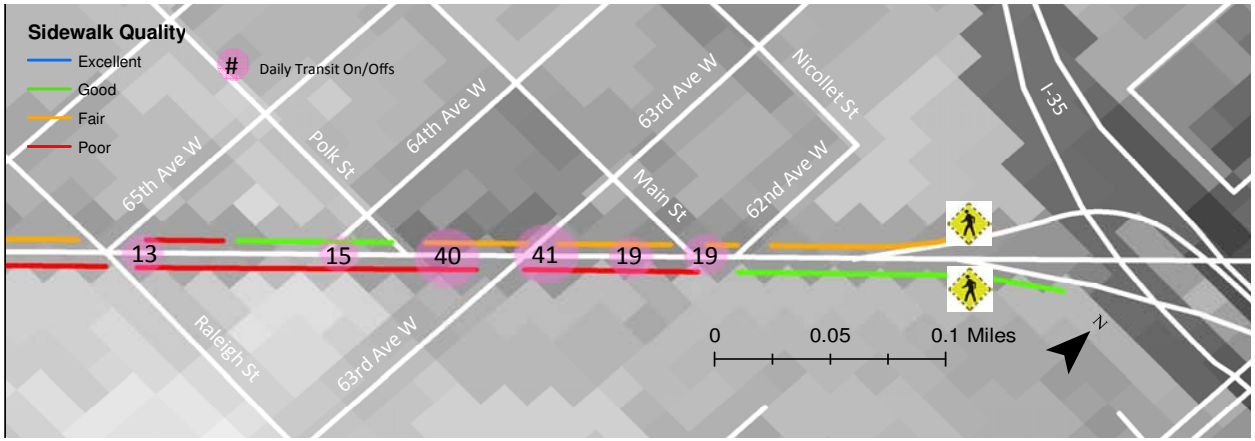


One reason that crashes near the intersection of 62nd Avenue W may be more severe is the intersection's close proximity to the I-35 off ramp, combined with the speeds at which vehicles may be exiting that ramp. That portion of Zone 6 represents an area where traffic traveling at different speeds is often merging. Because of this, there is likely a significant amount of lane changes that occur right before the 62nd Avenue W intersection. This can involve moments of distraction or even limited visibility, depending on the thickness of traffic. The crash records for 62nd Avenue W show that rear-ends and sideswipes make up the majority of crashes, a pattern which helps to validate the suspected role that the off-ramp plays in crashes happening in this area.

Zone 6 is also the zone with the highest number of reported bike and pedestrian crashes in the corridor (see Map 3.7, page 33). This is likely due to the fact that a higher levels of both motorized and non-motorized traffic occur in this more densely populated area and thus increase the risk for such events. This nonetheless underscores the significant challenge of providing safe and accessible transportation for all users in this area.

The combination of high traffic volumes, dense clusters of accesses, and limited shoulder widths explain the poor LOS rating for cyclists (see Table 3.17). Similarly, the traffic, wide roadway, number of lanes, and a limited support for pedestrian crossings result in a poor pedestrian LOS of "E".

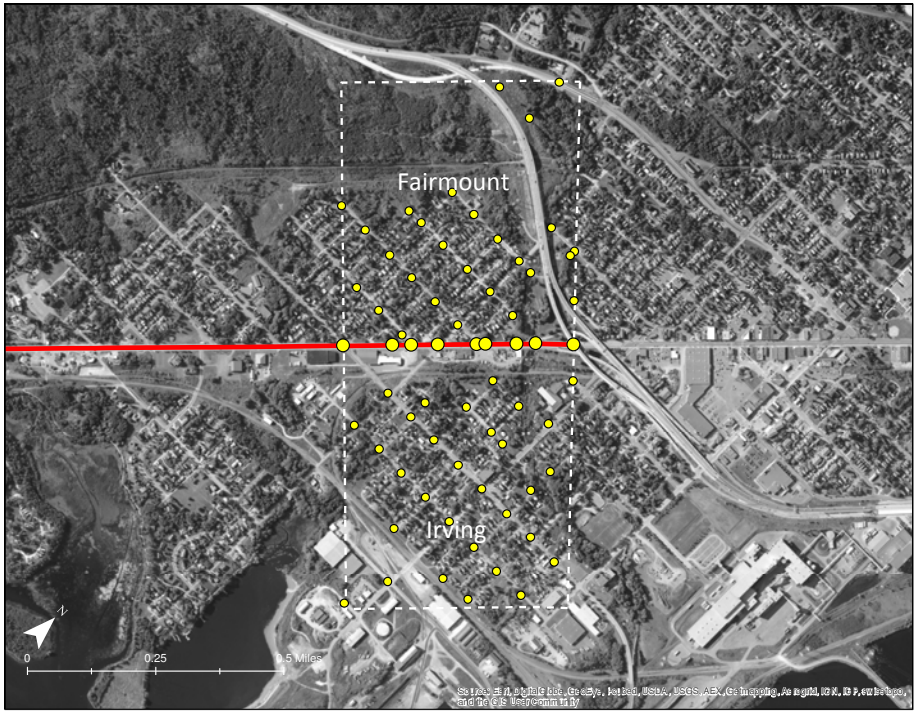
The situation for pedestrians is worsened by the fact that 65% of the sidewalk between Raleigh Street and 62nd Ave W is in poor condition (Map 3.26 on page 69). This is unfortunate, especially given the level of transit usage in this segment of the corridor.



M a p 3.27

Non-motorized aspects - Zone 6

The highest transit ridership for the corridor is found in Zone 6. Yet, the stops with the greatest ridership exist where there is no ped-crossing support. Also, much of Zone 6's sidewalk is in poor condition.



M a p 3.28 | Thru-route connections - Zone 6

The residential densities in Zone 6 correspond with the high traffic volumes there. Even though there are a lot of access points along Highway 23 in this area, it still is the only lateral thru-route serving the higher densities. This translates into a connectivity score that is below the benchmark established for this study (see Table 3.17).

ANL

Table 3.18: LOS Scores - Zone 6

Mode	LOS	LOS Score*	v/c
Auto	B	2.38	0.66
Transit	A	0.39	-
Bicycle	F	4.46	-
Pedestrian	E	4.43	-

* scores are not comparable across modes

Table 3.19: Access & Connectivity Scores - Zone 6

Measure	Zone 4	Benchmark
Principal connection ratio	0.12	0.15
% sidewalk ("Fair" or better)	65%	100%*
Protected X-ings per mile (Hwy 23)	3.67	3.00

* represents sidewalks on both sides of highway

As shown in Map 3.26 on the previous page, the bus stops with the highest numbers of boardings are not near the traffic signal at Raleigh Street. As has already been mentioned, such a pattern suggests that a significant number of people are crossing at non-designated crossing locations where there is little support for safe pedestrian movements. This is perhaps an issue of greater concern in Zone 6 than in the other sections of Highway 23, given the higher numbers of bike and pedestrian strikes and vehicle merging cited in this segment.

Despite being a challenging environment for non-motorized users, Zone 6 needs to be recognized as an important urban, residential area. The higher demand for bike and pedestrian movements in this area is a given, and yet the zone presents some of the worst conditions in the corridor relative to the potential demand. Regional connectivity is still dependent on Highway 23 in this area (Map 3.27, page 68), and yet the combination of the industrial activities along the south side of the highway, sidewalks in poor condition, and the presence of I-35 ramps create a number of impediments to accessibility and connectivity for non-motorized movements.

Summary of Findings

Upon reviewing existing conditions in terms of both the highway corridor at large and its six distinct context zones, a variety challenges and opportunities have been identified. While the highway's importance as a regional thru-route is asserted, its importance as a transit, pedestrian, and cyclist corridor is also recognized. The existing highway facilities, however, do not

provide the same level of support for these different user groups.

Because there is public and private interest in promoting Highway 23 as a growth corridor for residential, commercial, industrial, and recreational activities, the demand for all modes of travel is expected to increase. The need to retain the current four-lane capacity has been demonstrated, yet such a configuration will continue to create challenges for non-motorized travel both along and across the highway unless efforts are made to modify the corridor to include more support for other modes of transportation.

The existing and future conditions suggest that Highway 23 is a transportation facility that is insufficient in meeting the metropolitan area's transportation objectives as spelled out in the Duluth-Superior long-range transportation plan *Directions 2035* (2010)[4] and reflected in the guiding principals of MnDOT's *Minnesota GO* vision (2011)[5].

In light of all this, the recommendations in the following section are aimed at initiating a gradual transformation of the roadway environment to better connect the highway and adjacent land uses to other transportation opportunities in the corridor. Given financial constraints, most of the suggested improvements are designed to fit within the existing right-of-way and be lower-cost solutions targeted at specific locations. Some longer-term improvements, however, have also been included that would improve the general safety, connectivity, and multi-modalism of the Highway 23 / Grand Avenue corridor.

Minnesota GO Guiding Principles:

Leverage public investments to achieve multiple purposes: The transportation system should support other public purposes, such as environmental stewardship, economic competitiveness, public health and energy independence.

Ensure accessibility: The transportation system must be accessible and safe for users of all abilities and incomes. The system must provide access to key resources and amenities throughout communities.

Build to a maintainable scale: Consider and minimize long-term obligations–don't overbuild. The scale of the system should reflect and respect the surrounding physical and social context of the facility. The transportation system should affordably contribute to the overall quality of life and prosperity of the state.

Ensure regional connections: Key regional centers need to be connected to each other through multiple modes of transportation.

Integrate safety: Systematically and holistically improve safety for all forms of transportation. Be proactive, innovative and strategic in creating safe options.

Emphasize reliable and predictable options: The reliability of the system and predictability of travel time are frequently as important or more important than speed. Prioritize multiple multimodal options over reliance on a single option.

Strategically fix the system: Some parts of the system may need to be reduced while other parts are enhanced or expanded to meet changing demand. Strategically maintain and upgrade critical existing infrastructure.

Use partnerships: Coordinate across sectors and jurisdictions to make transportation projects and services more efficient.

ANL

4. Duluth-Superior Directions 2035: http://www.dsmic.org/lrtp

5. MnDOT Minnesota GO 50-Year Vision for Transportation: http://www.dot.state.mn.us/minnesotago/vision.html#principles

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4. Recommendations

The recommendations contained in the following pages have been developed with information collected through stakeholder engagement and technical analysis. They were developed with the goal of finding context sensitive solutions that can be both incorporated as part of MnDOT's highway resurfacing project scheduled for 2015-2016 and as stand-alone improvements in subsequent years. The majority of these recommendations were developed with a sensitivity to future capacity needs and current fiscal constraints, but some recommendations included relate to important opportunities versus critical needs.

The following pages contain general recommendations that are applicable to the entire 5-mile corridor between Beck's Rd and I-35. Those recommendations are then followed by others tailored specifically for the conditions found in each of the individual context zones that were identified during the study. Together these recommendations represent a package of options to be considered for implementation by MnDOT, the City of Duluth, and the Duluth Transit Authority (DTA).

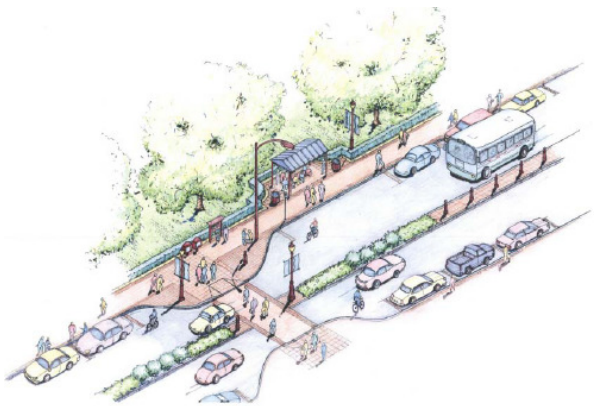

Image source: Institute of Transportation Engineers (2006)

Figure 4.1 | Illustration of context sensitive design

A context sensitive approach aims to provide for all modes of surface transportation and balance competing objectives of different user groups.

