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# Regional Truck Highway Corridor Study

## Final Report

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Metropolitan Council

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Solutions for growing economies

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## Ackowledgments

CPCS acknowledges and is thankful for input provided by the Metropolitan Council, the study Technical Advisory Group and other stakeholders consulted in the development of this report and identification of key truck corridors.

Cover image source: CPCS

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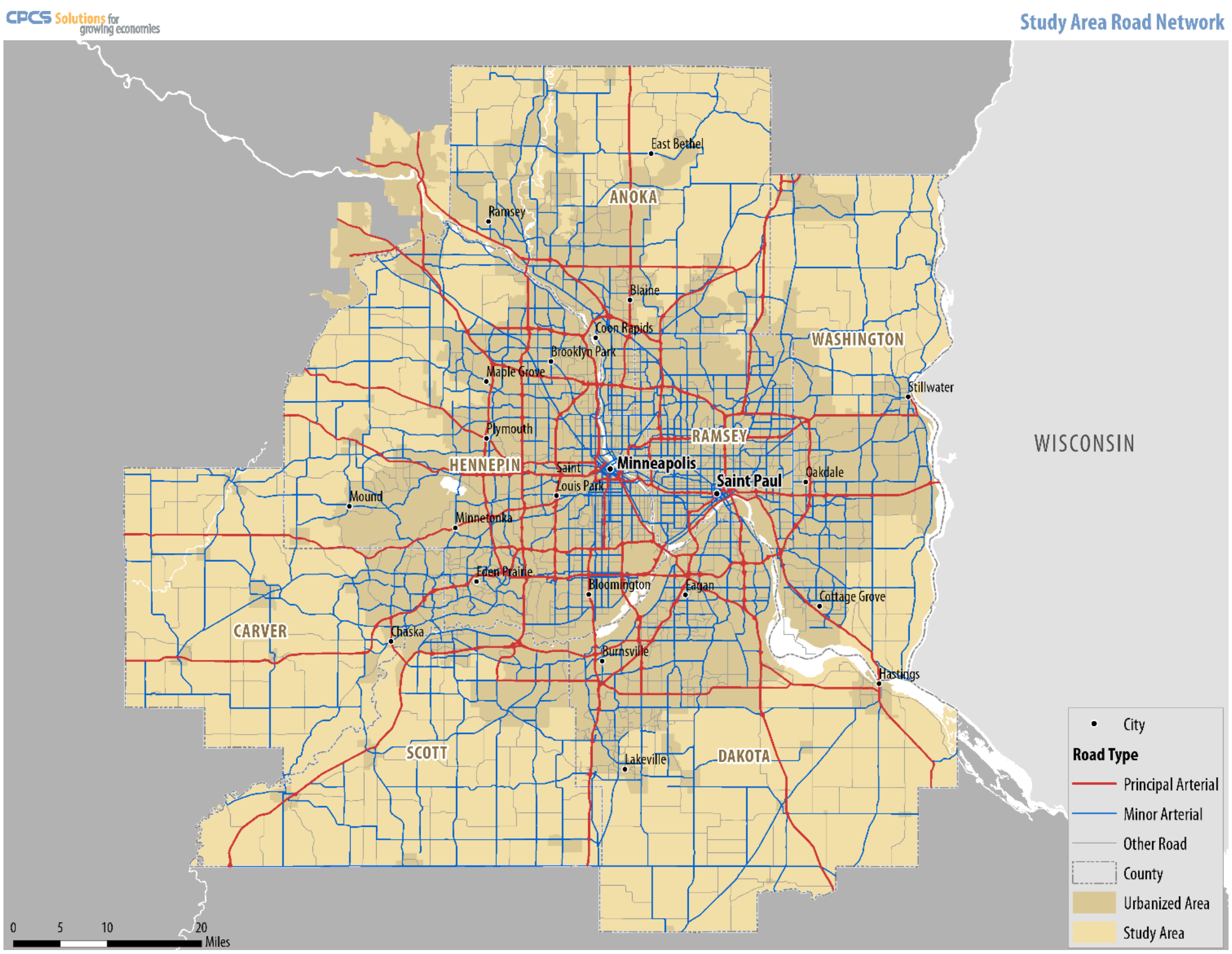
# Executive Summary

The efficient movement of freight is vital to the economic competitiveness of the Twin Cities metropolitan area, and truck highway corridors comprise a key component of the regional freight transportation system, along with rail and intermodal facilities, riverport barge terminals, and air cargo facilities.

This study sought to identify and prioritize the most significant regional truck highway corridors. It was conducted using a highly quantitative approach that took advantage of the best available data on truck transportation. These data were supplemented through interviews with industry professionals and ongoing input from a Technical Advisory Group (TAG). The TAG was comprised of representatives from the seven metropolitan counties, MnDOT, several municipalities, and private-sector practitioners and met four times during the study process.

The study area highway network is shown in Figure ES- 1.

**Figure ES- 1: Study Area Road Network**

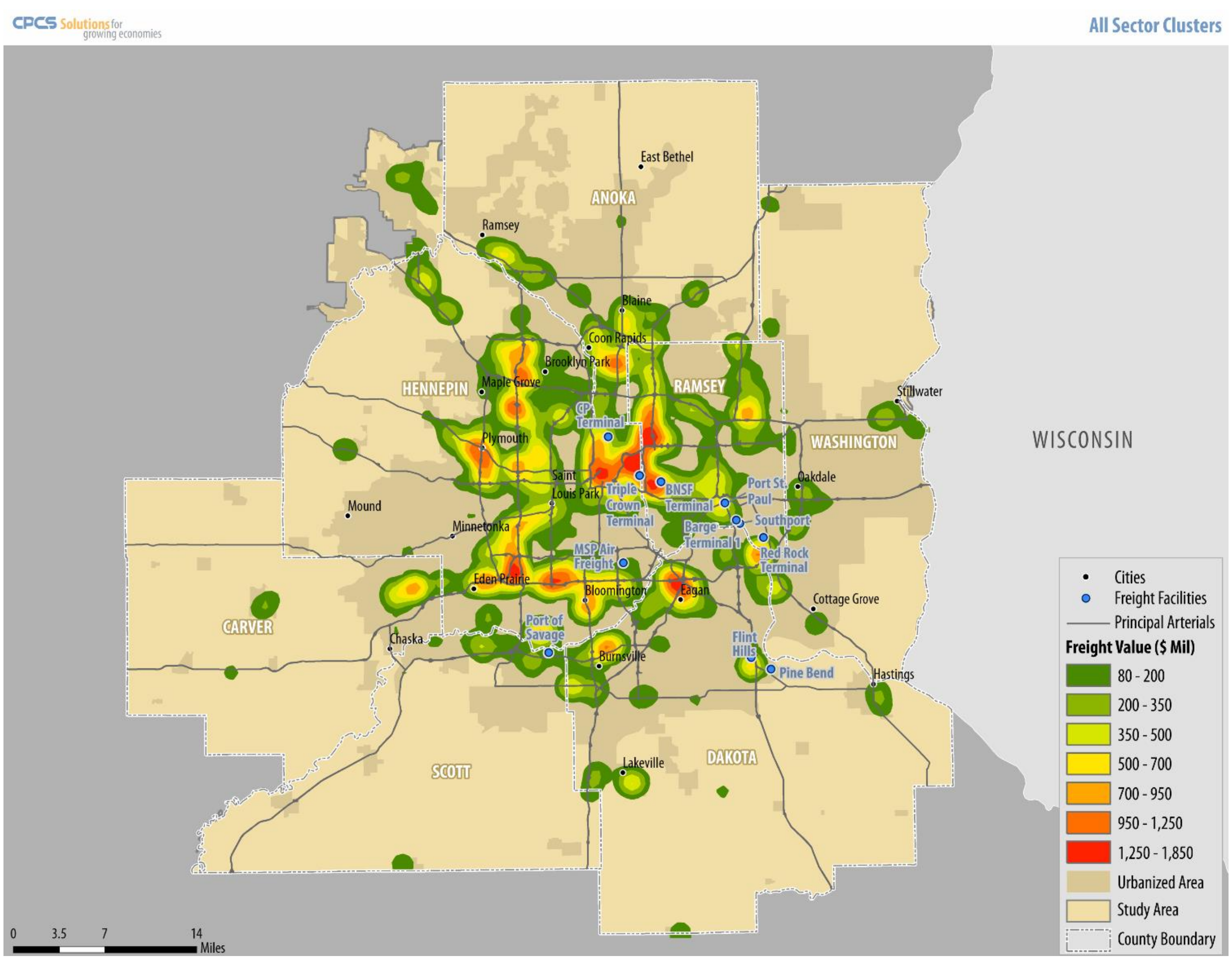



Source: Shapefile from MnDOT

Quantitative analysis of truck GPS data from study team member American Transportation Research Institute (ATRI), supported the finding that interstate highways, especially I-94, I-694, I-494, and I-35W, are the most highly used highways of all truck corridors in the metropolitan area. The interstate highway system is supported by a critical network of principal and minor arterials that serve to provide redundancy to the interstate system, as well as providing door-to-door access to manufacturing facilities, distribution centers, intermodal freight hubs, and ultimately, retailers and customers. The ATRI data facilitated the analysis of a much more comprehensive road network than what would have been possible using traditional truck counts.

Four freight-related sectors were identified on the basis of North American Industry Classification Standard (NAICS) codes: these were manufacturing, consumer goods, natural resources, and transportation and logistics. Analysis of highly granular business establishment data (from Infogroup USA, Inc.), illuminated clusters of freight-generating businesses (by annual sales value) as shown in Figure ES- 2. Many of the top clusters are located in the older metro core, with others following the I-494/I-694 ring, and still others further afield in growing freight clusters such as Shakopee.

**Figure ES- 2: Map of Freight Clusters in the Twin Cities Area**



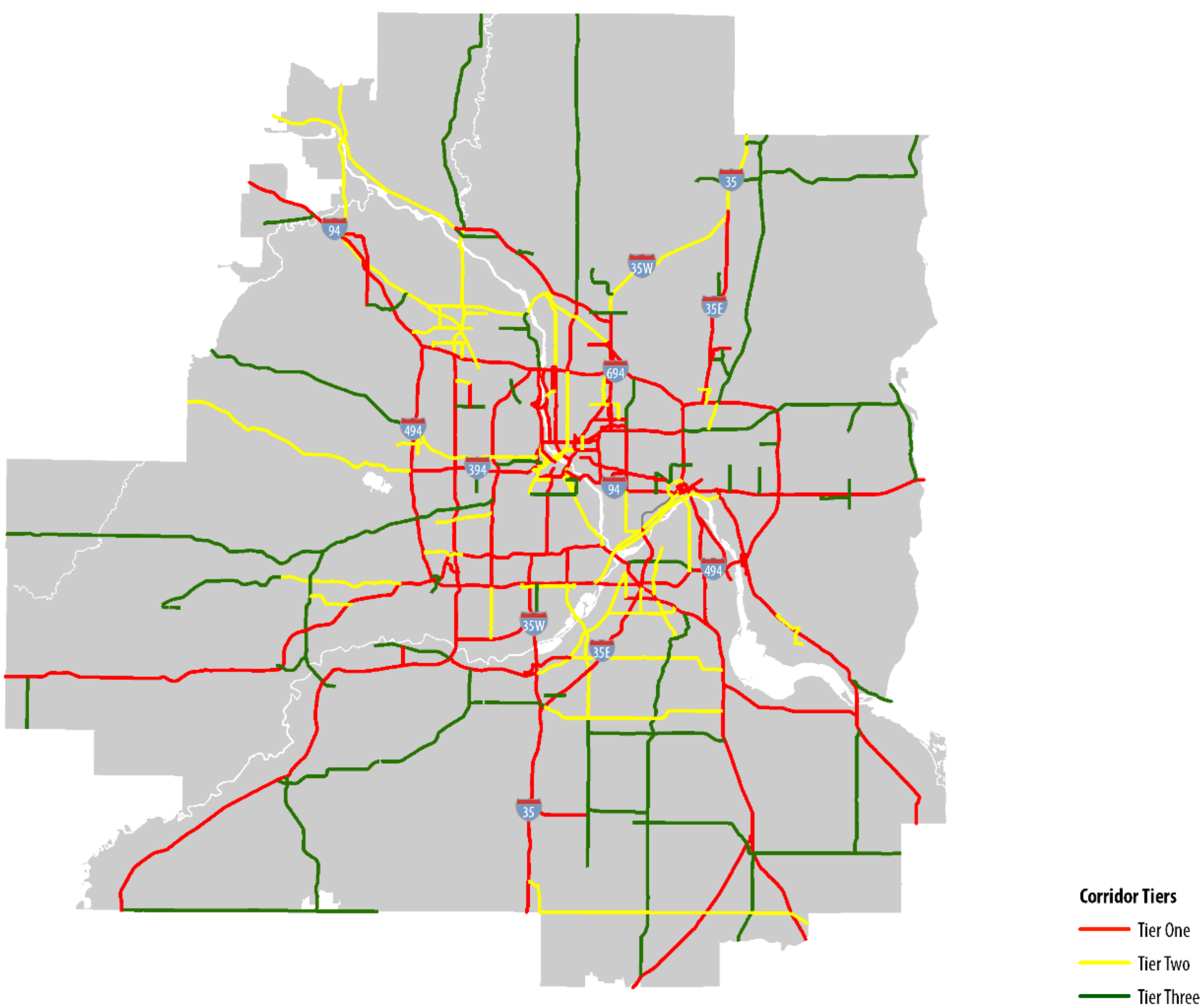

Source: CPCS Analysis of Infogroup Data, 2015. Freight facilities (in blue) provided by Met Council.

Corridors were evaluated across four factors including average annual truck volume, truck percentage of total traffic, proximity to identified freight clusters, and proximity to regional freight terminals (i.e., rail intermodal yards, riverport terminals and MSP airport). These variables were weighted according to a custom weighting scheme developed in consultation with the TAG. The results were validated with staff from each of the Counties and input on truck issues was also solicited through interviews with private-sector stakeholders.

Corridors were assigned to one of three tiers, using a data-driven scoring procedure. Tier One includes more than 200 miles of interstate highways, reflecting the high significance of these corridors. However, the list of Tier 1 corridors is sufficiently expansive to also include more than 300 miles of principal and minor arterials, many of which may serve as the important "last mile" connection to freight destinations.

The tiered corridors are displayed graphically in Figure ES- 3.

**Figure ES- 3: Regional Key Truck Corridors, by Tier**




Source: CPCS analysis

The mileage breakdown by tier is shown in table form in Figure ES- 4:

**Figure ES- 4: Centerline Road Mileage by Corridor Tier**

| | Interstate | Principal Arterial | Minor Arterial | Total |
|---|---|---|---|---|
| Tier One | 211 | 227 | 108 | 546 |
| Tier Two | 18 | 111 | 166 | 295 |
| Tier Three | 0 | 95 | 290 | 385 |
| TOTAL | 229 | 433 | 564 | 1226 |

Source: CPCS analysis

The Twin Cities region is not dominated by a single commodity or supply chain, as the industries served by shippers and carriers span the range from manufacturing to consumer goods distribution, and from natural resources to transportation logistics. Some supply chains are highly localized, while others more broadly include regional, state, national, or international sources and export destinations.

The Twin Cities metro area serves as a distribution and agricultural consolidation hub for much of the Upper Midwest, and is home to a number of significant manufacturers. What these companies share is that their economic success in a competitive landscape depends on fast, efficient, safe, and reliable truck transportation.

This Regional Truck Corridors Study draws attention to a number of locations on the Tier One corridors where performance issues such as truck delay or safety (i.e., truck crashes) have been identified as a concern in previous studies, but also focuses on off-interstate corridors that have not been the subject of recent analyses. Although this study was not intended to be a comprehensive analysis of truck freight performance issues and solutions, it proposes a simple toolkit of technical and policy solutions that should be considered in the development and implementation of projects to improve truck freight mobility and will, in turn, support the sustainability and competitiveness of the region's economy.

# 1 Introduction

## 1.1 Background

CPCS was retained by the Metropolitan Council (Met Council) to prepare a study on regional truck highway corridors in the seven-county, Twin Cities, Minnesota metropolitan area. The study identified key truck corridors through the application of various truck and industry/land use data sources.

## 1.2 Objectives

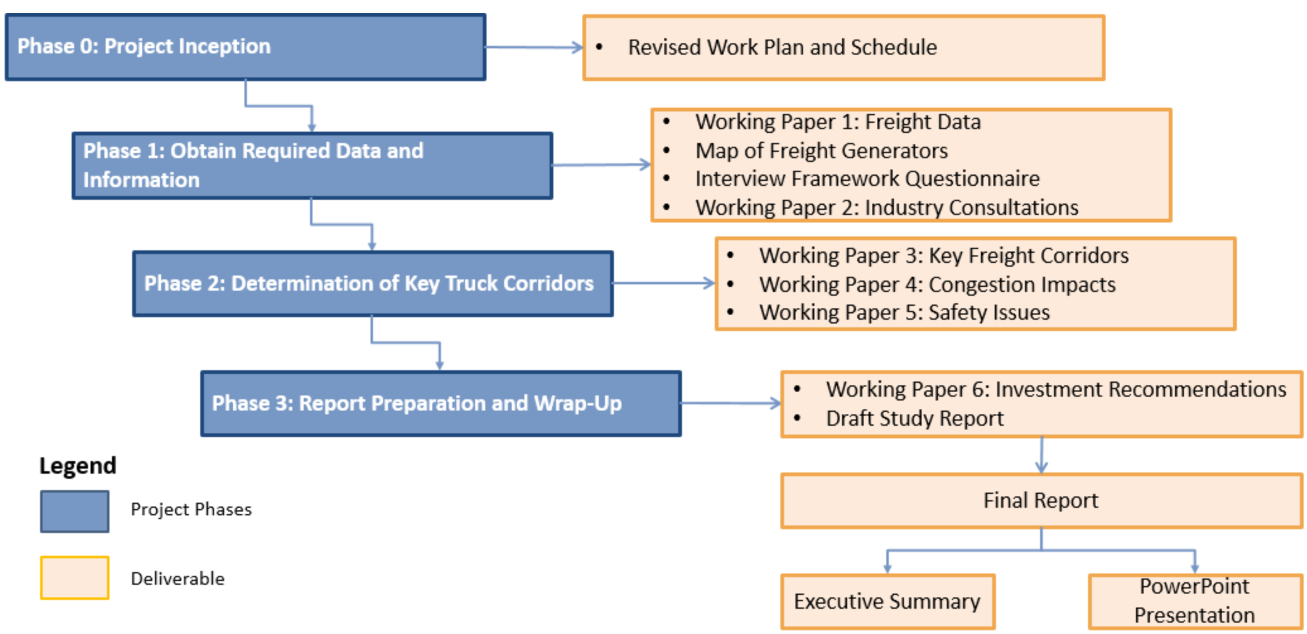
As described in the Scope of Work, the purpose of the study is:

> *To develop a better understanding of the most important highway freight corridors in the Twin Cities and to use this information to better inform highway investment decisions in the region.*

## 1.3 Project Structure

The project was developed in three broad phases, as set out in Figure 1-1. The present deliverable is the Final Report.

**Figure 1-1: Phased Approach to the Study**




The project structure was subsequently revised to consolidate Working Papers 4 and 5 into a single Working Paper 4 covering delay and safety. Working Paper 6 was rearranged, with the component dealing with truck mobility solutions integrated into the new Working Paper 4, and the remainder consolidated into a Conclusions & Recommendations memorandum.

## 1.4 Purpose of this Study

This study answered the following key questions:

**What are the most heavily used truck corridors on the Region's Principal and A-Minor Arterials?**

- Where and when are truck volumes greatest?
- When and where is truck mobility most problematic?

**What freight-dependent economic sectors are most impacted by mobility issues?**

- What are their major freight activity clusters (i.e. major truck traffic generators/destinations)?
- How do these mobility issues impact the performance of these sectors' supply chains and what is the implication for their competitiveness?

**What safety issues and geometry constraints negatively impact the performance of key freight corridors?**

**What road investments will yield the greatest benefit for the regions' economic competitiveness and growth, and the quality of life of residents in the Twin Cities area more broadly?**

- What underlying data and analysis can best support and justify road investment priorities?
- What, beyond investment in capacity or lane miles can help achieve the greatest performance out of existing key corridors (e.g. ITS, demand management approaches, etc.)

## 1.5 Methodology and Limitations

CPCS used a data-driven approach, relying on data from MnDOT and ATRI, among other sources. CPCS's approach was also consultative, seeking feedback, input and validation from the Technical Advisory Group (TAG) as well as from Met Council. The TAG is a group consisting of representatives from each of the Counties, MnDOT, and private companies. The methodology for each stage of this paper is described in the relevant chapter and section.

Part of the analysis in this paper relies on third party data. While CPCS took reasonable efforts to cross-check data sources where appropriate, CPCS cannot guarantee the accuracy of third party data.

# 2 Overview of Data Sources and Consultations

### Key Chapter Takeaways

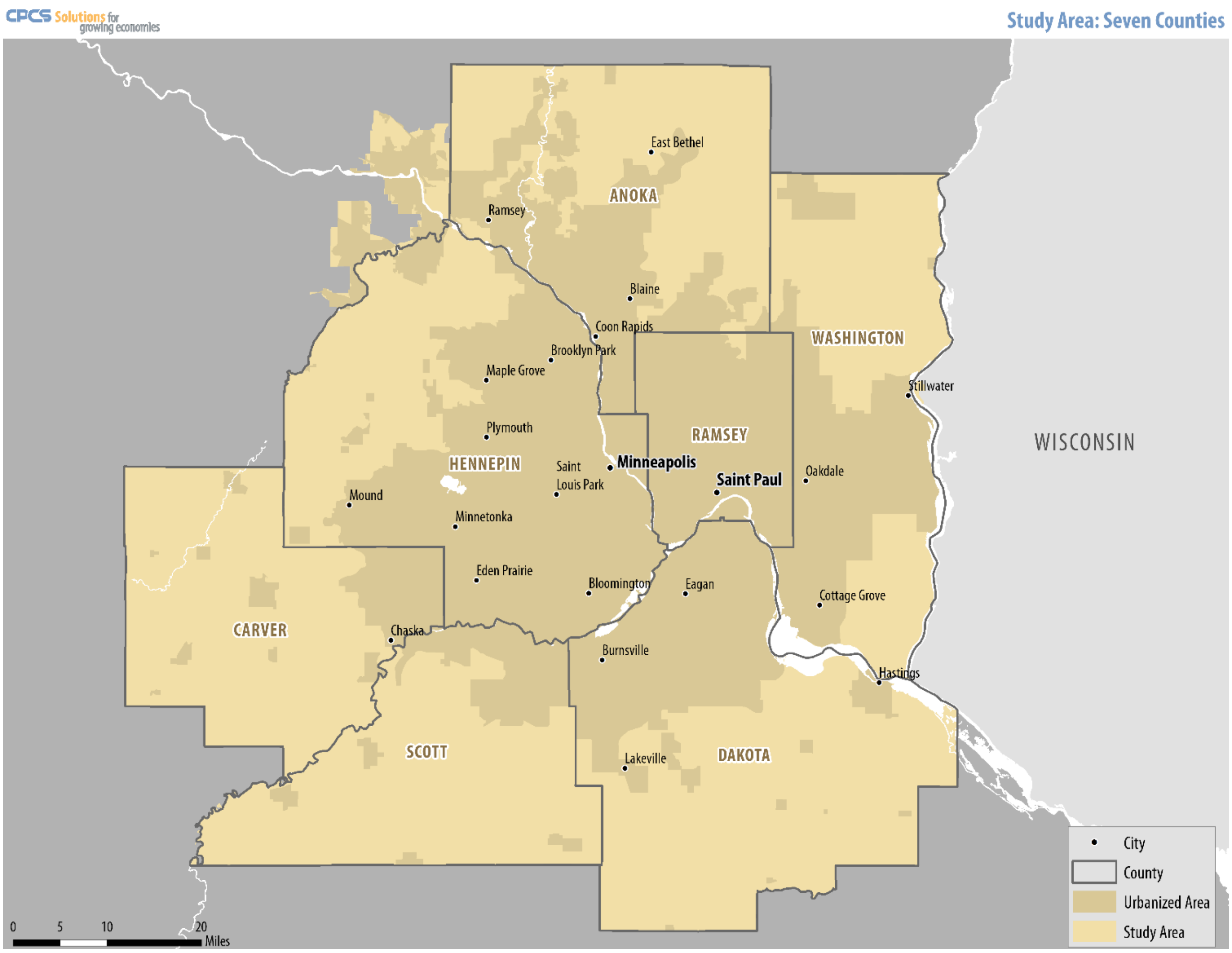
- This study was focused on the seven-county Twin Cities metropolitan area (plus small urbanized portions of Sherburne and Wright counties).
- The study used an innovative method of estimating truck volumes on all principal and minor arterials in the metro – by leveraging ATRI's national truck GPS database and scaling these values to match MnDOT's HCAADT truck volumes.
- This method took advantage of the main benefits of both sources: sample size comprehensiveness (MnDOT), and currency and geographic coverage (ATRI).
- This study also used highly granular business establishment data provided by Infogroup USA to identify clusters of freight-generating businesses by each of four key regional economic sectors.
- The highly data-driven approach was supplemented by interviews with industry practitioners.

## 2.1 Introduction to Study Area

### 2.1.1 Study Area

This study focused on the seven-county, Twin Cities metropolitan area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties). At the request of the Met Council, portions of nearby Sherburne and Wright Counties were also included as they are a part of the official Census-derived, Twin Cities urbanized area. These rapidly growing sub-areas include several freight-dependent businesses. The study area is shown graphically in Figure 2-1.