Corridor-wide Recommendations

It has been established that the vehicle capacity of Highway 23 should be protected for future demand. Yet, stakeholder input has also identified a demand for a safer pedestrian environment and room for bikes as well. The same reason that lane capacity should be protected is the same reason pedestrian and bike travel should also be accommodated: Highway 23 is the sole arterial connection between all the neighborhoods and commercial activity west of I-35. Both the

Figure 4.2 | Missing sidewalk

Because of the long distances, speed of traffic, and importance of the corridor as a transit route, it is recommended sidewalk be installed on both sides of the corridor.

stakeholder input summarized in Chapter 2 and the technical analysis summarized in Chapter 3 indicated that the current roadway environment does not sufficiently support these non-motorized modes.

Highway 23 is also an important route for transit. It is part of the DTA's busiest bus line; ridership data shows that significant passenger activity exists at bus stops all along the corridor. A number of these stops lack sidewalk connections or even level, ADA accessible spaces to stand and wait for a bus.

Sidewalks

For the reasons listed above, it is recommended that sidewalk be installed anywhere that there are gaps, where the width of existing sidewalk is insufficient, or where the current sidewalk is in disrepair. Sidewalk should exist on both sides of the highway, at least from the Morgan Park neighborhood eastward to I-35. Going west from Morgan Park, continuous sidewalk should exist on the southeastern side of the highway all the way to Gary/New Duluth in anticipation that more development will be occurring there in coming years.

A width of five feet is recommended for sidewalk along Highway 23 in order to be consistent with the majority of sidewalk infrastructure already in place. ADA accessible curb ramps should be installed at all intersections, bus pads, and any marked crosswalks.

Specific sidewalk improvements are also identified for each zone in the pages that follow.

Lane widths and bike lanes

Because the width of the roadway and vehicle speeds are concerns for pedestrian crossing safety along the highway, a reduction in lane widths

from their current 12-foot width down to 11-foot lanes is recommended. Doing this would have the potential to calm speeds through drivers' perceptions of a more restricted space. Just as important, it would allow for the shoulders to be increased to 6 feet on both sides of the highway, thus creating a six-foot wide space that could serve bike travel and also shorten the length that pedestrians are required to cross to get out of the lanes of traffic. In addition, six-foot shoulders would also provide more room for buses to pull out of traffic and allow more visibility and room for other vehicles to negotiate around them. Figure 4.3 illustrates the recommended lane configuration.

It is also recommended that the shoulders be designated as bike lanes with pavement markings throughout the entire five-mile corridor (Figure 4.4). This will help to dissuade people from parking cars in this space.

Image source: FHWA.gov (2013)

Figure 4.4 | Pavement to the curb

An even surface should be provided in the shoulders for safer cycling.

Image source: FHWA.gov (2013)

Figure 4.5 | Orientation of grates

Storm sewer grates should have their openings oriented perpendicular to the roadway.

Figure 4.3 | Recommended lane widths

Reducing travel lanes to 11 feet wide would provide for wider shoulders to accommodate bike traffic and improve safety for pedestrians and transit riders.

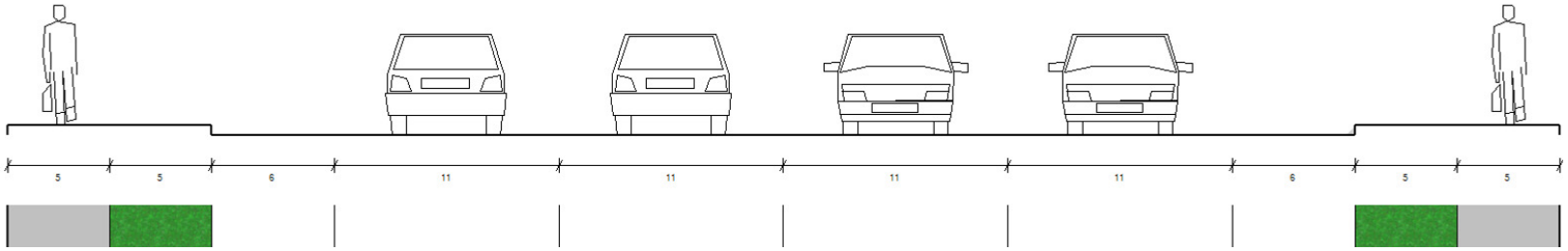

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Figure 4.6 | Prioritize snow removal

Because of Grand Avenue's importance as a multimodal corridor and sole arterial connector, it should be a priority route for snow removal.

Edge treatment and storm sewer grates

It is also recommended that MnDOT take the following steps to improve bike safety in the shoulders of the highway. It is recommended that MnDOT pave over the gutter pans, bringing the pavement all the way to the curb. In addition, MnDOT should ensure that the openings of all storm sewer grates are oriented to be perpendicular with the travel lanes (Figure 4.5, page 75) and set as flush with the pavement surface as possible.

Snow Removal

Because of the highway's importance as a transit route, a pedestrian corridor, and a bike commuting corridor, keeping the shoulders, sidewalks, and bus stops clear of snow throughout the winter should remain a priority of MnDOT, the City of Duluth, and the DTA. Based on the cooperative agreement between MnDOT and the City of Duluth, ensuring snow removal from the sidewalks will be the City's responsibility. It is recommended that the City prioritize the sidewalk in the Highway 23 corridor to be among the first plowed following a snowfall.

It is understood that MnDOT, the City of Duluth, and the DTA all have limited resources and that the deployment of those resources is often dictated by a variety of conditions encountered throughout their systems. These agencies can occasionally become overwhelmed with successive snowfall events, and the timing and coordination of plowing activities is often not possible. Nevertheless, it is a general recommendation that the three agencies continue to seek ways to coordinate snow removal activities along Highway 23 to ensure accessibility and mobility for pedestrians, bike commuters, and transit riders during the winter months.

REC

T a b l e 4.1 | Summary of corridor-wide recommendations for Highway 23 / Grand Avenue

Implementation Timeframe	Recommended Improvements	Implementation Agency
Short Range (2015—2020)	1. Reduce widths of travel lanes to 11 feet and create six-foot shoulders for pedestrian and bike commuting safety.	MnDOT
Short Range (2015—2020)	2. Ensure continuous sidewalk on both sides of the highway from I-35 to Arbor Drive (Morgan Park Entrance). Continue sidewalk on southeastern side of the highway	MnDOT
Short Range (2015—2020)	3. Bring curb ramps and points of access to bus stops into compliance with ADA design standards.	MnDOT/ City of Duluth
Short Range (2015—2020)	4. Designate highway shoulders as bike lanes via pavement insignia.	MnDOT
Short Range (2015—2020)	5. Pave roadway surface to the curb to provide an even surface for bike travel.	MnDOT
Short Range (2015—2020)	6. Orient openings in storm sewer grates to be perpendicular to the travel lanes.	MnDOT
Ongoing	7. Prioritize Highway 23 sidewalks for snow removal.	City of Duluth
Ongoing	8. Seek ways to coordinate and optimize snow removal activities along Highway 23.	MnDOT/ City of Duluth/ DTA

REC

Recommendations for Zone 1

It is recommended that sidewalk be installed on both sides of the highway between Clyde Avenue and Arbor Drive (88th Ave W). From there, continuous sidewalk should be provided on at least one side of the highway to Becks Road. The southeastern side of the highway is preferred in order to serve current residences and future development on that side of the corridor (1-a, page 79).

Arbor Drive is currently a signalized intersection with a pedestrian crossing phase. As a pedestrian crossing area, this intersection could be enhanced with a high-visibility, wide-block crosswalk pattern using a longer-lasting material such as polyurethane plastic (1-b).

Because additional industrial and commercial development is being anticipated for the segment of the highway between Idaho Street and Becks Road, the City of Duluth should develop an interior circulation plan (1-c) and access management plan (1-d) in advance of that growth. This will help manage the placement of accesses and reduce the potential for future congestion and traffic hazards.

It is anticipated that this segment of the highway will see increased truck traffic. A right-turn bay for northbound vehicles should be installed at Nick Glumac Drive as future traffic levels begin to warrant it (1-e). This should be designed to accommodate the lengths and turning radii of trucks in order to avoid the obstruction of northbound traffic.

Finally, the City of Duluth should investigate the feasibility of installing a paved trail connection to the Munger Trail within dedicated right-of-way at the end of Zimmerly Avenue (1-f). This would provide residents of the Smithville and Morgan Park neighborhoods an opportunity to access the Munger Trail in this area.

Figure 4.8 | High-visibility crosswalk

A high visibility crosswalk is recommended for the Arbor Street (88th Ave W) crossing in this more rural section of Grand Avenue.

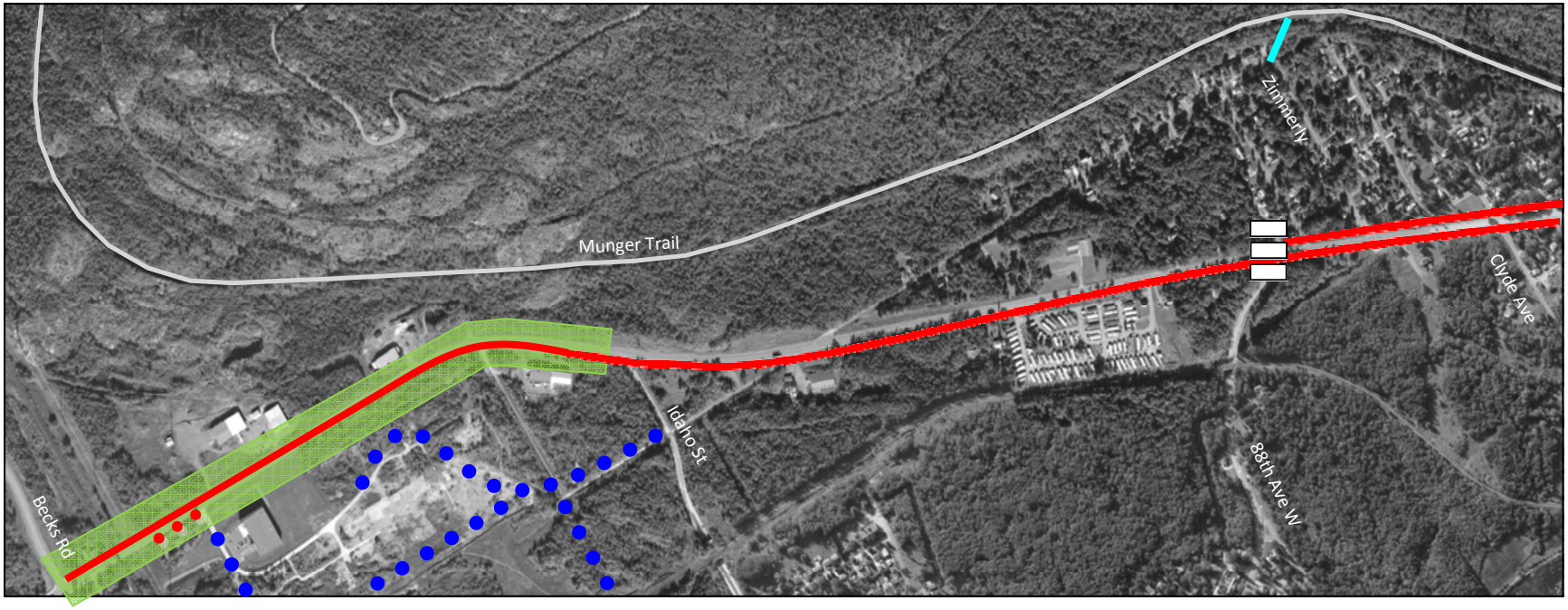
REC

Table 4.2 | Recommended Improvement Plan for Context Zone 1 (Becks Rd to Clyde Ave)

Implementation Timeframe	Recommended Improvements	Map Symbol	Cost Estimate[1]	Implementation Agency
Short Range (2015—2020)	1-a Install sidewalk, curb and gutter (southeastern side)		$500,000	MnDOT
	1-b Paint high-visibility crosswalk		$600	MnDOT
	1-c Develop an interior circulation plan for industrial park		NA	City of Duluth / Developers
	1-d Develop an access management plan to limit and direct the location of additional accesses.		NA	City of Duluth
Mid Range (2020—2025)	1-e Install Right-turn bay at Nick Glumac Drive, designed to accommodate the queuing and turning movements of semi-trailer trucks .		$35,000	City of Duluth
	1-f Create a paved trail link in existing ROW (between Munger Trail and Zimmerly Ave (approx. 500 ft)		$30,000	City of Duluth

1. Estimates in 2013 dollars - includes 20% for design, construction, and contingencies. Estimates do not reflect costs associated with continued maintenance.