Figure 2-1: Study Area

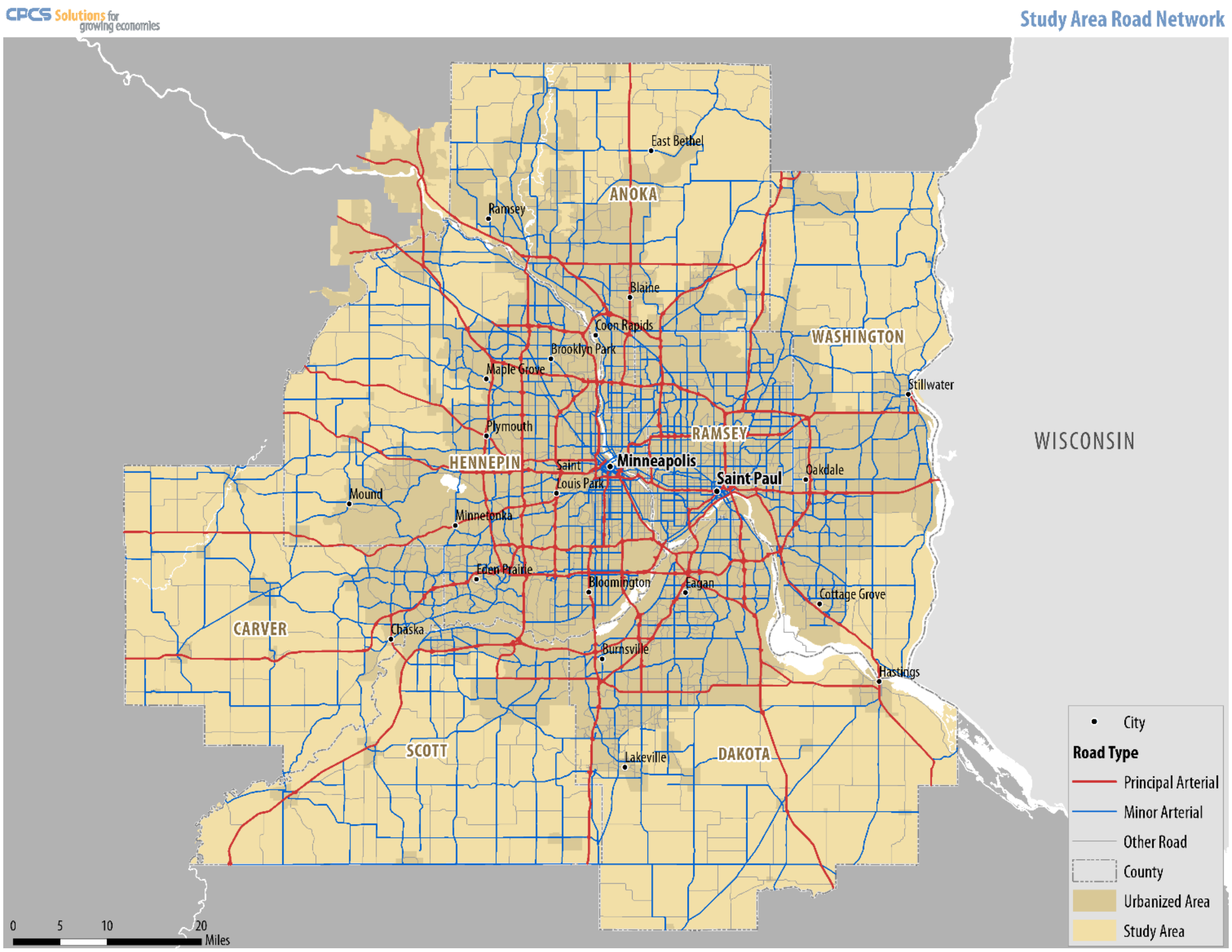



### 2.1.2 Study Area Road Network

Figure 2-2 shows the road network considered and evaluated through the study. This study specifically focused on roads classified as Principal and Minor Arterials. The Federal Highway Administration (FHWA) defines three main functional classes of roads. Arterials are distinguished from collectors and local roads, which primarily provide access to communities and to arterial roads. Arterials are in turn segmented into Principal and Minor Arterials: the network of Principal Arterials largely overlaps with Interstate and National Highway System

(NHS) networks, while the network of Minor Arterials is more dense and more geographically extensive.

**Figure 2-2: Study Area Road Network**




Source: Shapefile from MnDOT

## 2.2 Overview of Literature and Data Sources

### 2.2.1 Literature and Data Reviewed

**Literature Reviewed**

Several recent MnDOT and Met Council studies were reviewed in undertaking this study. These include:

- Twin Cities Metropolitan Region Freight Study (Met Council/MnDOT, 2013)
- Thrive MSP 2040 (Met Council, 2014)

- 2040 Transportation Policy Plan (Met Council, 2015)
- Transportation System Performance Evaluation Report (Met Council, 2012)
- Minnesota Statewide Freight System Plan (MnDOT, 2016)

**Data Reviewed**

The key data sources used for this study were as follows:

- Heavy Commercial Annual Average Daily Traffic (HCAADT): estimates based on data collected by MnDOT through automatic traffic recorders (ATRs), weigh-in-motion (WIM) sites, and daytime vehicle classification counts.
- Global positioning system (GPS) data for truck fleets from the American Transportation Research Institute (ATRI), a member of the study team.
- Business establishment data available from Infogroup USA, a private company specializing in collecting and selling business and consumer data.
- Other data from MnDOT, including crash data from the online Crash Mapping Analysis Tool (CMAT).

### 2.2.2 Description of Data Sources

These data sources are detailed in greater depth, including descriptions of their strengths and weaknesses:

**MnDOT HCAADT Volume Data**

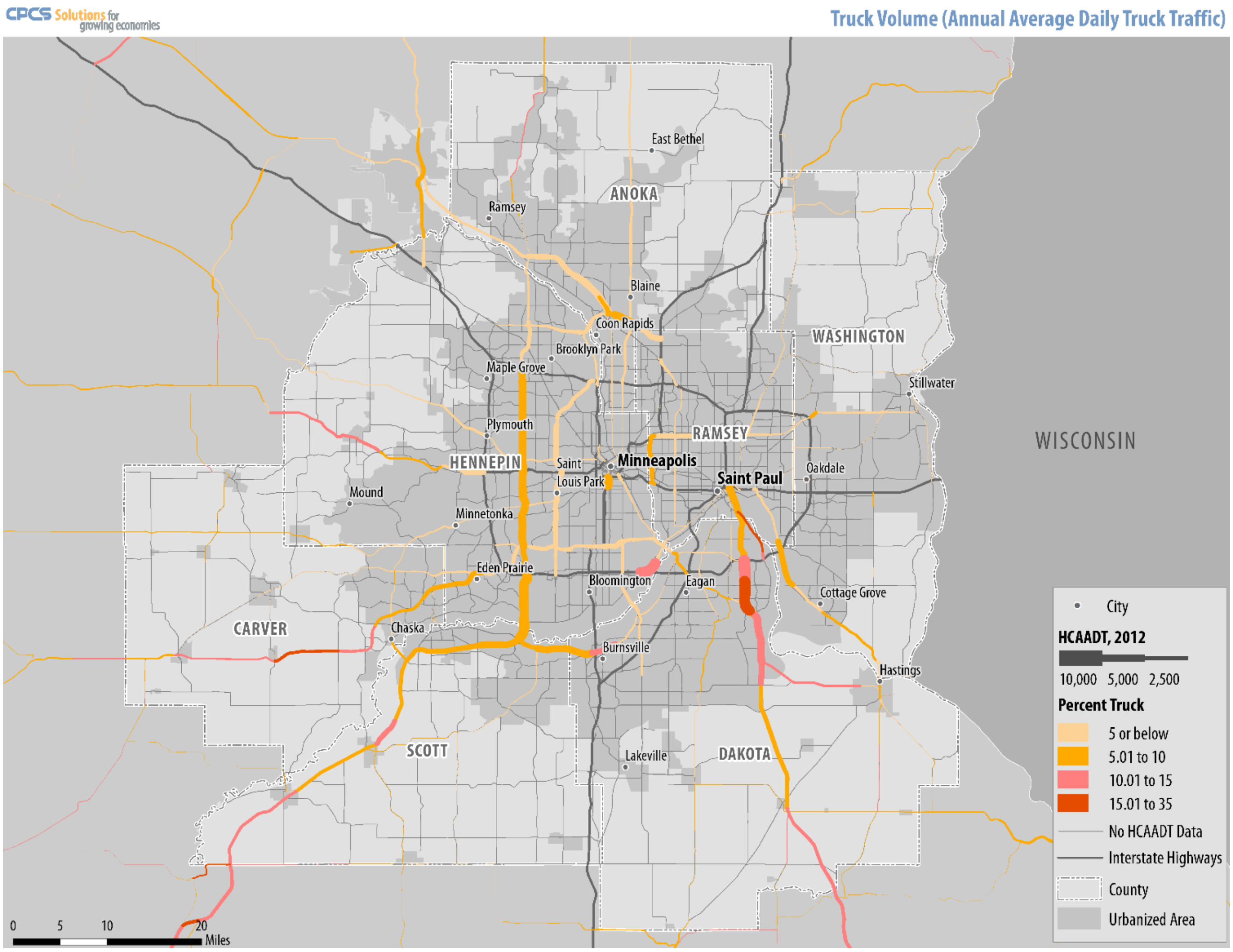
In the Twin Cities, the best available truck count data are available from MnDOT. MnDOT defines truck volumes as Heavy Commercial Annual Average Daily Traffic (HCAADT). Within the study area there are 15+ ATRs collecting vehicle class data, and six WIM sites, both of which sources provide continuous data collection. These sources are supplemented with vehicle classification counts, which are non-continuous and scheduled in most cases once every six years. Unlike in the remainder of the state, counts in the Twin Cities area are conducted manually rather than by 48-hour tube count. The manual counts are 4-hour counts generally conducted from 9 AM – 1 PM midweek.[1] Although manual counts do not cover a full day, they have the advantage of enabling collection of not only axle spacing but also body type data. The data were collected between April and October, and recorded on an hourly basis. MnDOT uses data from its continuous counts to generate AADT and HCAADT estimates for these count locations. There are hundreds of these sites in the study area.

Although MnDOT's annual average daily traffic (AADT) data are very extensive with respect to coverage, the availability of vehicle classification data is more restrictive. In general, truck

[1] Consultations with MnDOT

volumes are available for the Principal Arterial highway network; however, coverage for the Minor Arterial network is quite limited. Figure 2-3 shows truck volumes on MnDOT TH (trunk highways) based on 2012 data.[2] Although the counts also cover the interstate highways, these are removed from the map to emphasize the coverage on non-interstate corridors.

Figure 2-3: MnDOT HCAADT and Truck Percentage on Twin Cities Arterials (Excluding Interstate Highways)




Source: HCAADT from Minnesota Department of Transportation (2012)

## ATRI GPS Data

The ATRI GPS data used for this study rely on real-time feeds from a large number of North American commercial vehicle fleets spanning the US, Canada and Mexico, and covering both large and small trucks. This includes over 100 million data points per day and covers nearly 4 million miles of roadway in the US (for reference, the National Highway System comprises

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[2] 2013 data are available online, but consultations with MnDOT indicated that the 2012 data are the most recent reliable source for truck volumes

approximately 160,000 miles). The data points are highly granular, enabling identification of flows along individual roadways or even within large freight facilities. Given the high temporal and spatial coverage, the ATRI GPS data are essentially a large-scale sample of the nation's trucks. However, because not all trucks are included, these data can be used to estimate relative but not absolute truck volumes. ATRI's GPS dataset is somewhat more heavily weighted towards long-haul, intercity hauls, though all roads are covered.

Compared to the National Performance Management Research Data Set (NPMRDS), which also uses ATRI truck data and is made available to states and metropolitan planning organizations (MPOs) as a tool for performance measurement, the data used in this study are collected continuously for custom road segment geographies, and unlike the NPMRDS go beyond the national highway system to cover Minor Arterials.

**Infogroup USA**

This study made use of Infogroup USA's repository of business establishment listings. The advantage of this data source is its geographical granularity as well as the ability to segment the businesses into key economic sectors. One disadvantage of this data source is the "headquarters problem," (i.e., in some cases employment or other data reflective of an entire company with multiple outlets is geocoded to a single location). The study team used its familiarity with this data source from past projects to "weed out" such headquarters using a ratio of employment to square footage and quick checks of Google Maps. This did not completely eliminate the problem, but this screening method was successful at identifying the largest such sources of bias. There were also a handful of notable establishments that were missing from the Infogroup database. The study team used its familiarity with the area as well as direct feedback from Met Council and Technical Advisory Group (TAG) members to manually add several notable missing facilities.

**Crash Data**

Truck crash data were obtained from MnDOT via its Crash Mapping Analysis Tool (CMAT).[3] Data were obtained for the years 2010-2015 (inclusive), for all truck-related crashes. In other words, all crashes were included in the analysis if at least one of the vehicles was a truck. Excluded were crashes involving passenger vehicles (including pickup trucks) as well as other heavy vehicles such as buses (unless also involving one of the listed vehicles).