Map 4.1 | Recommended Improvement Plan for Context Zone 1 (Becks Rd to Clyde Ave)



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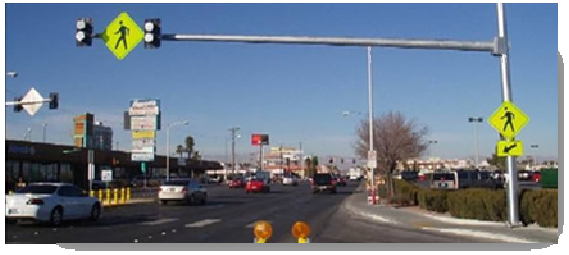


Image source: Safety.FHWA.dot.gov (2013)

Figure 4.9 | Overhead flashing beacons

Because of the wide, four-lane roadway and speeds in excess of 45 mph, an enhanced pedestrian crossings with ped-activated, overhead flashing beacons is recommended for the intersection of Highway 23 and Grand Avenue Place.

Recommendations for Zone 2

Because traffic on Highway 23 is traveling at speeds over 45 mph in Zone 2 and is not subject to stop controls anywhere in the segment, crossing the highway in Zone 2 is a challenge for pedestrians. The intersection of Grand Avenue Place is of particular concern because of sight limitations due to the curvature in the roadway. It is for this reason especially that a pedestrian–activated flashing beacon, placed atop a mast arm over the roadway (Figure 4.9), is recommended for this location (2-c, page 81), as well as a high-visibility crosswalk (2-b) to help delineate the crossing. It is also recommended that the raised centerline median found at the Grand Avenue Place intersection be cut back from the intersection (2-d) to allow for a more level, less obstructed path across the roadway.

Sidewalk is absent on the southeastern side of highway in the segment between the Munger Trail overpass and the Grand Avenue Place intersection. It is recommended that sidewalk be installed there in order to provide sidewalk connection to the bus shelter at Grand Ave Place.

Lastly, three paved connections to the Munger Trail are recommended (2-e). Despite being visible as a roadway overpass, the Munger Trail is not easily accessible in this area. It is recommended that ramp connections be made between the overpass and the sidewalk on both sides of the highway. This will not only allow for access to the trail, but will create a grade-separated crossing opportunity for pedestrians wishing to cross the highway. There is also an opportunity to create a short connection at 93rd Ave W., which will provide Smithville residents who live north of the highway more direct access to the Munger Trail.

REC

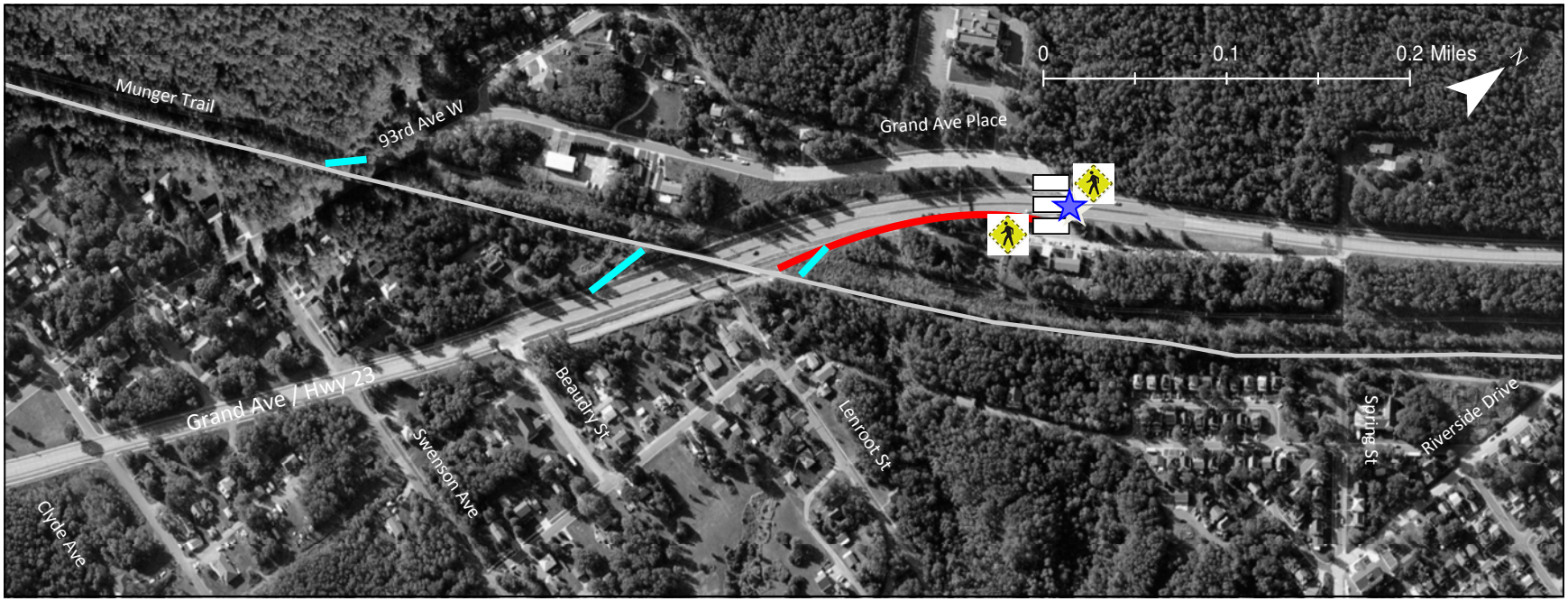
Table 4.3 | Recommended Improvement Plan for Context Zone 2 (Clyde Ave to Grand Ave Place)

Implementation Timeframe	Recommended Improvements	Map Symbol	Cost Estimate[1]	Implementation Agency
Short Range (2015—2020)	2-a Install sidewalk		$25,000	MnDOT
	2-b Paint crossing blocks at Grand Ave Place		$600	MnDOT
	2-c Install a set[2] of pedestrian-activated, high-visibility, flashing crossing signs on overhead mast arm at Grand Ave Place		$100,000	MnDOT
	2-d Remove centerline median from crosswalk area		$200	MnDOT
Mid Range (2020—2025)	2-e Create paved trail links to the Munger Trail		$50,000	City of Duluth

1. Estimates in 2013 dollars - includes 20% for design, construction, and contingencies. Estimates do not reflect costs associated with continued maintenance.

2. Two advance warning signs, plus two ped-activated flashing signs on mast arms, and power supply.

Map 4.2 | Recommended Improvement Plan for Context Zone 2 (Clyde Ave to Grand Ave Place)



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Recommendations for Zone 3

Most of Zone 3 lacks sidewalk, yet year-round recreational activities at the new Spirit Mountain facility are bringing more pedestrian and bike movements to this segment of the highway. Meanwhile, the DTA is reporting greater ridership from the new Spirit Mountain facility and reports people walking and waiting in the roadway. For these reasons, it is recommended that sidewalk be installed on both sides of the highway, as well as along one side of Warwick Street up to the chalet (3-a, page 83).

DTA buses are also experiencing longer waits at Warwick Street due to skiers and bikers loading and unloading equipment. The installation of bus pull-outs are recommended at that location (3-e) to allow buses to get completely out of the way of traffic and to put more space between passing vehicles and riders unloading bikes.

Driver awareness of non-motorized users is a concern in Zone 3, and so pedestrian-activated flashing beacons (3-c) and high visibility crosswalk patterns (3-b) (Figure 4.10) are recommended for the intersections of Riverside Drive and Warwick Street, where there are higher numbers of transit boardings. When flashing, they would alert drivers of a pedestrian's intention to cross. Even when not flashing, they would communicate the message to drivers that pedestrians are significant users of even this more rural segment of the corridor.

Input from stakeholders also indicates that the new Spring Street intersection lacks visibility at night. The installation of street lighting is recommended for that intersection to improve traffic safety there (3-d).

Finally, three paved links to the Munger Trail are also recommended in this segment of the highway (3-f) to improve access to Spirit Mountain and the neighborhoods.

Image source: TheCityFix.com (2013)

Figure 4.10 | Recommended crosswalk patterns

Large block crosswalk designs are recommended for increased visibility, with clear stop bar markings set back from the crossing.

REC

Table 4.4 | Recommended Improvement Plan for Context Zone 3 (Grand Ave Place to 85th Ave W)

Implementation Timeframe	Recommended Improvements	Map Symbol	Cost Estimate[1]	Implementation Agency
Short Range (2015—2020)	3-a Install sidewalk (including excavation & retaining wall)		$420,000	MnDOT/City of Duluth/ Private Partner
	3-b Paint crossing block at Warwick St		$600	MnDOT
	3-c Install two sets[2] of pedestrian-activated, high-visibility, flashing crossing signs at Riverside Drive and Warwick St		$20,000	MnDOT
	3-d Install street lights to improve visibility of Spring Street intersection		$12,000	MnDOT
	3-e Install bus pullouts near the Spirit Mountain entrance		$80,000	City of Duluth / DTA
	3-f Develop an access management plan to help limit and direct the locations of additional accesses in the area.		NA	City of Duluth
Mid Range (2020—2025)	3-g Create paved trail links to the Munger Trail		$60,000	City of Duluth

1. Estimates in 2013 dollars - includes 20% for design, construction, and contingencies. Estimates do not reflect costs associated with continued maintenance.
2. Two advance warning signs, plus two ped-activated flashing signs, and power supply.

Map 4.3 | Recommended Improvement Plan for Context Zone 3 (Grand Ave Place to 85th Ave W)

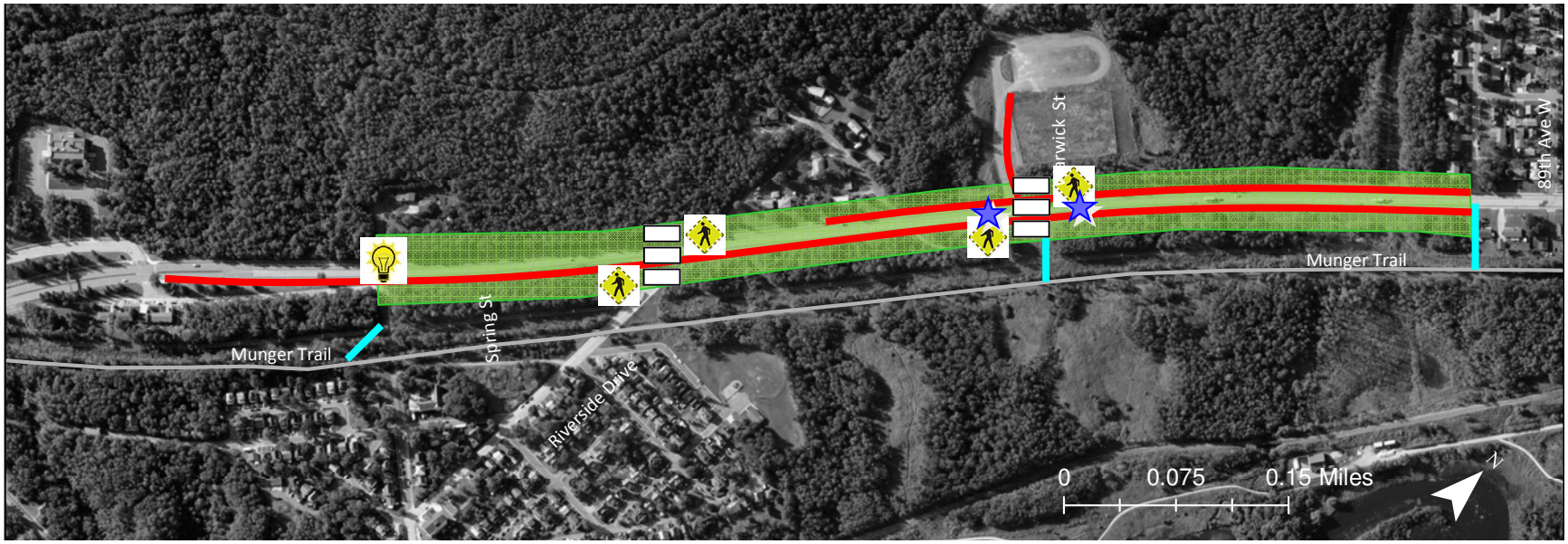

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Image source: RRMdesign.com (2013)

Image source: TheProwersJournal.com (2013)

Figures 4.11 and 4.12 | Trailhead features

72nd Ave W presents an opportunity to create tourism parking with an information kiosk and a gateway monument to the various trails that converge there.

Recommendations for Zone 4

Inefficiencies and potential hazards exist with the current traffic signal serving the zoo entrance at 71st Ave W. This signal is especially important for the DTA's transit operations and for seasonal increases in traffic with events at the zoo. There is interest in seeing 72nd Ave W become the new main entrance for the zoo. This would provide an opportunity to relocate the signal there and reprogram it for longer crossing times (4-d, page 85), ameliorating the current problems at 71st Ave W but also allowing the City of Duluth to capitalize on a number of added opportunities for recreational tourism.

A confluence of the Munger, Western Waterfront, and future Cross City trails occur in the vicinity of 72nd Ave W, and a traffic signal would create a protected crossings for pedestrians, cyclists, and snowmobilers there. The City of Duluth should investigate the feasibility of creating a Park-and-Ride lot with trailhead features (4-e) (Figures 4.11 and 4.12), but also design it to serve as a new turn-around spot for DTA buses. A new, well defined pathway on the other side of the highway (4-g) would also connect this recreational node to the DWP Trail to the northwest.

In the meantime, access to the Munger Trail can be improved for the residents of the Norton Park neighborhood by creating new paved connections between the trail and the highway (4-f), and pedestrian travel in general in Zone 4 would be better served by upgrading and filling in sidewalk gaps on the northern side of the highway and by installing sidewalk on the southern side (4-a).

Lastly, pedestrian safety has long been a concern for seniors living at the St. Eligius Health Center. It is recommended that the flashing pedestrian signs currently at 77th Ave W be replaced with pedestrian-activated signs (4-c) to increase the effectiveness of the flashing beacon.

REC

Table 4.5 | Recommended Improvement Plan for Context Zone 4 (85th Ave W to 72nd Ave W)

Implementation Timeframe	Recommended Improvements	Map Symbol	Cost Estimate	Implementation Agency
Short Range (2015—2020)	4-a Install/replace sidewalk		$150,000	MnDOT
	4-b Paint crossing blocks at 77th Ave W and 72nd Ave W		$1,000	MnDOT
	4-c Install a set of pedestrian-activated, high-visibility, flashing crossing signs at 77th Ave W		$12,000	MnDOT
	4-d Relocate traffic signal to 72nd Ave W; install new signal equipment, and reprogram for longer crossing times.		$250,000	MnDOT
Mid Range (2020—2025)	4-e Expand existing public parking lot; design for bus turnaround; enhance existing trailhead.		$300,000 to $500,000	City of Duluth / DTA
	4-f Create paved trail links to the Munger Trail		$50,000	City of Duluth
	4-g Create a well-defined trail connection to the DWP trail; design for snowmobile use; install way-finding signage		NA	City of Duluth/ Private Partner

Map 4.4 | Recommended Improvement Plan for Context Zone 4 (85th Ave W to 72nd Ave W)

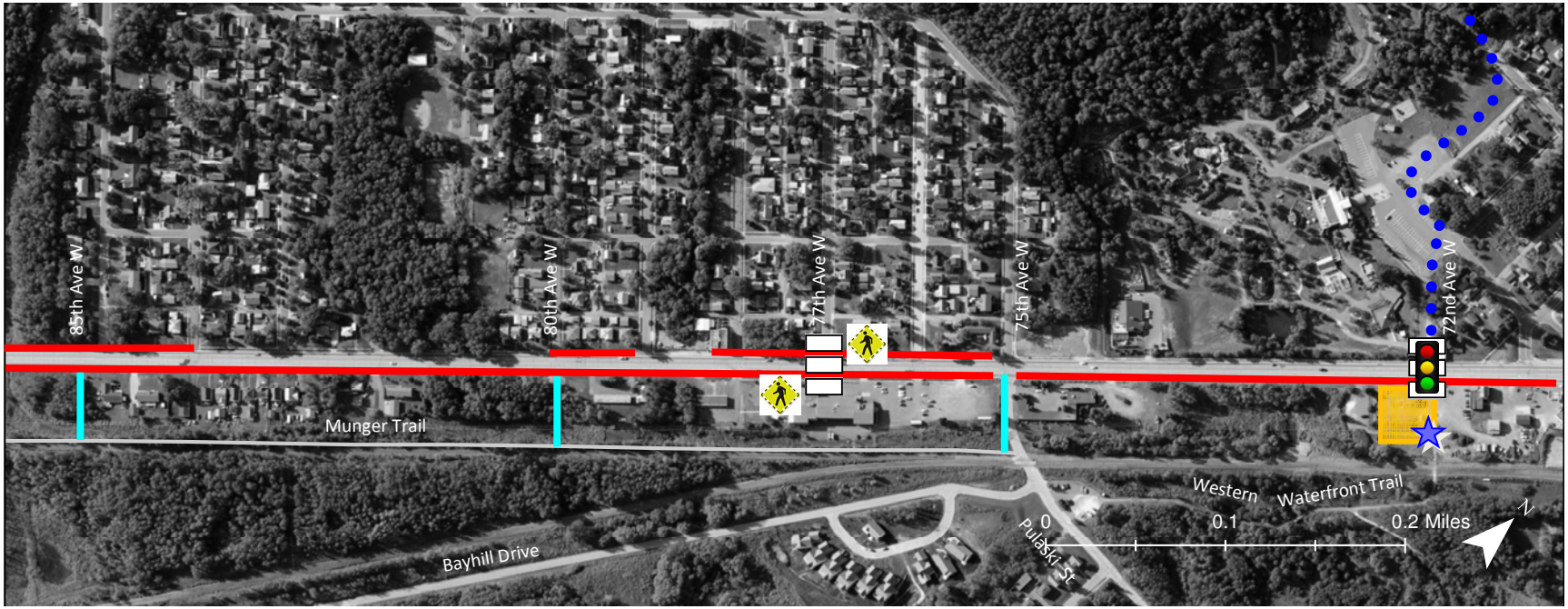

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Image source: FHWA.dot.gov (2013)

Image source: ohiobikeways.net (2013)

Figures 4.13 and 4.14 | Intersection closures

Intersection closures can be accomplished with a combination of raised curb and bollards. Wherever this occurs on Highway 23 / Grand Ave, sidewalk should also be installed.

Recommendations for Zone 5

Based on this zone's traffic volumes and high number of transit boardings, sidewalk should be installed on the south side of the highway and sections of existing sidewalk in poor condition on the north side of the highway should be replaced (5-a, page 87). These improvements should be accompanied by pedestrian ramps and crossing surfaces that are constructed to ADA standards. It is also recommended that the traffic signal at Raleigh Street be upgraded and the current pedestrian phase be lengthened (5-d).

Even though Raleigh Street has a traffic signal to support pedestrian crossings, more pedestrians are crossing at Redruth Street, according to DTA data. It is therefore recommended that this intersection be enhanced with pedestrian-activated flashing beacons (5-c) and high-visibility crosswalk markings (5-b).

The prevalence of angled intersections in Zone 5 do not support safe traffic operations. It is recommended that the City of Duluth and MnDOT plan for and seek out opportunities to address a number of these intersections. One such opportunity is the ample space available to line up Sherburne Street with S 67th Ave W on the south side of the highway (5 -e). Another opportunity is the intersection of 67th Ave W, which is suitable for closure . Freemont Street would also be an intersection suitable for closure if the traffic signal and DTA turnaround gets moved to 72nd Ave W. Any street closures should be done by installing curb and sidewalk across the intersections at those locations (Figures 4.13 and 4.14).

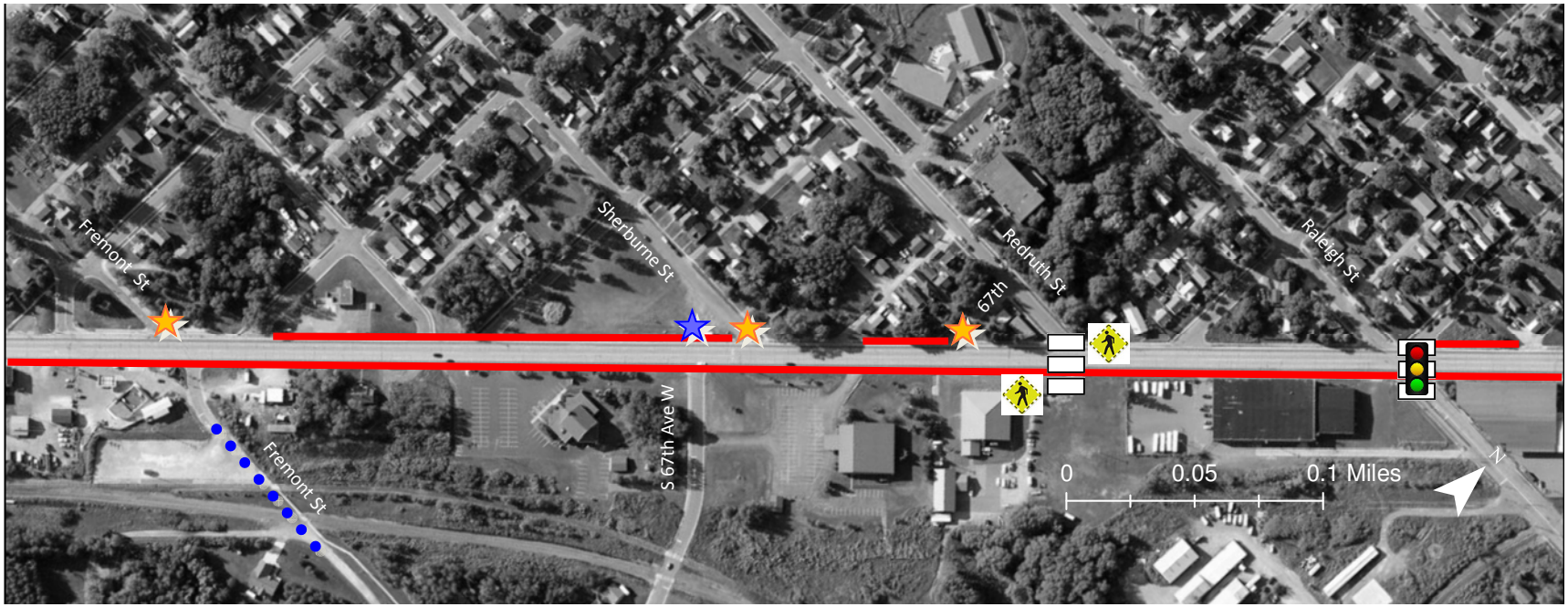
Freemont Street also represents an opportunity for a future paved trail connection south of the highway (5-g). Creating this link would provide access to the Munger Trail, Western Waterfront Trail, and future Cross City Trail.