## 2.3 Stakeholder Interviews

### 2.3.1 Overview of Stakeholder Interviews

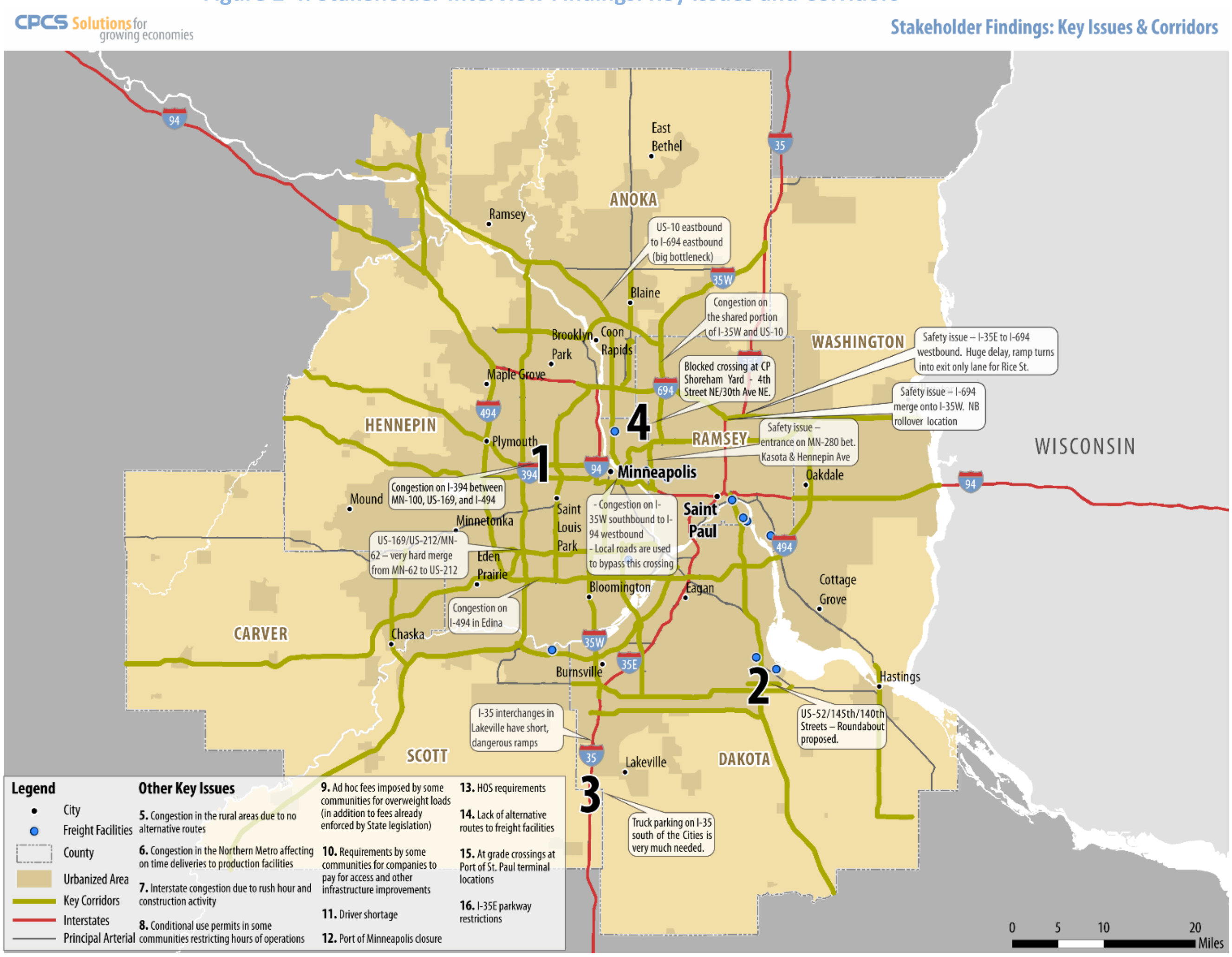
Stakeholder interviews were conducted to obtain qualitative information to inform the selection of key truck corridors during this study. These interviews complement rather than simply parallel the data-based analysis. Stakeholders were identified by examining the key

[3] MnDOT CMAT: https://www.dot.state.mn.us/stateaid/crashmapping.html

industries in the metro area, by obtaining contacts from MnDOT's roster of Minnesota Freight Advisory Committee members, and through reviews by Met Council and the TAG.

The key corridors identified by the stakeholders, as well as issues of concern, are shown graphically in Figure 2-4.

**Figure 2-4: Stakeholder Interview Findings: Key Issues and Corridors**




Source: CPCS presentation of stakeholder consultations

Stakeholders span a variety of industries (manufacturing, consumer goods, natural resources, transportation and logistics) and also span a range in terms of commodities transported, equipment used, fleet size, and supply chain orientation (localized to global). The stakeholders consulted are identified in **Appendix A** along with a discussion guide that focused the interviews. All interviews were conducted over the phone.

### 2.3.2 Physical Issues on the Key Truck Corridors

Figure 2-4 also provides an overview of the issues and obstacles identified by stakeholders during consultations. The physical issues generally fit within two categories, congestion and access, and are described in more detail below. Generally, stakeholders commented that the transportation system in the seven-county Twin Cities region works well for their trucking needs, and they had relatively few complaints.

**Congestion**

Interstate congestion during the morning and afternoon peak hours was the most frequently cited issue by stakeholders. Most noted that while this recurring congestion is inconvenient, it was something they could plan around and calculate into their travel times. Congestion on I-394 between TH 100, US 169, and I-494 was cited by several stakeholders as particularly heavy. Congestion in the north metro was also mentioned. One stakeholder noted that this congestion is a result of a poorly designed system that has too many cloverleaf interchanges (instead of fly-overs) where the congestion is concentrated, and too many or too closely-spaced points for drivers to enter and exit the system.

However, non-recurring congestion on Interstates and other roads, due to accidents and construction activity, was cause for greater concern for stakeholders, as it impacts the reliability of their shipments. One company, noted that they have key performance measures they hold their contract carriers to. When critical parts do not arrive on time for assembly, their production slows and carriers risk not meeting their contract requirements. Several consultees noted that advanced information on construction activity, travel times and rerouting options would be helpful. In some cases drivers are able to re-route themselves around congested points in the system, in other cases they must defer to the directions provided by a dispatcher and cannot reroute out of congestion on their own.

Congestion was also cited in the context of suburban growth. For one company, their excavation pits have been located historically in rural areas. Today these pits are in the same locations they have always been, but residential development has been growing around them. This is particularly true in the northwest metro in Sherburne County. Congestion in the morning has increased significantly due to area residents' rush hour commutes. However, a critical issue in rural areas is that there is a lack of alternative routes. Therefore, trucks and autos all use the same few routes at exactly the same time, which exacerbates the level of congestion.

**Access**

Freight facility access, or the ability for trucks to get to where they need to go efficiently, was the second most cited concern of stakeholders. There were five distinct locations where access concerns arose, as described below.

*Shoreham Yard*: The Midwest Shippers Association noted that a blocked crossing at Canadian Pacific's (CP) Shoreham Yard is a frequent concern of their members. CP's own track crosses the truck access road (30$^{th}$ Ave NE) to the intermodal facility from University Ave NE (TH 47). At times trucks may be blocked from entering or exiting the yard due to a CP train occupying the crossing. The truck delays noted as a result of the blocked crossing range from short to extreme, including one driver who was blocked both entering and exiting the facility, that resulted in a 6-hour facility round trip. When the crossing is blocked, trucks queue onto 4$^{th}$ Street NE and may also spill onto University Avenue. There have been some reports that the queue can be 1-mile long on University Ave (one halfmile both north and south of 4$^{th}$ Street NE). Access to this facility is unpredictable and can cause trucking companies to incur high costs due to truck delays. One company noted that they are considering a $15 surcharge to their customers to help defray the cost of accessing the CP yard. The spillover traffic onto University Avenue is also a safety issue, as space has not been allocated to accommodate the long truck queues on the highway.

*Lack of Alternative Routes*: Lack of alternate routes for trucks was identified in two contexts: first for those shippers that have suburban development sprouting up around them (previously noted in congestion subsection), and second for those accessing intermodal and port facilities. Access to the Shoreham Yard was noted above as a standout issue, but the Port of St. Paul is in a similar situation with few routes to access the port complex, terminals with a single point of entry, and at-grade rail crossings at terminal locations. The Port notes that this configuration is very problematic, and causes unpredictable delays for the businesses located there.

*Port of Minneapolis*: The second issue relates to the closing of the Port of Minneapolis. Aggregate Industries had extensively used the port, but with the closing of the St. Anthony locks in 2014, must now use trucks, as transporting aggregate by barge is no longer an option. This has had a big impact on their business bottom-line and has resulted in a significant increase in truck traffic. They previously shipped four barges per day to a customer facility, filling each with 1,200 tons of aggregate. They calculate that this now equates to 192 trucks on the road to meet customer needs.

*US-52 in Rosemount*: US-52, south of St. Paul, has been cited by several stakeholders as a critical route. This is the location of Flint Hills Resources, other thriving industries, as well as dispatch hubs for several local trucking companies including Bay & Bay Transportation, CHS, Wayne Transport, and B&R Cattle and Trucking. The intersections in the vicinity of US-52/145th/140th Streets were called out as problematic due to the high truck turning volumes and absence of traffic signals. Trucks frequently make U-turns on the road to access destinations. One stakeholder noted that roundabouts have been proposed as a traffic control mechanism at the 145$^{th}$ Street interchange and deemed that an inappropriate solution given the heavy truck volumes in the area.

*Truck Parking*: Last, truck parking was mentioned by one stakeholder as a need for their long-haul drivers making their way back to the Cities. there is an existing truck parking facility on I-35 near Lakeville, however it is under-sized. The demand for parking is much greater than what is provided, and a stakeholder noted the facility needs to be expanded or another facility provided. Also see "Hours of Service (HOS) Requirements and Electronic Logging" in the following subsection related to concern for the need for additional truck parking in the future.

**Policy/Regulatory Issues and Obstacles for Trucking**

Several policy/regulatory issues were mentioned by a few stakeholders consulted. One stakeholder did note that while it is good for Met Council to be aware of these issues, they are not optimistic it will lead to change as most trucking regulations are governed by Federal law. The identified regulatory issues are briefly described below.

*Truck Driver Shortage*: In recent years, there has been a nation-wide truck driver shortage. In the Twin Cities the companies that operate entirely within the region did not indicate shortages as an issue, but those with a long-haul focus and tight tolerance for delivery indicated that finding good drivers is a challenge. As an example, one consultee is currently working through negotiations with their contract carriers and the carriers are demanding wage increases be part of any new agreement as this is essential for, at a minimum, attracting new truck drivers. It may also help with retaining existing workforce. Another consultee noted that the driver shortage tracks with the economy – currently the economy is not doing as well as it has in the past, so the company has sufficient drivers for their needs. They acknowledge drivers will be in need as current workforce retires (average driver age is in the mid-50's) and when the economy improves. They also note that pay will have to go up for drivers in the future to attract and retain the workforce.

*Hours of Service (HOS) Requirements and Electronic Logging:* Several consultees noted that meeting HOS requirements is challenging, and that the requirements need to be revisited. Trucking companies are not necessarily seeking additional hours for trucks on the road, but would prefer some common-sense modifications. As an example, HOS currently require drivers to limit their day to 14 hours with 11 hours of driving. Typically, truckers have to load their trucks – taking 1-3 hours. This means that in a 14-hour day truckers will need to drive 11 hours straight to be able to maximize time under requirement. This lengthy drive is deemed unsafe by some, and one consultee tells its drivers that if they are tired and need to sleep in that 11 hour window that they should. Previously drivers could work, take a 4 hour break between customers and then drive again.

To ensure drivers and companies are complying with HOS requirements, beginning in December 2017 drivers will be required to electronically log their hours; equipment to accomplish this must be included in the cab. As an example, one consultee has devices for all their cabs utilizing PeopleNet. The company notes that in order for drivers to log their activity they will need to pull over. While truck parking is not an issue today, it may become an issue as drivers will need to find safe areas to do their documentation.

*Aggregate Fee*: Second, the State legislature passed a bill that allows counties to charge a fee to companies hauling aggregates due to the damage that they place on road. This is a common practice, and all companies that haul this commodity have to pay. That is, currently there is a level playing field: no matter where in the state one operates one will pay the fee (typically 15 cents/ton that goes to the county road fund). These fees are generally passed on to customers. However, cities and other communities in the 7-County Twin Cities region are beginning to (inconsistently) charge additional fees, as well as require companies to pay for access and other infrastructure improvements. Industry opposes these actions and new, inconsistent fees.

*Land Use*: Third, a few issues were cited that generally relate to land use.

- *Conditional use permits*. A municipality may choose to issue a conditional use permit for certain types of developments, resulting in land development in that area that is more closely regulated than others, so it can be more compatible with other surrounding land uses. One stakeholder noted that in the community where they operate, a conditional use permit prevents them from working during their preferred hours of operations. Today their operations begin at 7 AM, but they would like to start by 5 or 6 AM so they can avoid the morning rush hour.

- *Connecting land use and transportation*. In the previous section it was noted that developing the rural areas without providing sufficient infrastructure was leading to serious congestion issues for one business.