REC

Table 4.6 | Recommended Improvement Plan for Context Zone 5 (72nd Ave W to Raleigh St)

Implementation Timeframe	Recommended Improvements	Map Symbol	Cost Estimate	Implementation Agency
Short Range (2015—2020)	5-a Install/replace sidewalk; upgrade curb ramps		$150,000	MnDOT
	5-b Paint crossing blocks at Redruth St and Raleigh St		$600	MnDOT
	5-c Install a set of pedestrian-activated, high-visibility, flashing crossing signs at Redruth St		$12,000	MnDOT
	5-d Install new signal equipment; lengthen pedestrian crossing times		$250,000	MnDOT
Mid Range (2020—2025)	5-e Realign Sherburne St		$200,000	City of Duluth
	5-f Close intersections; install curb and sidewalk		$150,000	City of Duluth
	5-g Create a well-defined trail connection to the Cross City Trail and Western Waterfront trail; install wayfinding signage		$30,000	City of Duluth/ Private Partner

Map 4.5 | Recommended Improvement Plan for Context Zone 5 (72nd Ave W to Raleigh St)



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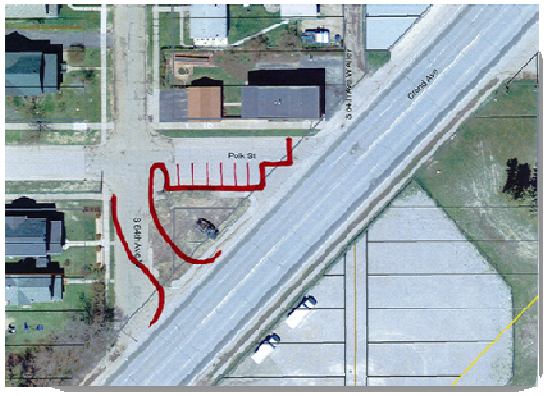

Image source: City of Duluth (2013)

Figures 4.15 | Polk Street closure concept sketch

Closing Polk Street could create parking spaces for retail businesses in the area.

Recommendations for Zone 6

Zone 6 is the segment with presumably the most pedestrian traffic, yet 73% percent of the area's sidewalks are in poor condition. It is recommended that this sidewalk be replaced and that all curb ramps be brought into compliance with ADA standards (6-a, page 89).

Based on transit boarding numbers, the intersection of 63rd Ave W has been identified as one of the busiest pedestrian crossings in the corridor, and stakeholders report that this intersection may often be challenging for transit riders trying to catch their buses. For these reasons, pedestrian-activated flashing beacons (6-c) and high-visibility crosswalks (6-b) are recommended for this location. The higher traffic volumes and speeds of vehicles coming off I-35 to the north, as well as a potential for drivers jockeying for lanes and speeding up to beat the traffic signal at Raleigh Street, might create unsafe situations frequently enough to justify mounting flashing beacons over the roadway.

It is also recommended that MnDOT and the City of Duluth investigate the feasibility of closing three intersections on the northern side of the highway (6-d) to address inefficiencies and potential hazards related to the prevalence of angled intersections in Zone 6. Closing 65th Ave W will convert a 5-legged intersection to a 4-legged intersection and improve conditions for the signal operations there. Closing the Polk Street intersection would both reduce access density and create an opportunity to provide parking for businesses there (6-e) (Figure 4.15). The closure of 62 Ave W is recommended for safety. That intersection is experiencing higher crash severity rates than should be expected, and patterns in the crash records suggest that the speeds of vehicles coming off of the I-35 ramp just to the north may not be mixing well with turning movements there. It is recommended that all three street closures be accomplished with the installation of curb and sidewalk.

REC

Table 4.7 | Recommended Improvement Plan for Context Zone 6 (Raleigh St to 62nd Ave W)

Implementation Timeframe	Recommended Improvements	Map Symbol	Cost Estimate[1]	Implementation Agency
Short Range (2015—2020)	6-a Install/replace sidewalk; upgrade curb ramps		$30,000	MnDOT
	6-b Paint crossing blocks at Raleigh St		$600	MnDOT
	6-c Install a set[2] of pedestrian-activated, high-visibility, flashing crossing signs on overhead mast arm at 63rd Ave W		$100,000	MnDOT
Mid Range (2020—2025)	6-d Close intersections; install curb and sidewalk		$200,000	City of Duluth
	6-e Create parking area for businesses		$5,000	City of Duluth/ Private Partner

1. Estimates in 2013 dollars - includes 20% for design, construction, and contingencies. Estimates do not reflect costs associated with continued maintenance.

2. Two advance warning signs, plus two ped-activated flashing signs on mast arms, and power supply.

Map 4.6 | Recommended Improvement Plan for Context Zone 6 (Raleigh St to 62nd Ave W)

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Appendix A: Methodologies

The following pages contain descriptions of the type of data and various analyses used in this study. Explanations of how or where the various data were collected, as well as justification for why and how the data were used.

Traffic forecasts

Trend lines based on historical annual average daily traffic (AADT) volumes dating back to 1994 were used to produce 20-year projections of future traffic on Highway 23. These straight-line projections were then compared with a forecast generated via the MIC area transportation demand model, which is based on demographic and employment trends, as opposed to changes in AADT. From these two projections, a mid-range forecast was also generated. Together, these three trend lines represent a range of the potential increase in daily traffic on Highway 23 over the next 20 years. The variability of this range is depicted in Figure A.1 below.

In addition to developing traffic forecasts based on trend lines, the traffic impacts of various development proposals and economic development initiatives were also estimated. For this purpose, trip-generation rates as developed by the Institute of Traffic Engineers (ITE) were used to estimate the effects of a "full-build" scenario for each of these proposals. The trip-generation rates associated with each full-build scenario were carried across the six context zones proportionate to the existing and projected number of households within each zone and beyond the study area.

The total trip generation of these development proposals are shown in Table A.1 and Table A.2 on the

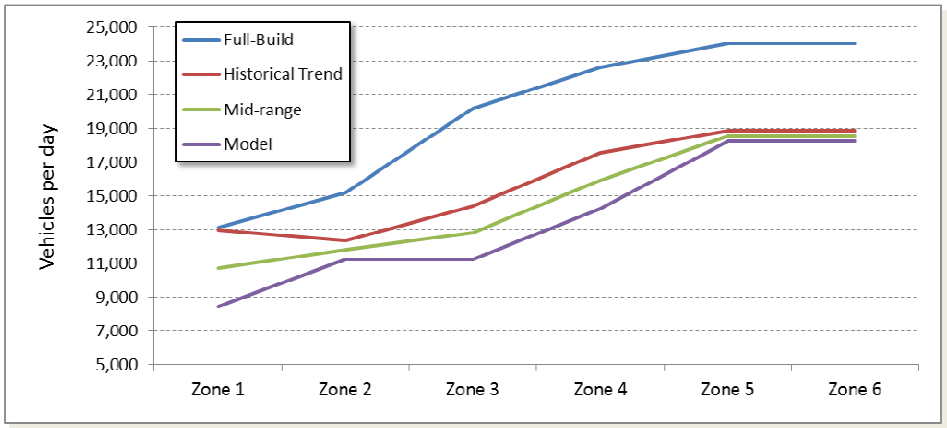

Figure A.1 | Range of future traffic - forecast year 2040

A range of 20-year traffic forecasts were considered during this study. The lowest projected traffic is based on demographic and employment trends. The highest projected traffic is based on full build-out scenarios of existing development proposals for the corridor.

Table A.1 lists three sites that have been identified as locations for future manufacturing and light-industry operations. Table A.2 shows estimated uses based on commercial and residential development proposals the City of Duluth has received in recent years. Those proposals were general and these estimates, therefore, do not necessarily reflect the eventual sizes or specific developments that may ultimately occur. The estimates were developed in order to assess a full build out scenario based on those general proposals.

The full-build estimates of the three industrial sites in Table A.1 were derived using an average plant size of

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	Bldg Gross Sq Ft	Daily Vehicle Trip Rate (per 1,000 GFA)	Daily Volume (ADT)	PM Peak (15.5%)
Atlas Site (Zone 1)	400,000	6.97	2,788	432
Redruth Site (Zone 5)	100,000	6.97	697	108
US Steel Site (Zone 1)	800,000	6.97	5,576	864
TOTAL	**1,300,000**	***NA***	**9,061**	**1,404**

Table A.1 | Traffic estimates - new industry[1]

1.3 million square feet of floor space has been estimated for future industrial development along Highway 23. A daily rate of 6.97 vehicle trips was applied per 1,000 ft^2 of estimated floor area.

Warwick St - Southeast Side of Hwy 23						
Land Use	ITE No.	Trip Rate	Per Unit	Daily Trips	Pass-By Reduction Factor	TOTAL DAILY
MF Housing (28 units)	221	6.59	*1 dwelling*	185	1.00	185
Gas Station (12 pumps)	945	162.78	*1 pump*	1,953	0.66	1,289
Bank with drive-thru (6270 sq ft)	912	148.15	*1,000 sq ft*	929	0.47	437
Retail (11,760 sq ft; 6 shops)	814	48.74	*1,000 sq ft*	573	0.34	195
Office (20,000 sq ft)	710	11.01	*1,000 sq ft*	220	1.00	220
Retail (19,600; 10 shops)	820	42.94	*1,000 sq ft*	842	0.34	286
Office (40,000 sq ft; 2 buildings)	710	11.01	*1,000 sq ft*	440	1.00	440
MF Housing (48 units)	221	6.59	*1 dwelling*	316	1.00	316
Restaruant (8,000 sq ft)	932	127.15	*1,000 sq ft*	1,017	0.43	437
Hotel (80 rooms, 90 parking spaces)	310	8.92	*1 room*	714	1.00	714
Fast food Drive-Thru (2,000 sq ft)	934	496.12	*1,000 sq ft*	992	0.50	496
Coffee Shop (2,000 sq ft)*	936*	866	*1,000 sq ft*	1,732	0.50	866
Townhomes (6 units)	230	6.65	*1 dwelling*	40	1.00	40
MF Housing (48 units)	221	6.59	*1 dwelling*	316	1.00	316
Pharmacy (e.g. Walgreens, 14,385 sq ft)	881	88.16	*1,000 sq ft*	1,268	0.49	621
					SUBTOTAL	*6,859*
Spring St - Northwest Side of Hwy 23						
Land Use	ITE No.	Trip Rate	Per Unit	Daily Trips	Pass-By Reduction Factor	TOTAL DAILY
Low Density SF Res (35 units)	210	9.57	*1 unit*	334.95	1.00	335
Villas (40 small units)	260	3.16	*1 unit*	126.4	1.00	126
Villas (20 large units units)	260	3.16	*1 unit*	63.2	1.00	63
Ski Lodge (36 units)	260	3.16	*1 room*	113.76	1.00	114
					SUBTOTAL	*638*
Hulett Ave - Southeast Side of Hwy 23						
Low Density SF Res (75 units)	210	9.57	*1 unit*	717.75	1.00	718
					TOTAL	**8,215**

Table A.2 | Traffic estimates - new commercial and residential development[1]

A "full-build" scenario was devised based on development proposals that have been brought to the City of Duluth in recent years. An attempt was made to fill all buildable acreage with the types of land uses identified in those proposals, and daily trip rates developed by ITE were applied according to those uses.

1. Source: Trip Generation, Institute of Transportation Engineers, 7th Edition (2003).

50,000 square feet and multiplying that by estimates of the total gross square feet available that were provided by the Duluth Economic Development Administration (DEDA).

Traffic forecasted to occur as a result of these full-build scenarios were then determined by applying the ITE trip-rates that are also shown in the tables. The result is that an estimated addition of 1,404 daily trips will occur on Highway 23 as a result of fully occupying the three industrial sites, and an additional 8,250 trips will occur from the three commercial/residential developments.

The total forecasted trips were then added to the socioeconomic-based forecast (MIC model) and allocated directionally and proportionally across the six zones in the study area based on Longitudinal Employer -Household Dynamics (LEHD) data published by the Census Bureau. The allocation scheme is shown in Table A.3 below.

State	Municipality	# of People Employed in Duluth	% of People Employed in Duluth	Approach Direction	From West	From East
Minnesota	City of Duluth (excl. Gary / New Duluth)*	24058	63.1%	East via Grand Ave		63.1%
	*Gary / New Duluth**	624	1.6%	West via Becks Rd and Hwy 23	1.6%	
	City of Hermantown	1793	4.7%	North & West via Becks Rd and Hwy 23	2.7%	2.0%
	City of Proctor	759	2.0%	North & West via Becks Rd and Hwy 23	2.0%	
	City of Cloquet/Thompson Township	2087	5.5%	From the North & West via Becks Rd and STH 23	5.5%	
	Scanlon/Twin Lakes Township		0.0%			
	Carlton/Thompson/Wrenshall		0.0%			
	Silver Brook Township		0.0%			
	City of Two Harbors	439	1.2%	East via Grand Ave		1.2%
	Canosia Township	569	1.5%	North & West via Becks Rd and Hwy 23	1.5%	
	Duluth Township	478	1.3%	East via Grand Ave		1.3%
	Grand Lake Township	550	1.4%	North & West via Becks Rd and Hwy 23	1.4%	
	Lakewood Township	646	1.7%	East via Grand Ave		1.7%
	Midway Township	325	0.9%	North & West via Becks Rd and Hwy 23	0.9%	
	Rice Lake Township	1219	3.2%	East via Grand Ave		3.2%
	Solway Township	360	0.9%	North & West via Becks Rd and Hwy 23	0.9%	
Wisconsin	City of Superior	3564	9.3%	East via US Hwy 2, I-35, and Grand Ave		9.3%
	Village of Oliver	71	0.2%	South and West via Hwy 39 and Hwy 23	0.2%	
	Village of Superior	67	0.2%	South and West via Hwy 39 and Hwy 23	0.2%	
	Town of Lakeside	68	0.2%	East via US Hwy 2, I-35, and Grand Ave		0.2%
	Town of Parkland	188	0.5%	East via US Hwy 2, I-35, and Grand Ave		0.5%
	Town of Superior	286	0.7%	South and West via Hwy 39 and Hwy 23	0.7%	
	Total	*38151*	*100.0%*		*17.6%*	*82.4%*

Source: US Census Bureau, Longitudinal Employer-Household Dynamics (LEHD) data (2010)

Table A.3 | Employment splits

Traffic projections based on proposed future developments were allocated across the six zones in the study area according to census-based origin and destination data.

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Transit riders and pedestrian estimates

The Duluth Transit Authority (DTA) collected passenger boarding and alighting on all its routes in 2008. This is the most recent data set for transit stops in Duluth and Grand Avenue in particular, and therefore was chosen to represent transit usage within in the study area. The data represents the average daily boardings and/or alightings at each bus stop. For the purpose of this study, stops on opposite sides of the highway were considered as one, and their boardings and alightings were summed together as one representative number for that location along the highway, as illustrated in Figure A.2.

Pedestrian count data is more limited for the City of Duluth. No pedestrian counts exist for Highway 23, and conducting such counts was beyond the timeframe and resources of this study. Therefore, the transit stop data was used as proxy data for assessing the level of pedestrian use along the highway. Although this data admittedly underrepresents pedestrian travel along the corridor, it provides a relative comparison of minimal pedestrian use in each of the six zones of the study corridor. Where there is a lot of transit boardings and alightings, for instance, it can be assumed that there is a lot of movement along the sidewalk segments and across the highway at those locations.

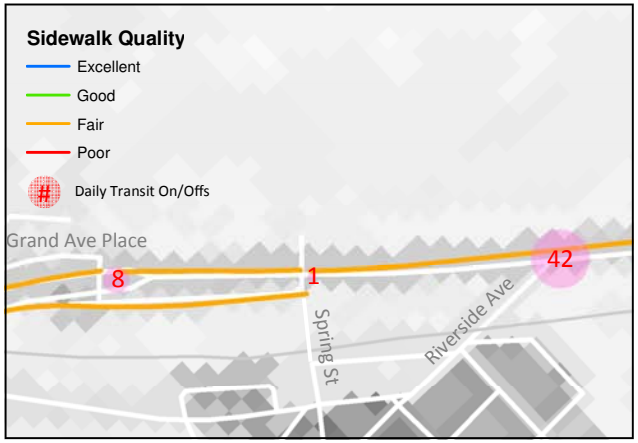

Figure A.2 | Transit boarding and alighting data

Passenger on/off counts collected by the DTA were used to study transit use and pedestrian patterns along Highway 23. This data represents the annual average daily boardings and alightings. Counts for stops on opposite sides of the street were summed together and represented as one bus stop location along the highway.

Multimodal LOS

In transportation planning, level of service (LOS) has traditionally been a measure of the vehicle capacity of a roadway. However, with the increasing understanding that roadway environments serve the movements of a variety of different users, the 2010 Highway Capacity Manual (HCM) has been expanded to include a collection of LOS measures for cyclists, pedestrians, and transit riders in addition to automobiles. These new measures go beyond the notion of capacity to reflect the safety, ease, and comfort of using a roadway from the perspectives of these other user groups. They are meant to be combined as a measure of multimodal level of service (mmLOS) to help evaluate "complete streets" or context sensitive design alternatives for a particular roadway.

For this study, the methodology developed from the NCHRP 03-07 research effort and outlined in NCHRP Report No. 616: *Multimodal Level of Service Analysis for Urban Streets* was used to derive individual LOS scores representative of conditions found in each of the six context zones being studied. These measures are identified in Table A.4 at right.

To help calculate these scores, a spreadsheet template developed by Richard Dowling Associates was used. This template calculates LOS scores per one half of the roadway. Therefore, each of the six context zones were qualitatively evaluated to determine which stretch of the highway segment, and which side of the highway would be most representative in terms of a single mmLOS evaluation. Generally, if sidewalk was present on one side of the highway, that side was chosen for evaluation. Figure A.3 through A.14 found in the following pages show the locations and parameters used in the mmLOS scoring.

Table A.4 | Factors influencing LOS scores

Measures of the following factors were used in calculating the four individual modal LOS scores.

Auto LOS

- Demand (volumes) and available capacity
- Number of lanes
- Posted speed
- Number of stops per mile
- Interference from other users (modes)

Transit LOS

- Frequency of service
- Average wait time
- Pedestrian LOS scores
- Passenger load
- Number of bus stops per mile

Pedestrian LOS

- Traffic volume and speed
- Buffer separation
- Presence and width of sidewalk
- Crossing difficulty
- *Pedestrian density*

Bicycle LOS

- Traffic volume and speed
- Lateral separation
- Percent of traffic that is heavy trucks
- Pavement quality
- Number of driveways per mile

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NCHRP 3-70 Multimodal LOS

			Range Check	
ADT	8,400	(>=0 vpd)	OK	Yes
% HV	4%	(0-100%)	OK	No
Buses/hr	1	(>=0 bph)	OK	No
Peds/hr	1	(>=0 pph)	OK	If Very High

Ped LOS	LOS	LOS #
Pseg	D	4.07
Pint	D	3.85
Model 1	E	4.50
Model 2	F	5.14
RCDF 1	A	1.20
RCDF 2	A	1.20

Mode	LOS	LOS #	v/c
Auto	B	2.38	0.3356
Transit	E	4.53	
Bicycle	E	3.73	
Pedestrian	E	4.50	

ROW 140 ft

West side — East side

Street Cross-Section

Sidewalk	Buffer	Parking	Bike Ln	Trav. Lane	Trav. Lane	Trav. Lane	Median	Trav. Lane	Trav. Lane	Trav. Lane	Bike Ln	Parking	Buffer	Sidewalk	Range Checks
0	0	6	0	0	11	11	0	11	11	0	0	6	0	0	OK

(all entries in feet, enter zero for non-existant lanes)

Street : Grand Ave (STH 23)
Limits: Commonwealth Ave to 88th Ave W (representing Zone 1)

Important?	Key Parameters			Range Checks
Yes	Signal Spacing:	10,560	(200-10,560 ft.)	OK
slight	Progression Quality:	5	(1=poor, 6=excellent)	OK
slight	Speed Limit	45	(15-70 mph)	OK
no	Bus Stops w. Shelter:	0%	(0-100%)	OK
no	Pavement Quality:	3	(1=poor, 5=excellent)	OK

Additional Parameters

Auto LOS Inputs		Important?
Peaking Factor (k)	0.09	Yes
Directional Factor (d)	0.64	Yes
Peak Hr. Fac. (PHF)	0.89	Yes
Adj. Sat Flow (vphgl)	1800	Yes
Through g/c	0.45	slight
Cycle Length (sec)	100	slight

Pedestrian LOS Inputs		Important?
% Parking Occ.	0%	Yes
Barrier (Yes/No)	No	Yes
RTOR+Perm LT (vph)	180	slight
X-Street Vol. (vph)	840	Yes
X-Street Speed (mph)	50	Yes
X-Street Lanes (#)	4	slight
Right Turn Islands (#)	0	slight
X-Street Walk g/c	0.10	Potential

Transit LOS Inputs		Important?
% On Time	90%	No
% Stops w. Benches	0%	No
Load Factor (p/seat)	0.28	No
CBD (Yes/No)	No	No
Bus Stops/segment	3	No
Delay/Bus Stop (sec)	20	No

Bicycle LOS Inputs		Important?
Unsig Conflicts/Mile	10	No

Figure A.3 | Zone 1 multimodal LOS scores

Because of a combination of vehicle speeds, low transit frequency, and a lack of continuous sidewalk and space for cycling, the non-auto LOS scores for Zone 1 are poorer than a LOS rating of "D".

Figure A.4 | Zone 1 mmLOS analysis segment

The eastern side of the 0.9 mile segment of Highway 23 between Commonwealth Ave and 88th Ave W was chosen to represent the mmLOS scores of Zone 1.

Figure A.5 | Zone 2 multimodal LOS scores

The presence of sidewalk, center median give Zone 2 a better pedestrian LOS score. However, the absence of shoulder space results in a poor bike LOS rating.

NCHRP 3-70 Multimodal LOS

			Range Check	
ADT	10,800	(>=0 vpd)	OK	Yes
% HV	4%	(0-100%)	OK	No
Buses/hr	1	(>=0 bph)	OK	No
Peds/hr	2	(>=0 pph)	OK	If Very High

Ped LOS	LOS	LOS #
Pseg	C	2.96
Pint	D	3.80
Model 1	D	3.66
Model 2	D	3.89
RCDF 1	A	1.08
RCDF 2	A	1.03

Mode	LOS	LOS #	v/c
Auto	B	2.17	0.4315
Transit	E	4.29	
Bicycle	E	4.14	
Pedestrian	D	3.66	

ROW 250 ft

South Side — North Side

Street Cross-Section

Sidewalk	Buffer	Parking	Bike Ln	Trav. Lane	Trav. Lane	Trav. Lane	Median	Trav. Lane	Trav. Lane	Trav. Lane	Bike Ln	Parking	Buffer	Sidewalk	Range Checks
5	15	0	0	0	12	12	8	12	12	0	0	0	15	5	OK

(all entries in feet, enter zero for non-existant lanes)

Street :	Grand Ave (STH 23)
Limits:	Beaudry St to Grand Ave Place (representing Zone 2)

Important?	Key Parameters			Range Checks
Yes	Signal Spacing:	10,560	(200-10,560 ft.)	OK
slight	Progression Quality:	5	(1=poor, 6=excellent)	OK
slight	Speed Limit	45	(15-70 mph)	OK
no	Bus Stops w. Shelter:	50%	(0-100%)	OK
no	Pavement Quality:	3	(1=poor, 5=excellent)	OK

Additional Parameters

Auto LOS Inputs		Important?
Peaking Factor (k)	0.09	Yes
Directional Factor (d)	0.64	Yes
Peak Hr. Fac. (PHF)	0.89	Yes
Adj. Sat Flow (vphgl)	1800	Yes
Through g/c	0.45	slight
Cycle Length (sec)	100	slight

Pedestrian LOS Inputs		Important?
% Parking Occ.	0%	Yes
Barrier (Yes/No)	No	Yes
RTOR+Perm LT (vph)	0	slight
X-Street Vol. (vph)	1080	Yes
X-Street Speed (mph)	45	Yes
X-Street Lanes (#)	4	slight
Right Turn Islands (#)	0	slight
X-Street Walk g/c	0.00	Potential

Transit LOS Inputs		Important?
% On Time	90%	No
% Stops w. Benches	0%	No
Load Factor (p/seat)	0.28	No
CBD (Yes/No)	No	No
Bus Stops/segment	2	No
Delay/Bus Stop (sec)	20	No

Bicycle LOS Inputs		Important?
Unsig Conflicts/Mile	6.7	No

Figure A.6 | Zone 2 mmLOS analysis segment

The eastern side of the 0.3 mile segment of Highway 23 between Beaudry St and Grand Ave Place was chosen to represent the mmLOS scores of Zone 2.