  Another business notes that at times it does not appear there is an appreciation for the impact transportation improvements will have on land use and vice versa, with the US-169 Bridge over the Minnesota River provided as an example. In this case, huge increases in traffic on US-169 through Eden Prairie, Bloomington and Edina were unanticipated, and the system was inefficient and congested for 10 years until a solution could be constructed. Developments must better take into account transportation system requirement, and transportation system planning must more fully consider how improvements may spur growth.

*Public Processes***:** Last, one stakeholder noted that the current system for transportation planning, design, funding and operations is muddled and ineffective. In the Twin Cities too many stakeholders are part of these processes and provide input that dilutes good projects, delays them, and adds significant costs to a final result that is outdated by the time of its opening. One stakeholder noted that in some cases this may result in a solution that doesn't align with truck configurations. An example of this is a roundabout that is difficult for trucks to navigate. Another stakeholder cited the need to focus more on projects and funding that provide last mile connections to allow for more predictability and reliability in travel times. Yet another stakeholder suggested that to benefit industry MnDOT should change their approach to construction activity; industry would much rather have a roadway closed entirely for a full week to get the job done, than have to live through 6 months of construction. All stakeholders noted that it will be a challenge to be able to effectively move forward with projects that can truly provide benefits to industry.

## 2.4 Meetings with Counties

As part of this study, Met Council conducted individual meetings with each of the 7 Counties in the metropolitan area. In addition to validating the key corridors, the Counties also related some of the specific truck and freight issues in their jurisdictions, which are described in Figure 2-5.

**Figure 2-5: Issues Identified in County Meetings**

| County | Issue Identified |
|---|---|
| Anoka County | Much aggregate and industrial development (refuse/dry fuel plant) in Sherburne County near US 10 NW of US 169 |
| Carver County | • US 212 is the most important corridor for movement of freight<br>• Capacity along U.S. 212 (many, 2-lane segments) create issues for trucks due to lack of lane continuity, substandard shoulders, and |

| | |
|---|---|
| | safety issues when trucks have mechanical issues or when slow-moving vehicles take up the roadway. Also, oversized loads cannot get permits to operate on narrow segments of this corridor<br>• Sub-standard sections along Lyman Blvd in Chanhassen does create some congestion during peak traffic hours, as well as lack of areas to pull off the roadway and tight turn movements at intersections.<br>• High traffic volumes and sub-standard shoulders also found on CSAH 10 between Waconia and Chaska, and TH 5 between Chaska and Victoria. |
| Dakota County | • There are issues with access to Port of Savage from TH 13; the Washburn signalized intersection may need grade separation |
| Hennepin County | • CSAH 101 in Rogers area is experiencing much growth north and south of I-94<br>• Marshall Ave in Minneapolis and Nicollet Ave in Bloomington are also important corridors<br>• There is a lack of redundancy in the 10-ton network in the Lake Minnetonka area. When one road is under construction there are major impacts |
| Ramsey County | • Rice St near the I-694 interchange is an important last-mile connection to a manufacturing area<br>• I-35W interchanges with I-694 and with TH 36 are problem spots for truck traffic<br>• Turns to and from University Ave are challenging for trucks, especially between Snelling Ave and Vandalia St.<br>• There may be signal timing issues on County Road D near I-35W and CSAH 88 |
| Scott County | • Important corridors include US-169, TH 13<br>• On US-169 between CR 14 and CR 69: many high-truck volume entry points occur. These are unsignalized intersections or driveways and have some safety concerns to general traffic due to slow movements and possibly, inadequate turn radii.<br>• US 169 interchanges at CR 21 and CSAH 101 are problematic |
| Washington County | • I-694/494/94 interchange has systemic congestion on SB to EB clover ramp due to trucks having to travel very slowly. This causes major back-ups to general traffic. MnDOT has project programmed to reconstruct the ramp<br>• Roadway connection to Grey Cloud Island aggregate site (CR 75 north to 61) through St Paul Park<br>• TH 36 will become a more active truck route once new St Croix Bridge to Wisconsin is completed<br>• Manning Ave n/of 94 may see more trucks.<br>• BNSF recently purchased land s/of 61 7 just n/of Grey Cloud Island township for a transfer facility; will need to improve access roads from 61 in that area |

Source: Met Council discussions with County representatives

# 3 Key Truck Freight Corridors in the Twin Cities Region

## Key Chapter Takeaways

- An initial screening of highways eliminated principal or minor arterials with low truck volumes
- The remaining roads were evaluated on four factors: annual average truck volume, truck percentage of total traffic, proximity to freight clusters, and proximity to regional freight terminals (i.e., rail intermodal yards and riverport terminals)
- Corridors were assigned to one of three tiers based on a customized weighting scheme developed with direction from the TAG
- This study identified the most significant truck freight corridors regionally; it does not define a comprehensive detailed network nor does it capture every local roadway that may provide access to important local freight destinations

## 3.1 Criteria for Identifying Truck Corridors

### 3.1.1 Study Objective

The objective of this phase of the study was to identify key regionally important truck freight corridors in the Twin Cities metropolitan area, from among principal and minor arterials.

This study was not intended to define a truck corridor "network" (i.e. an interconnected and planned system of designated truck corridors). Corridors were not systematically evaluated on the basis of their suitability for truck traffic in terms of road design, bridge clearances, network routing, land use planning, or other such principles.[4] In other words, the study focused not on the supply of truck routes, but rather the demand (i.e. asking which roads are *actually used and most relied on* by truck operators, in practice).

The study focused regionally and was not intended to capture all roads that may have local freight significance (e.g., local roads, private roads, or short arterial road segments of less than one mile that provide access to freight facilities).

### 3.1.2 Long List of Criteria

The research team identified the initial criteria and refined them based on feedback from the Technical Advisory Group (TAG). The research team then developed four variables for quantitative evaluation. Two of these were truck usage variables:

- Annual average truck volumes
- Truck percentage of total traffic

The other two variables were related to "land use":

- Proximity to existing freight clusters
- Proximity to regional freight terminals

Relating to other potential criteria, the research team identified the following approaches detailed in Figure 3-1.

**Figure 3-1: Potential Criteria**

| Potential Criterion | Approach Selected |
|---|---|
| Truck Volume Variables | - Truck volume and truck percentage are included as variables and detailed in the next section |
| Land Use Variables | - Proximity to freight clusters and proximity to freight facilities are included as variables and detailed in the next section |
| Roadway Functional Classification | - The study considers the region's principal and minor arterials, including all interstate highways and other freeways, and is not extended to local |

[4] A later phase of the study looks at truck issues, including road geometry, for certain segments on key corridors where performance issues have been identified. However, these are not systematically evaluated as a scoring criterion for defining key corridors.

| Potential Criterion | Approach Selected |
|---|---|
| | roads. Although some local roads may be important local freight corridors in some cases, they were deemed too small for consideration as regional freight corridors.<br>- Interstates are included as candidate regional freight corridors because of their importance in regional freight transportation, but were not selected as candidates for further study or analysis due to the significant operational, traffic management, and project development focus these corridors already receive<br>- The study team applied the same weights and considerations to all corridors irrespective of functional classification. This was considered to produce the most technically sound results, reflecting how corridors are being used today |
| Connectivity | - Connectivity was not explicitly considered as the objective of the study is not to designate a freight "network," but rather identify the most important corridors. However, at the micro scale certain adjustments were made (particularly in response to comments from County representatives) so that corridor definitions would reflect actual usage (for example, capturing the connection to an interstate highway) |
| Redundancy and Geographic Coverage | - Geographic coverage was not considered as a criterion, in the sense of allocating certain mileage among geographic divisions, since the primary objective is to identify through a data-driven approach the most significant regional freight corridors regardless of location. Redundancy was not explicitly considered, although in some cases it has been noted when pointed out by county representatives |
| Regulatory Factors | - Factors like bridges, posted speeds, and pavement adequacy were not considered since the goal was not to designate a "network" but to represent how trucks are actually using the system. One interstate highway was not included as a candidate corridor (I-35E immediately south of downtown St. Paul) as this is a designated parkway where trucks are specifically prohibited |
| Performance Issues | - Performance issues related to safety and congestion were not considered in identifying regional freight corridors. Instead, these were considered at a later stage in assessing the performance of the most important freight corridors (detailed in a subsequent Working Paper) |

### 3.1.3 Description of Evaluation Criteria

**Truck Volume**

Truck volumes are defined as heavy commercial annual average daily traffic (HCAADT), as compiled and disseminated by MnDOT. As the MnDOT coverage for HCAADT data did not extend to all roads under consideration in this study (notably many Minor Arterials), the data were supplemented by "partial volume" data from ATRI obtained under a data license specific to this project. The data are "partial" in the sense that ATRI's data represent a large but not complete sample of the trucks on the road.

The combination of the two sources was as follows. The research team scaled up the ATRI volume data from October 2015 by an appropriate factor (multiplier) based on a comparison of

ATRI volumes and MnDOT volumes for those arterials for which both data sources were available. The comparison was performed on a Highway Performance Monitoring System (HPMS) segment basis, reflecting a centerline network. Truck volumes were normalized according to the length of the segment and were not assigned twice to the same segment. Trucks were assigned to the nearest segment of the entire roadway network, with a buffer of 50 feet. This process resulted in a synthetic truck volume reflecting both HCAADT and ATRI data.

This is by no means a perfect method, because MnDOT and ATRI data are not directly comparable. In addition to the very different collection methodologies and the fact that ATRI volumes are scaled up from a sample, it should be noted that the ATRI data are for one full month of observations (October 2015), whereas MnDOT volumes are mostly scaled up from 4-hour peak counts and from 2012 or years prior (HCAADT is not collected every year). The ATRI data set may also underrepresent certain types of vehicles compared to others – for example concerns were raised by the TAG about whether aggregate-related traffic is fully captured.

Despite these shortcomings, the combination of ATRI and HCAADT data is likely the best available method (short of expanded truck counts) of evaluating Minor Arterials in terms of truck volumes. Specifically, it leverages the primary advantage of the MnDOT data (comprehensiveness in terms of capturing a full sample of trucks), as well as the primary advantage of the ATRI data (recentness and geographic coverage). To make best use of both datasets, the approach taken was to use HCAADT data for interstates, and to use the maximum of HCAADT and scaled ATRI data for other segments (obviously where no HCAADT are available, the scaled ATRI data are used).

In a few cases (several dozen segments), Counties were able to provide specific truck count data, such as data obtained from specific projects. These data were found to be not directly comparable to the HCAADT data, because the latter is seasonally adjusted and reflects the average over all days of the year, whereas the former may only reflect the time it was collected. These data were integrated by scaling the county volumes downward (under the assumption that collectively (i.e. over all sites) the county and leveraged ATRI volumes should be equal), and selecting the maximum of the two results for each individual segments (thus increasing the volume on a few corridors where the ATRI data were particularly low).

**Truck Percentage**

Truck volumes as a percentage of total vehicular annual average daily traffic (AADT) was the second variable considered. Volumes were defined as in the preceding subsection, and AADT was taken from the HPMS layer (which in turn relies on data provided by MnDOT).

**Proximity to Freight Clusters**

The study team along with Met Council identified four key freight-generating sectors: manufacturing, natural resources, transportation and logistics, and consumer goods (including retail and most wholesale trade). Business establishment data were segmented into sectors on the basis of their North American Industry Classification System (NAICS) code. With all freight-generating establishments identified, their sales of freight-generating establishments (as a proxy for value of freight hauled by truck) was mapped and GIS kernel density analysis was used to identify concentrations of freight-generating activity. The highest intensity areas were denoted as "freight clusters." These were areas with a high intensity of freight-generating establishments overall, plus those with a relatively high intensity in any one of the four identified sectors individually. The use of sales (an economic measure) for freight clusters counterbalances the use of truck volumes (an economically neutral measure) in the first two variables.