NCHRP 3-70 Multimodal LOS

			Range Check	
ADT	11,500	(>=0 vpd)	OK	Yes
% HV	4%	(0-100%)	OK	No
Buses/hr	1	(>=0 bph)	OK	No
Peds/hr	2	(>=0 pph)	OK	If Very High

Ped LOS	LOS	LOS #
Pseg	D	4.11
Pint	D	3.92
Model 1	E	4.53
Model 2	F	5.19
RCDF 1	A	1.20
RCDF 2	A	1.20

Mode	LOS	LOS #	v/c
Auto	B	2.38	0.4594
Transit	E	4.66	
Bicycle	E	3.78	
Pedestrian	E	4.53	

ROW 100 ft

South Side — North Side

Street Cross-Section

Sidewalk	Buffer	Parking	Bike Ln	Trav. Lane	Trav. Lane	Trav. Lane	Median	Trav. Lane	Trav. Lane	Trav. Lane	Bike Ln	Parking	Buffer	Sidewalk	Range Checks
0	0	4	0	0	12	12	0	12	12	0	0	4	0	0	OK

(all entries in feet, enter zero for non-existant lanes)

Street : Grand Ave (STH 23)
Limits: Bessemer St to 85th Ave W (representing Zone 3)

Important?	Key Parameters			Range Checks
Yes	Signal Spacing:	10,560	(200-10,560 ft.)	OK
slight	Progression Quality:	5	(1=poor, 6=excellent)	OK
slight	Speed Limit	35	(15-70 mph)	OK
no	Bus Stops w. Shelter:	0%	(0-100%)	OK
no	Pavement Quality:	3	(1=poor, 5=excellent)	OK

Additional Parameters

Auto LOS Inputs		Important?
Peaking Factor (k)	0.09	Yes
Directional Factor (d)	0.64	Yes
Peak Hr. Fac. (PHF)	0.89	Yes
Adj. Sat Flow (vphgl)	1800	Yes
Through g/c	0.45	slight
Cycle Length (sec)	100	slight

Pedestrian LOS Inputs		Important?
% Parking Occ.	0%	Yes
Barrier (Yes/No)	No	Yes
RTOR+Perm LT (vph)	0	slight
X-Street Vol. (vph)	1150	Yes
X-Street Speed (mph)	45	Yes
X-Street Lanes (#)	4	slight
Right Turn Islands (#)	0	slight
X-Street Walk g/c	0.00	Potential

Transit LOS Inputs		Important?
% On Time	90%	No
% Stops w. Benches	0%	No
Load Factor (p/seat)	0.28	No
CBD (Yes/No)	No	No
Bus Stops/segment	3	No
Delay/Bus Stop (sec)	20	No

Bicycle LOS Inputs		Important?
Unsig Conflicts/Mile	7.5	No

Figure A.7 | Zone 3 multimodal LOS scores

Low transit frequency and lack of shoulder space for cycling lead to poor transit and bike LOS scores, while lack of sidewalk is the main factor leading to the low pedestrian LOS rating.

Figure A.8 | Zone 3 mmLOS analysis segment

The western side of the 0.4 mile segment of Highway 23 between Bessemer St and 85th Ave W was chosen to represent the mmLOS scores of Zone 3.

Figure A.9 | Zone 4 multimodal LOS scores

The minimal shoulder space and higher number of unsignalized intersections per mile lead to a bike LOS rating of "F" Zone 4. The infrequent transit service and 4-lane highway continue to produce transit LOS and pedestrian LOS ratings of "E".

NCHRP 3-70 Multimodal LOS

			Range Check	
ADT	15,500	(>=0 vpd)	OK	Yes
% HV	4%	(0-100%)	OK	No
Buses/hr	1	(>=0 bph)	OK	No
Peds/hr	4	(>=0 pph)	OK	If Very High

Ped LOS	LOS	LOS #
Pseg	C	3.32
Pint	E	4.88
Model 1	E	4.48
Model 2	F	5.11
RCDF 1	A	1.20
RCDF 2	A	1.20

Mode	LOS	LOS #	v/c
Auto	B	2.38	0.6192
Transit	E	4.65	
Bicycle	F	4.27	
Pedestrian	E	4.48	

ROW 100 ft

South side — North side

Street Cross-Section

Sidewalk	Buffer	Parking	Bike Ln	Trav. Lane	Trav. Lane	Trav. Lane	Median	Trav. Lane	Trav. Lane	Trav. Lane	Bike Ln	Parking	Buffer	Sidewalk	Range Checks
0	0	4	0	0	12	12	0	12	12	0	0	4	2	5	OK

(all entries in feet, enter zero for non-existant lanes)

Street : Grand Ave (STH 23)
Limits: 77th Ave W to 75th Ave W (representing Zone 4)

Important?	Key Parameters			Range Checks
Yes	Signal Spacing:	10,560	(200-10,560 ft.)	OK
slight	Progression Quality:	5	(1=poor, 6=excellent)	OK
slight	Speed Limit	35	(15-70 mph)	OK
no	Bus Stops w. Shelter:	0%	(0-100%)	OK
no	Pavement Quality:	3	(1=poor, 5=excellent)	OK

Additional Parameters

Auto LOS Inputs		Important?
Peaking Factor (k)	0.09	Yes
Directional Factor (d)	0.64	Yes
Peak Hr. Fac. (PHF)	0.89	Yes
Adj. Sat Flow (vphgl)	1800	Yes
Through g/c	0.45	slight
Cycle Length (sec)	100	slight

Pedestrian LOS Inputs		Important?
% Parking Occ.	0%	Yes
Barrier (Yes/No)	No	Yes
RTOR+Perm LT (vph)	100	slight
X-Street Vol. (vph)	1473	Yes
X-Street Speed (mph)	50	Yes
X-Street Lanes (#)	4	slight
Right Turn Islands (#)	0	slight
X-Street Walk g/c	0.10	Potential

Transit LOS Inputs		Important?
% On Time	90%	No
% Stops w. Benches	0%	No
Load Factor (p/seat)	0.28	No
CBD (Yes/No)	No	No
Bus Stops/segment	3	No
Delay/Bus Stop (sec)	20	No

Bicycle LOS Inputs		Important?
Unsig Conflicts/Mile	19.9	No

Figure A.10 | Zone 4 mmLOS analysis segment

The western side of the 0.1 mile segment of Highway 23 between 77th Ave W and 75th Ave W was chosen to represent the mmLOS scores of Zone 4.

NCHRP 3-70 Multimodal LOS

			Range Check	
ADT	16,500	(>=0 vpd)	OK	Yes
% HV	4%	(0-100%)	OK	No
Buses/hr	4	(>=0 bph)	OK	No
Peds/hr	5	(>=0 pph)	OK	If Very High

Ped LOS	LOS	LOS #
Pseg	C	3.40
Pint	E	4.25
Model 1	E	4.35
Model 2	E	4.93
RCDF 1	A	1.20
RCDF 2	A	1.20

Mode	LOS	LOS #	v/c
Auto	B	2.38	0.6592
Transit	A	0.54	
Bicycle	F	4.81	
Pedestrian	E	4.35	

ROW 80 ft

South side — North side

Street Cross-Section

Sidewalk	Buffer	Parking	Bike Ln	Trav. Lane	Trav. Lane	Trav. Lane	Median	Trav. Lane	Trav. Lane	Trav. Lane	Bike Ln	Parking	Buffer	Sidewalk	Range Checks
0	0	4	0	0	12	12	0	12	12	0	0	4	2	5	OK

(all entries in feet, enter zero for non-existant lanes)

Street : Grand Ave (STH 23)
Limits: 71st Ave W to 69th Ave W (representing Zone 5)

Important?	Key Parameters			
Yes	Signal Spacing:	10,560	(200-10,560 ft.)	OK
slight	Progression Quality:	5	(1=poor, 6=excellent)	OK
slight	Speed Limit	35	(15-70 mph)	OK
no	Bus Stops w. Shelter:	0%	(0-100%)	OK
no	Pavement Quality:	3	(1=poor, 5=excellent)	OK

Additional Parameters

Auto LOS Inputs		Important?
Peaking Factor (k)	0.09	Yes
Directional Factor (d)	0.64	Yes
Peak Hr. Fac. (PHF)	0.89	Yes
Adj. Sat Flow (vphgl)	1800	Yes
Through g/c	0.45	slight
Cycle Length (sec)	100	slight

Pedestrian LOS Inputs		Important?
% Parking Occ.	0%	Yes
Barrier (Yes/No)	No	Yes
RTOR+Perm LT (vph)	30	slight
X-Street Vol. (vph)	1418	Yes
X-Street Speed (mph)	42	Yes
X-Street Lanes (#)	4	slight
Right Turn Islands (#)	0	slight
X-Street Walk g/c	0.10	Potential

Transit LOS Inputs		Important?
% On Time	90%	No
% Stops w. Benches	0%	No
Load Factor (p/seat)	0.48	No
CBD (Yes/No)	No	No
Bus Stops/segment	2	No
Delay/Bus Stop (sec)	20	No

Bicycle LOS Inputs		Important?
Unsig Conflicts/Mile	35	No

Figure A.11 | Zone 5 multimodal LOS scores

The high traffic volumes, minimal shoulder width, and high density of non signalized access points result in an "F" rating for cycling. The high volumes, minimal buffer space, and wide crossing distance across four-lanes of traffic lead to a poor pedestrian LOS rating of "E".

Figure A.12 | Zone 5 mmLOS analysis segment

The western side of the 0.2 mile segment of Highway 23 between 71st Ave W and 69th Ave W was chosen to represent the mmLOS scores of Zone 5.

Figure A.13 | Zone 6 multimodal LOS scores

High traffic volumes, minimal shoulder width, and high density of non signalized access points result in an "F" rating for cycling. The high volumes, minimal buffer space, and wide crossing distance across four-lanes of traffic lead to a pedestrian LOS rating of "E".

NCHRP 3-70 Multimodal LOS

			Range Check	
ADT	16,500	(>=0 vpd)	OK	Yes
% HV	4%	(0-100%)	OK	No
Buses/hr	4	(>=0 bph)	OK	No
Peds/hr	5	(>=0 pph)	OK	If Very High

Ped LOS	LOS	LOS #
Pseg	C	3.40
Pint	E	4.57
Model 1	E	4.43
Model 2	F	5.04
RCDF 1	A	1.20
RCDF 2	A	1.20

Mode	LOS	LOS #	v/c
Auto	B	2.38	0.6592
Transit	A	0.39	
Bicycle	F	4.46	
Pedestrian	E	4.43	

ROW 80 ft

South side — North side

Street Cross-Section

Sidewalk	Buffer	Parking	Bike Ln	Trav. Lane	Trav. Lane	Trav. Lane	Median	Trav. Lane	Trav. Lane	Trav. Lane	Bike Ln	Parking	Buffer	Sidewalk	Range Checks
5	0	4	0	0	12	12	0	12	12	0	0	4	2	5	OK

(all entries in feet, enter zero for non-existant lanes)

Street : Grand Ave (STH 23)
Limits: Raleigh St to 63rd Ave W (representing Zone 1)

Important?	Key Parameters			Range Checks
Yes	Signal Spacing:	10,560	(200-10,560 ft.)	OK
slight	Progression Quality:	5	(1=poor, 6=excellent)	OK
slight	Speed Limit	35	(15-70 mph)	OK
no	Bus Stops w. Shelter:	50%	(0-100%)	OK
no	Pavement Quality:	3	(1=poor, 5=excellent)	OK

Additional Parameters

Auto LOS Inputs		Important?
Peaking Factor (k)	0.09	Yes
Directional Factor (d)	0.64	Yes
Peak Hr. Fac. (PHF)	0.89	Yes
Adj. Sat Flow (vphgl)	1800	Yes
Through g/c	0.45	slight
Cycle Length (sec)	100	slight