**Proximity to Regional Freight Terminals**

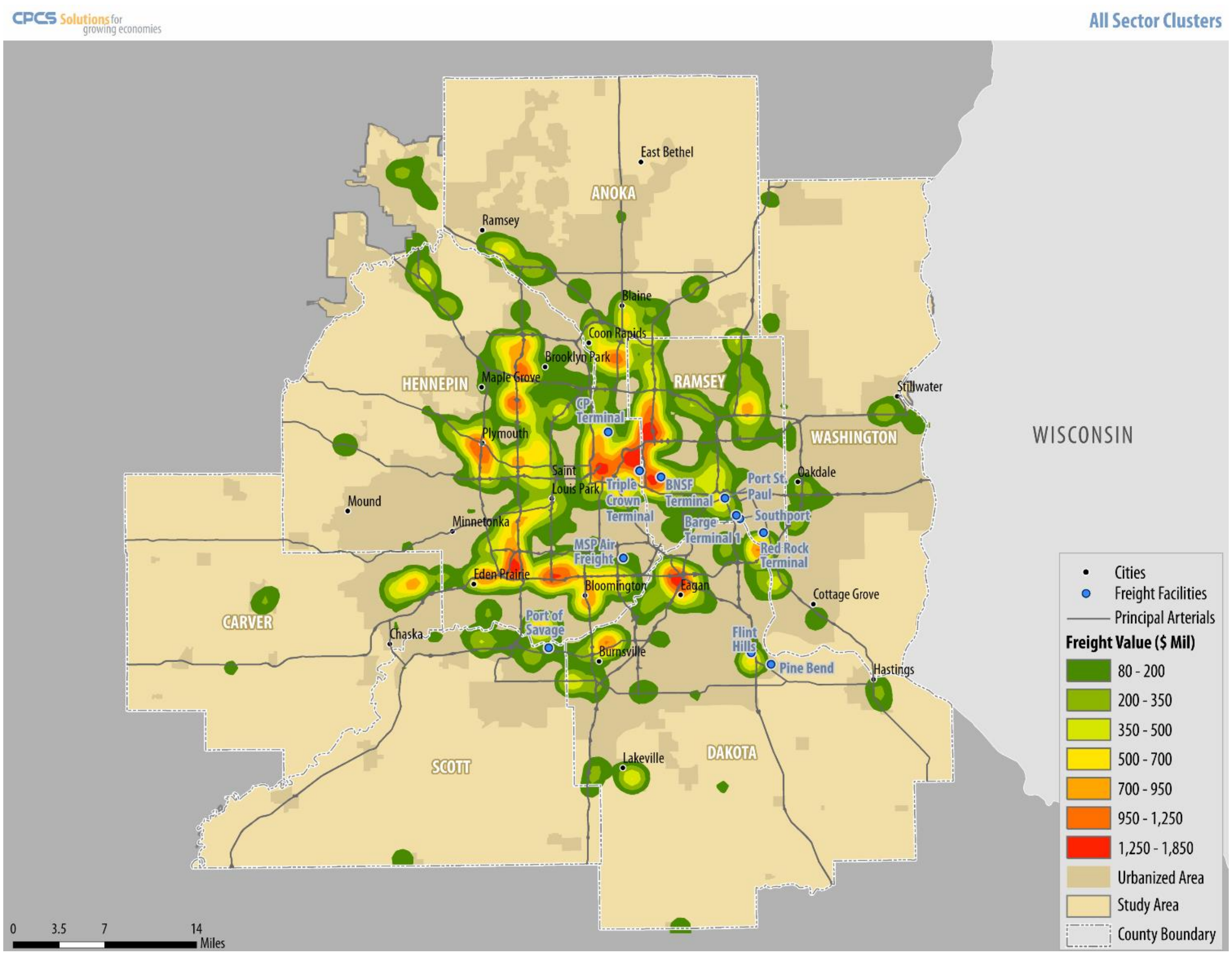
Regional freight terminals were defined based on the key freight intermodal facilities identified in the Council's long range Transportation Policy Plan. These facilities include rail intermodal terminals, riverport terminals, and MSP airport. Each of these terminals was near an existing identified freight cluster as well. Thus, the effect of including freight terminals is to give them extra weight to reflect their importance as key locations for transporting goods.

Figure 3-2 shows a heat map of freight-generating land uses (all sectors) in the Twin Cities area, overlaid with key freight terminals. The intensity of the "heat map" reflects both the size (in value of sales) of establishments and the number of relevant establishments in proximity to one another.

The largest and most significant cluster is in and around Minneapolis, driven largely by consumer goods and manufacturing. However, there are a number of additional local clusters, many situated along, or at the confluence of, multiple freight corridors. The map shows major suburban clusters around the I-35E/I-494 interchange around Eagan, the I-494 corridor around Edina, and the MN-55/I-494 interchange at Plymouth, among others.

Appendix B contains additional freight cluster maps for the four primary freight-generating sectors in the Twin Cities region.

**Figure 3-2: Map of Freight Clusters in the Twin Cities Area**




Source: CPCS Analysis of Infogroup Data, 2015. Freight facilities (in blue) provided by Met Council.

### 3.1.4 Initial Screening and Corridor Definition

**Initial Screening**

The first step was an initial screening of all Principal and Minor Arterials on the basis of road segments, which are short stretches of road (typically well under 1 mile, but of varying lengths due to factors such as intersection spacing). In the initial screening step, segments were compared on the basis of truck volume and truck percentage. The objective of this step was to remove from consideration road segments falling below certain thresholds. In other words, in spite of their other redeeming characteristics (such as proximity to clusters), these roads simply do not move much freight and thus cannot be considered to function as regional freight corridors. By limiting the subset of road segments in this way, the road network for further consideration was made more manageable.

A road segment was considered to pass the initial screen if it exceeded at least one of the following thresholds:

- Average daily truck volume >= 300
- Average daily truck volume >= 200 and Truck percentage >= 10%

The thresholds were set based on discussions with Met Council and the TAG. The purpose of setting two screening levels to qualification was to include some roads that may have somewhat lower absolute truck volumes but where freight traffic is a large percentage of total traffic, such as is the case in the region's outer suburban and rural areas.

**Corridor Definition**

The short segments passing the initial screening were combined longitudinally to form corridors. The objective was to keep the total number of corridors within a reasonable range while ensuring broad homogeneity within corridors. Specifically, corridors were defined based on:

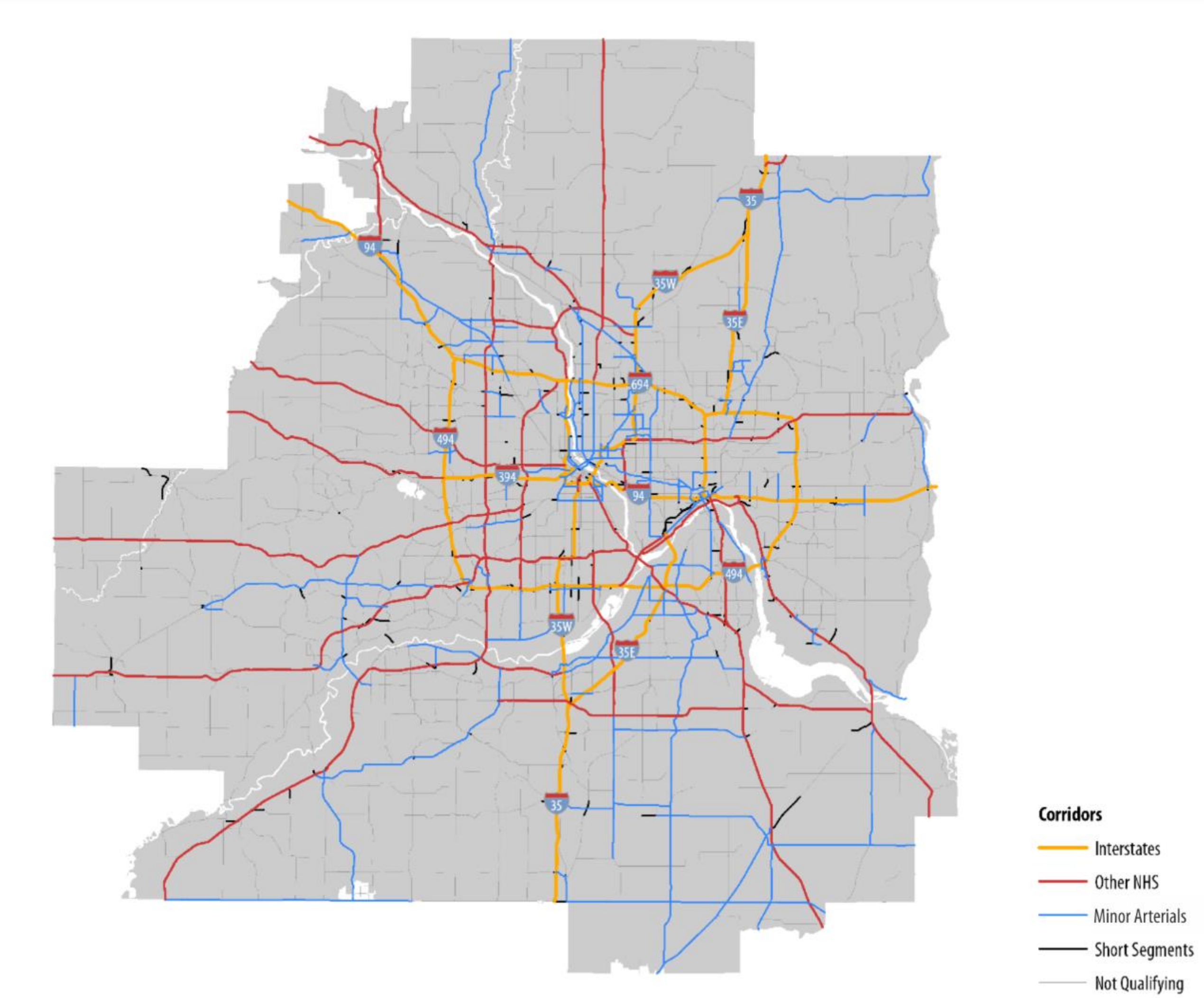
- Broadly consistent (i.e. non-variable) truck volumes throughout the corridor
- Natural breaks as end points, such as interchanges with larger roads or roads with significant truck volumes
- Presence of multiple segments on a single corridor extending at least 1 mile in total (i.e. short, unconnected/geographically isolated segments are rejected). Although some of these roads may be significant for freight transportation, the micro-scale required to properly identify these segments was beyond the scope of the project)

This step was performed using an automated process. In some cases, the corridor definitions were later modified manually (for example, TH 55 at I-494 in Eagan where TH 55 does not physically have an interchange with the intersecting interstate).

A map of corridors (and remaining segments that were not aggregated into corridors) passing the initial screening is presented as Figure 3-3.[5]

[5] Notably most of the "short segments" that appear longer than 1 mile, such as I-35E near St. Paul, are ones that were initially classified as corridors but were manually removed based on feedback from the TAG or Met Council.

Figure 3-3: Corridors Passing Initial Screening




### 3.1.1 Corridor Scoring

#### Detailed Description of Scoring Scheme

The two volume variables and two land use variables were used to score corridors. The technical details of the scoring process for each variable are detailed in Figure 3-4:

Figure 3-4: Technical Application of Scoring Process

| Variable | Scoring |
|---|---|
| Truck Volume | Scored linearly as a function of truck volumes, normalized to a scale of 0-100 based on the minimum and maximum values.<br>(100 = 10,674 HCAADT, 1 = 206 HCAADT. Note that in some cases short segments that did not pass the screening were included if they were part of a corridor where the large majority of segments did pass the screening. For example if out of 10 consecutive segments 8 qualified and 2 did not, all ten were included so as to ensure the corridor maintained continuity.) |

| | |
|---|---|
| Truck Percentage | Scored linearly as a function of truck percentage, normalized to a scale of 0-100. 100 is set to 30% trucks/total vehicles. In a limited number of cases truck percentage exceeds 30%; however, 30% was roughly the high range of credibility based on an analysis of the available data, and thus was set as the maximum. For practical purposes this means that corridors with truck percentages exceeding 30% get the maximum score and no "extra points."<br>(100 = 30%, 1 = 0.98%) |
| Proximity to Freight Clusters | Scored as a distance to a polygon, where the polygons represent the clusters. There are two components: first, the minimum distance of any segment within the corridor to any part of the nearest polygon. Second, the average distance of segments within the corridor to any part of the nearest polygon. These two distances are scored 0-100 (representing minimum and maximum scores) and then averaged. The use of the average measure ensures that a corridor passing through many clusters has a higher score than a corridor with a cluster only on one end. The use of the minimum measure ensures that long, outlying corridors do not obtain a low score despite the presence of a cluster on the corridor. The combination of these two measures ensures a compromise between these objectives. |
| Proximity to Freight Facilities | Scored as a distance to a point, with the points representing facilities. The distance is the minimum distance of any segment within the corridor to the freight facility. 100 is assigned for corridors within 0.5 miles of a regional freight facility; the score declines linearly as distance increases. |

### Unweighted Corridor Scores

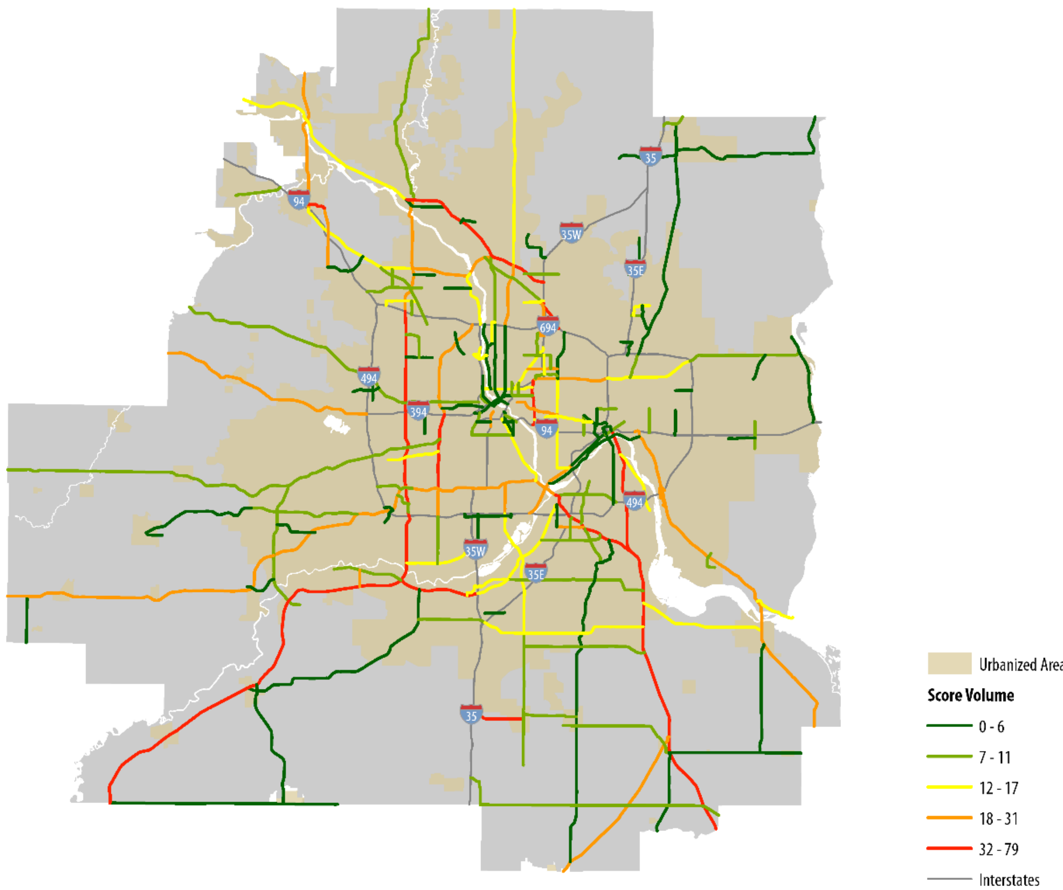
Each of the corridors was scored according to the four variables on a scale of 0-100 as described.

The corridors were classified into five categories, based on the natural breaks of the scores. All corridors, regardless of functional classification, were compared on the same scale. However, in the maps below interstate corridors have been grayed out, so as to draw more attention to off-interstate corridors.

### Truck Volume

As shown in Figure 3-5, aside from interstate highways which are not shown, truck volumes are highest on non-interstate freeways and expressways, such as US-10, US-52, US-169, and TH 13 among others. These corridors are highly complementary of and act similarly to the region's interstate highways.

Figure 3-5: Truck Volumes

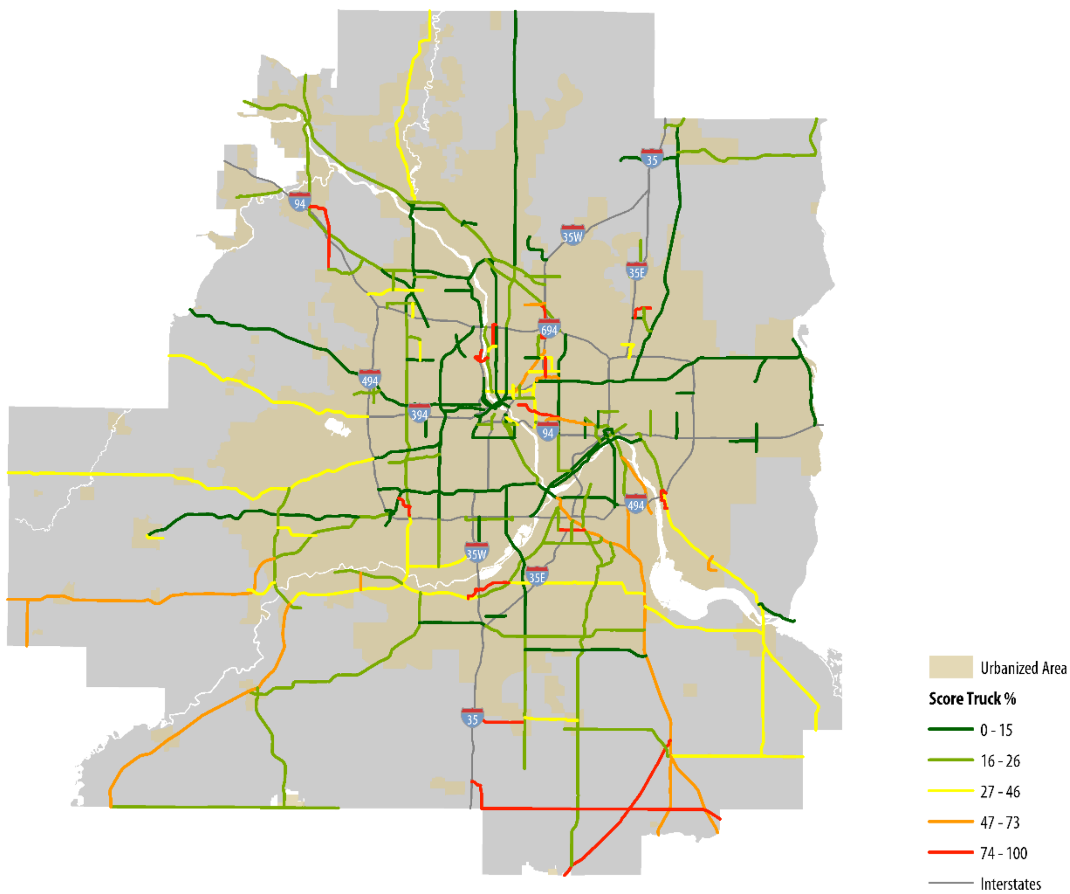



Source: CPCS analysis of MnDOT and ATRI data

### Truck Percentage

As shown in Figure 3-6, truck percentage is highest on certain routes in the rural areas of the study. This is likely due to the fact that, in general, these routes have lower overall traffic volume, compared to routes in urban areas. Truck percentages are also high on corridors near certain transportation facilities, such as the BNSF Midway Intermodal Hub in St. Paul.

Figure 3-6: Truck Percent

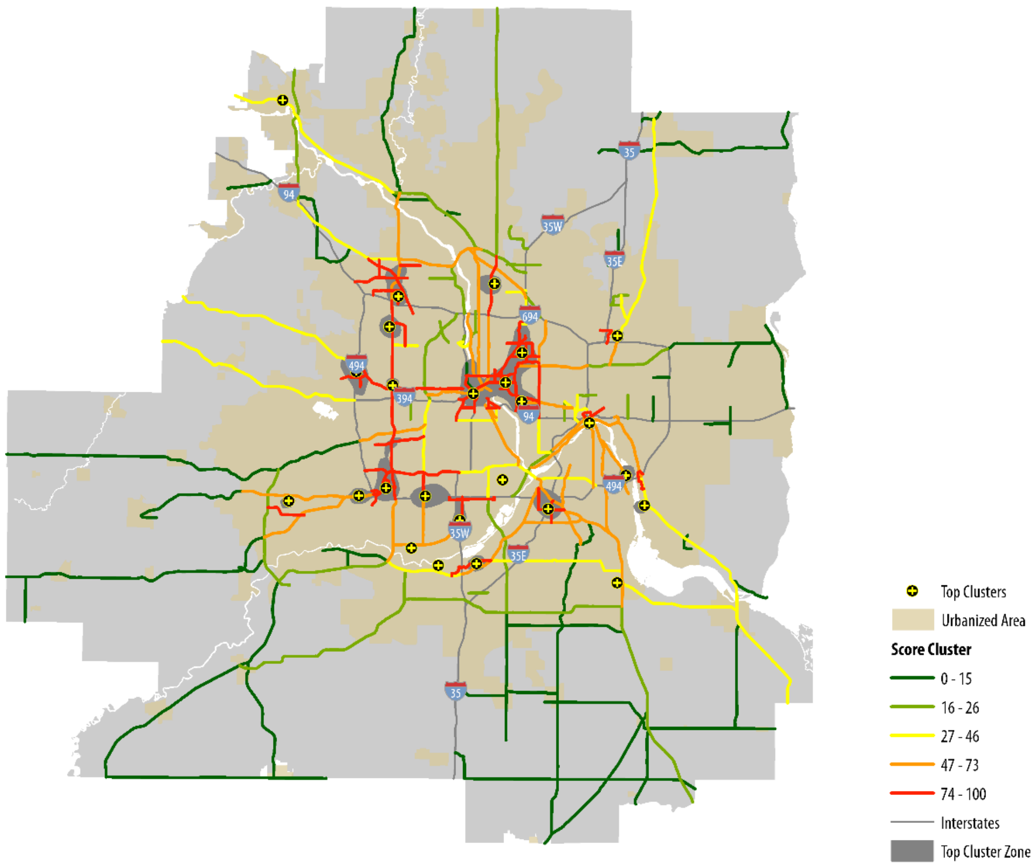



Source: CPCS analysis of MnDOT, ATRI, and HPMS data

### Proximity to Industry Clusters

As shown in Figure 3-7, industry clusters are generally located along the region's interstates, including those corridors that are in the city core (likely older, established businesses) and I-694 and I-494 bypasses (likely newer and relocated facilities that developed as the city core became more congested and land more expensive).

**Figure 3-7: Proximity to Industry Cluster**

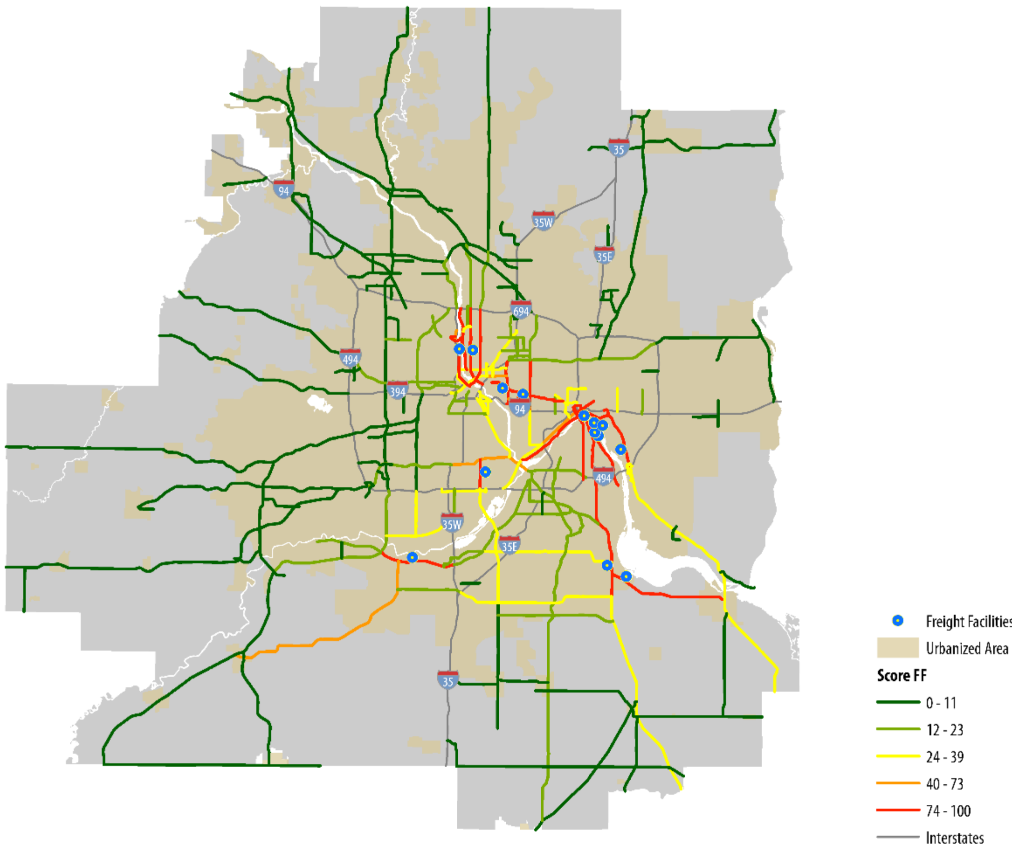



Source: CPCS analysis of InfoGroup data

### Proximity to Regional Freight Terminals

As shown in Figure 3-8, the majority of key regional freight terminals are located in the city core and include long-established facilities such as the BNSF and CP intermodal yards and the Port of St. Paul. Other facilities are located south of the core and include the Ports of Savage, Minneapolis St. Paul International Airport and the Flint Hills oil refinery in Inver Grove Heights.

Figure 3-8: Proximity to Freight Facilities




Source: CPCS analysis of Met Council data

## 3.1.2 Tiered Corridors

### Weighting Scenarios

Four alternative scenarios were evaluated to inform the selection process of key corridors. Overall, it was not immediately intuitive to what extent volume variables should be emphasized relative to land use variables. Evaluating several distinct scenarios illuminated which corridors stood out as significant under any scenario, and also brought attention to corridors "at the margins," which may or may not be significant depending on the scenario.

The criteria are applied uniformly to all corridors, regardless of functional classification or presence within the urban area versus a rural (non-urbanized) part of the metro area.

Scenarios 1 through 3 were presented at the second meeting of the Technical Advisory Group (TAG). Based on feedback obtained at that meeting, it was decided that the second and third scenarios were most reasonable, but that the weight applied to truck percentage should be relatively high and that the weight assigned to all variables should be at least 10% (to justify the presence of all variables) and should be rounded to 5% rather than 2.5%.

A new scenario (Scenario 4) was created based on the input received from the TAG.

The summary of initial scenarios are shown in Figure 3-9.