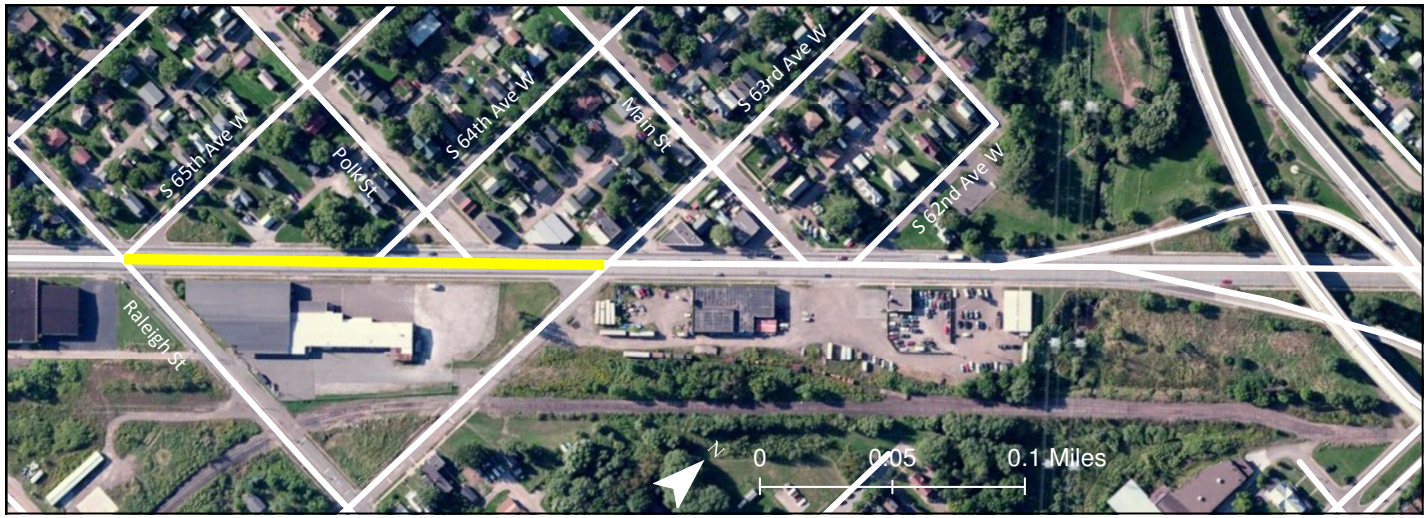
Pedestrian LOS Inputs		Important?
% Parking Occ.	0%	Yes
Barrier (Yes/No)	No	Yes
RTOR+Perm LT (vph)	160	slight
X-Street Vol. (vph)	1490	Yes
X-Street Speed (mph)	42	Yes
X-Street Lanes (#)	4	slight
Right Turn Islands (#)	0	slight
X-Street Walk g/c	0.10	Potential

Transit LOS Inputs		Important?
% On Time	90%	No
% Stops w. Benches	0%	No
Load Factor (p/seat)	0.48	No
CBD (Yes/No)	No	No
Bus Stops/segment	2	No
Delay/Bus Stop (sec)	20	No

Bicycle LOS Inputs		Important?
Unsig Conflicts/Mile	25	No

Figure A.14 | Zone 6 mmLOS analysis segment

The western side of the 0.2 mile segment of Highway 23 between 65th Ave W and 63rd Ave W was chosen to represent the mmLOS scores of Zone 6.



A

Connectivity scores

Connectivity is the concept of how well connected a transportation network is to various land uses and activity centers, as well as between its various components. It can be uni-modal, looking only at road links, or it can be multi-modal in scope. Multimodal connectivity considers how well the various networks link together for the various users.

Connectivity is most often measured as a ratio between the number of links (i.e. street segments) versus the number of nodes (i.e. intersections) that exist within a community or area. Because this study is focused on the multimodal relationships between a principal arterial (Highway 23), the adjacent neighborhoods, and the larger city, a different approach was taken. For this study, connectivity was assessed as a ratio of *major nodes per distance divided by minor nodes per area*, as expressed in Equation A.1 below. This was measured against the benchmark ratio of 3:20 (or 0.15) illustrated in Figure A.15 at right.

Accesses on Highway 23 and the Munger Trail were identified as the major nodes because they represent the only two through-ways connecting the neighborhoods west of I-35 with the rest of Duluth to the east.

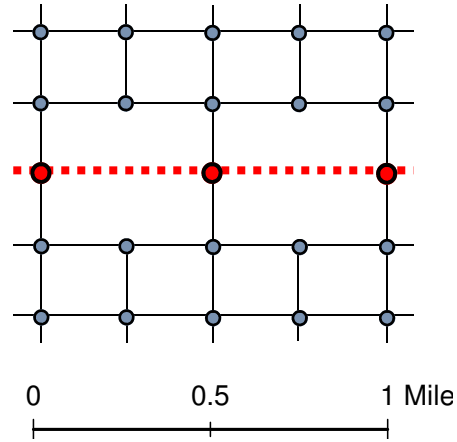


Figure A.15 | Connectivity benchmark

A per-square-mile ratio of 3 primary connections to 20 minor connections was used as a benchmark of ideal connectivity for this study. This represents accesses spaced 1/2 mile apart on the highway and intersections spaced 1/4 mile apart on adjacent neighborhood streets.

Equation A.1 | Principal connection ratio

The equation below was used to derive connectivity scores for each of the six zones within the study area. It represents a ratio of regional vs. local connections. A ratio of 0.15 was used as the benchmark delineating standard vs. sub-standard connectivity.

$$\left(\frac{\text{primary nodes}}{\text{linear mile}}\right) \div \left(\frac{\text{minor nodes}}{\text{mile}^2}\right) = \text{Connectivity ratio}$$

Sidewalk Quality

The MIC conducted a city-wide survey of sidewalks in Duluth during the summer of 2010. Sidewalks were rated on a scale of 1 to 4 based on methodology devised by MnDOT and represented by the images and criteria in Figure A.16. These ratings were generally applied to block-length segments of sidewalk and were saved as part of the Duluth Sidewalk Inventory which is maintained and updated by the MIC.

For the purpose of the Grand Ave/Highway 23 study, sidewalk quality information was initially collected via the existing sidewalk inventory and was then ground-trothed with on site visits. This information was then tallied on a lineal foot basis for each of the six study segments, as well as any sidewalk gaps. This information was then compared on a percent-basis to a benchmark street with sidewalks on both sides of the street that are in a condition that is "fair" or better.

The subsequent scores were thus derived using equation A.2 shown below..

Equation A.2 | "% Sidewalk" score

Each zone was scored in terms of the amount of sidewalk they contained alongside Highway 23. Sidewalk was counted only if it was in "Fair" condition or better according to the schema shown at right, and scores were derived using the following equation:

$$\left(\begin{array}{c}\text{miles of sidewalk}\\ \text{in "Fair" condition}\\ \text{or better}\end{array}\right) \div \left(\begin{array}{c}\text{miles of highway}\\ \text{segment x 2 sides}\end{array}\right) = \text{"\% sidewalk" score}$$

Figure A.16 | Sidewalk rating criteria

1 -- Excellent Condition

- Uniform, flat cross slope
- No dips/heaves
- Minimal small cracks
- No obstacles in the vicinity
- No spalling or displacement

2 -- Good Condition

- Uniform, flat cross slope
- Multiple cracks with minimal dips/heaves
- Minor spalling
- Minor displacement

3 -- Fair Condition

- Some large cracks
- A moderate level of spalling
- Slight non-uniform cross slope
- Small dips/heaves, not level
- 1 or 2 obstacles

4 -- Poor Condition

- Steep or multiple cross slopes
- Many multi-directional cracks
- Concrete chunks missing
- Excessive spalling
- Large dips/heaves
- Several obstacles

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Crash rates and severity rates

Most vehicle crashes occur at intersections, and so an initial step in evaluating traffic safety along the Highway 23 corridor was an analysis of crash rates and severity rates for all intersections along the 5-miles of highway being studied. These rates included all crashes that occurred within a 50-foot radius of the intersection from 2010 to 2012 and were determined using equations A.3 and A.4 at right and they were compared with averages for MnDOT District 1 reported on the 2011 "green sheets" found at http://www.dot.state.mn.us/stateaid/sa_traffic_safety.html.

Crash rates and severities were also evaluated per segment for each of the six zones. These values account for only the crashes that occurred on the highway (not intersecting streets) and were determined using the "segment" modifiers also shown in equations A.3 and A.4 and also compared to district averages reported via the above web address.

In addition to comparing crash and severity rates with the district averages, an effort was made to evaluate the trends in these rates over time. This was done by following the running three-year average starting from years 2003-2005 to 2010-2012. This analysis looked at only the trend in severity rates because that calculation inherently accounts for the number of crashes, but also because, in terms of the MIC's long-range planning objectives and the objectives of the county safety plans and the statewide *Toward Zero Deaths* (TZD) initiative, the focus is on reducing those crashes that result in serious injuries or fatalities.

Equation A.3 | Intersection crash rate

The following equation measures the number of crashes per 1 million vehicles entering the intersection. It is used as an expectation for future crashes at a location if all other factors remained the same.

$$\text{Crash rate} = \frac{1{,}000{,}000 \times \text{number of crashes}}{\text{years} \times 365 \times \text{AADT [x miles]}}$$

AADT = average annual daily traffic

[x miles] = modifier used to calculate rates for a highway segment

Equation A.4 | Intersection crash severity rate

Weighted values can be attributed to crashes based on the severity of resulting injuries, which can then be summed up and used in the crash rate equation to derive a severity rate.

$$\text{Severity rate} = \frac{1{,}000{,}000 \times [(10)K+(8)A+(6)B+(3)C+PD]}{\text{years} \times 365 \times \text{AADT [x miles]}}$$

K = total number of fatality crashes

A = total number of incapacitating injury crashes

B = total number of non-incapacitating injury crashes

C = total number of possible injury crashes

PD = total number of property damage only crashes

AADT = average annual daily traffic

[x miles] = modifier used to calculate rates for a highway segment

Appendix B: Identified Stakeholder Groups

Table B.1 shows the list of stakeholder groups that were contacted at the beginning of the MIC's Highway 23 / Grand Avenue corridor study. Recommendations were received from these initial contacts about additional stakeholders who should be contacted. These included land owners, interested residents, small business owners, and potential developers. Representatives from most of these groups participated in a series of public outreach meetings scheduled throughout the study.

	Stakeholder
Jurisdictional	MnDOT
	City of Duluth Planning
	City of Duluth Engineering
	City of Duluth Parks
	DEDA
	DTA
	ISD 709
	City of Duluth Police Dept.
	DNR
	US Forest Service
Business-oriented	Spirit Mountain
	West Duluth CDC
	Duluth Zoo
	Spirit Lake Marina
	Twin Ports Cyclery
	Munger Inn
	Chamber of Commerce
Residential	Smithville
	Morgan Park
	Riverside
	Norton Park
	Irving Park
	St Eligius Health Center
	Pleasant View Mobile Home Park
Special Interest	St Louis River Alliance
	COGGS
	Community Action Duluth
	Duluth Office of Human Rights
	Visit Duluth
	Healthy Duluth Coalition

Table B.1 | Identified stakeholder groups

Stakeholder outreach efforts for this study began by identifying key stakeholder groups with varying interests in the Highway 23 corridor.

A

Appendix C: List of Maps

Section 1 INTRODUCTION & BACKGROUND

Section 2 STAKEHOLDER INPUT

Section 3 EXISTING CONDITIONS & ANALYSIS

Appendix D: List of Tables

Section 3 EXISTING CONDITIONS & ANALYSIS

Section 4 RECOMMENDATIONS

Appendix A

Appendix B

Appendix E: List of Figures

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Section 2 STAKEHOLDER INPUT

Section 3 EXISTING CONDITIONS & ANALYSIS

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APPENDICES

Appendix F: List of Figures