**Figure 3-9: Summary of Initial Scenarios**

| | Volume | Truck Percent | Proximity to Industry Cluster | Proximity to Freight Facility | Total Score |
|---|---|---|---|---|---|
| Scenario 1 | 90 | 2.5 | 5 | 2.5 | 100 |
| Scenario 2 | 70 | 12.5 | 12.5 | 5 | 100 |
| Scenario 3 | 50 | 20 | 20 | 10 | 100 |
| Scenario 4 | 60 | 20 | 10 | 10 | 100 |

It should also be noted that although superficially a 50-50 balance between volume and land use may appear to represent the middle ground, in practice this was found to not be the case. This is because there is more variability in the statistical distributions of some variables compared to others. For example, in the case of truck volume, there are a few interstates at the top, and a large number of non-interstates toward the middle and bottom of the distribution. Thus, assigning a higher weight to truck volume helped accentuate the difference between a corridor with 200 trucks per day and one with 1,000 trucks per day, which would both otherwise be dominated by a few interstate corridors with up to 10,000 trucks per day.

Aside from the variability issue, truck volume was deemed to be the most impactful metric in describing the extent to which truck corridors are actually *used* as freight corridors.

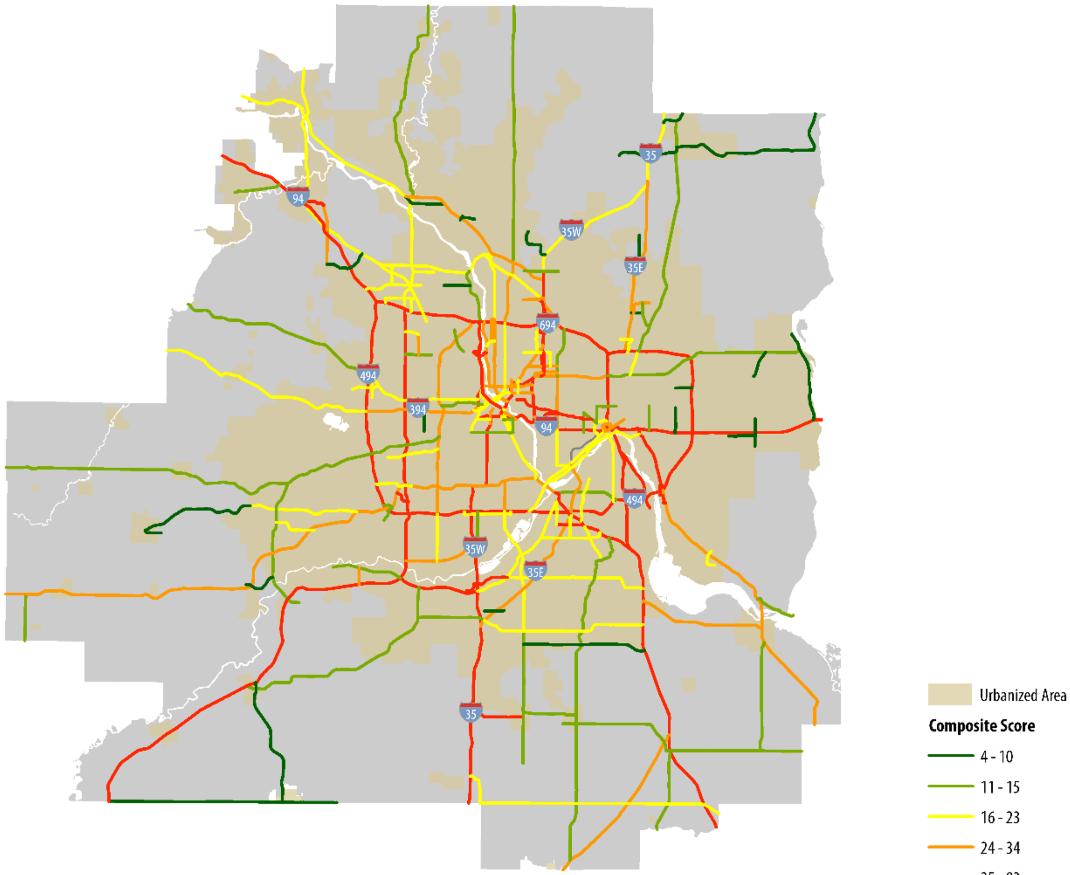
The weighted corridor scores for the preferred scenario are shown in Figure 3-10.

**Figure 3-10: Weighting Scheme Applied to Variables**

| Volume | Truck Percent | Proximity to Industry Cluster | Proximity to Freight Facility | Total Score |
|---|---|---|---|---|
| 60 | 20 | 10 | 10 | 100 |

The weighted corridor scores are mapped in Figure 3-11. These scores are based on the maps shown as Figure 3-5 to Figure 3-8 for the individual unweighted scores, combined with the weighting scheme from Figure 3-10.

**Figure 3-11: Composite Score for Selected Scenario**




Source: CPCS analysis

### Identification of Corridor Tiers

To simplify the interpretation of the corridor scores, the five categories from Figure 3-11 were distilled to three categories. The tiered corridors are shown in Figure 3-12.

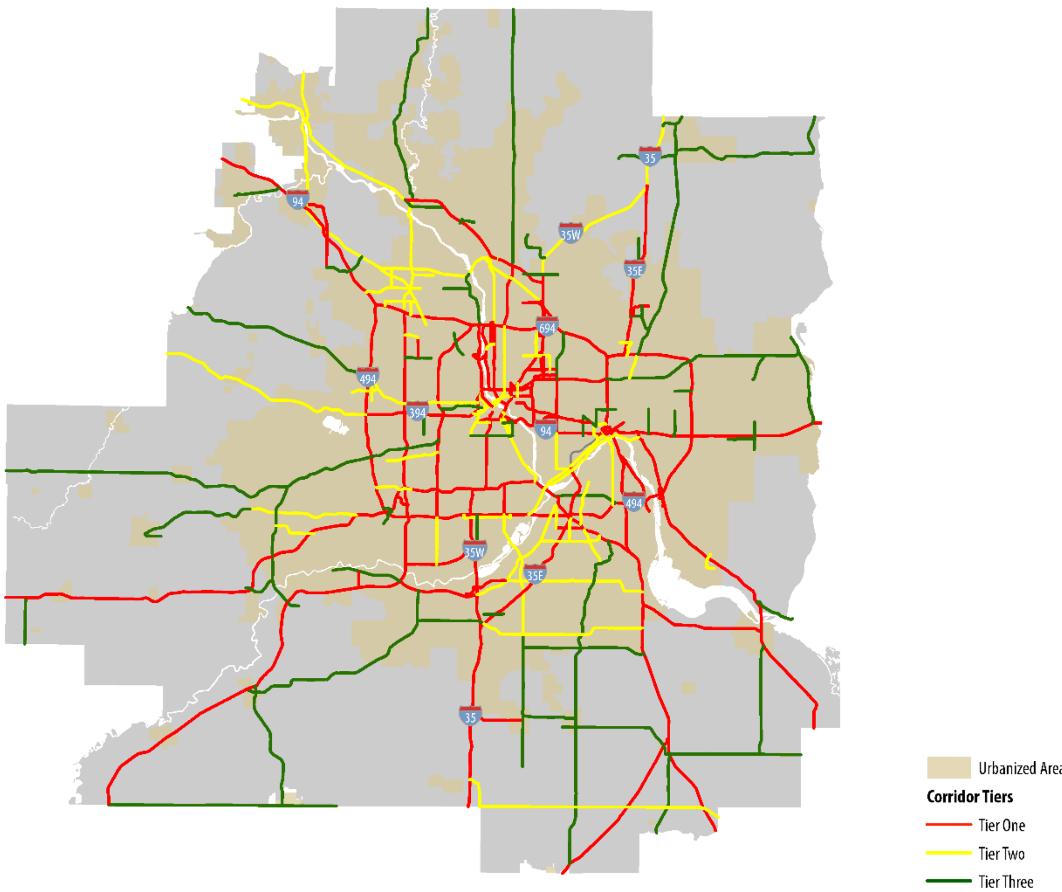
Specifically, the relationship between the five categories shown in Figure 3-11 and the three tiers in Figure 3-12 is as follows:

- Tier One: composite score 24-83, reflecting red and orange colors on Figure 3-11
- Tier Two: composite score 16-23, reflecting yellow-colored corridors on Figure 3-11
- Tier Three: composite score 4-15, reflecting light and dark green colors on Figure 3-11

The large range for the first category reflects the large skew in truck volumes (as mentioned previously, there are a few interstate corridors with high scores and most corridors have low volume scores), in combination with the large weight assigned to truck volume. The scores are entirely relative and are indicative of the order of importance of corridors, but not necessarily the magnitude (for example, a corridor with a score of 50 is not necessarily "twice as important" as a corridor with a score of 25).

The tiered corridors are shown in Figure 3-12.

Figure 3-12: Corridor Tiers




Source: CPCS analysis

Tier One includes a large number of interstate highways, reflecting the high importance of these corridors. However, it is sufficiently expansive as to also include more than 300 miles of principal and minor arterials that serve an important function in truck freight mobility.

Figure 3-13: Centerline Road Mileage in Each Corridor Tier

| | Interstate | Principal Arterial | Minor Arterial | Total |
|---|---|---|---|---|
| Tier One | 211 | 227 | 108 | 546 |
| Tier Two | 18 | 111 | 164 | 295 |
| Tier Three | 0 | 95 | 290 | 385 |
| TOTAL | 229 | 433 | 564 | 1226 |

Source: CPCS analysis

### Manual Modifications to the Tiered Approach

The assignment of corridors to tiers followed a highly quantitative, data-driven process. Although qualitative criteria were not introduced on a systematic basis, in some cases modifications were introduced based on stakeholder feedback. The process for making such modifications is detailed in this section.

As part of a county review process, Met Council staff met with planners and engineers from each county to provide the counties the opportunity to discuss key corridors in their jurisdiction, including identifying any issues with the designation of corridors. The counties also had the opportunity at the meetings and in subsequent emails to ask specific questions about corridors as well as to provide truck count data where these were available.

All seven counties comprising the metropolitan area participated in the review process.

The key changes arising from these meetings were:

- Adoption of the “maximum volume” method described in 3.1.3, whereas previously the approach had been to use MnDOT HCAADT volumes, where available, and scaled ATRI volumes elsewhere
- Adjustments made based on new information/data, including new truck counts and information about specific corridors (for example that a county had transferred jurisdiction of a road to a municipality)
- Adjustments made based on consultant review of specific corridors flagged by the counties. For example, in some places arterial corridor start and end points were at interstates even though there was no interchange. Also, the comments received through the consultant review served as a validation of volumes along certain corridors; (for example, in a small number of cases the automated volume assignment process smoothed out traffic volumes excessively when in reality the volumes were highly concentrated).

In addition, the county review meetings also served to produce information on the counties’ own perceptions of key corridors as well as significant truck freight issues within the county.

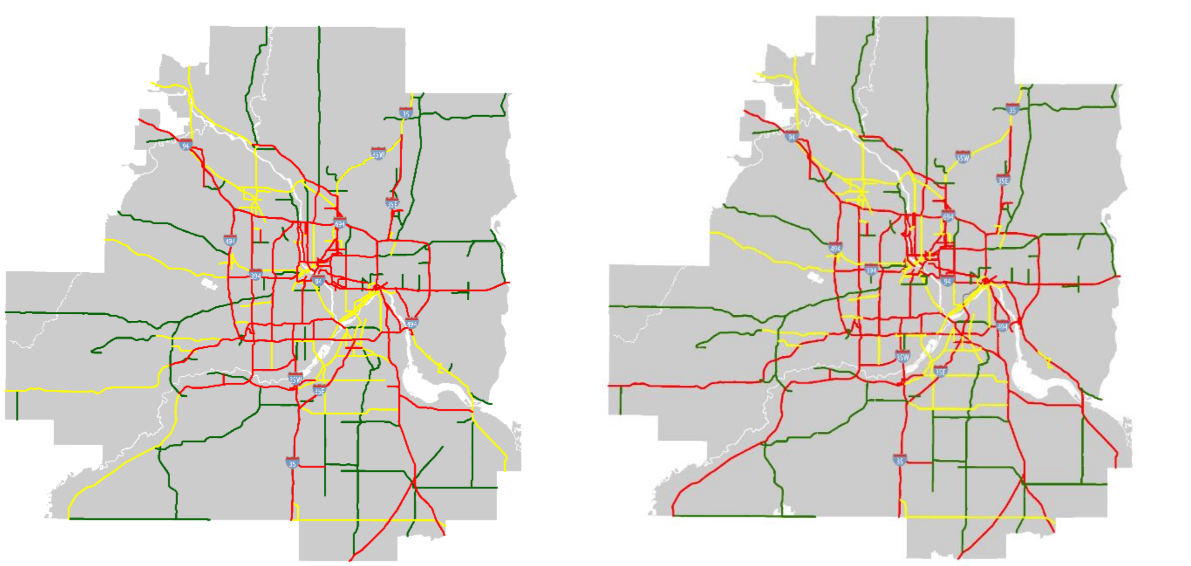
Figure 3-14 summarizes the general principles that were applied in making changes to the corridors based on comments received during the county review process. In general, changes were made where they were supported by data and by the existing methodology or involved small, intuitive changes to corridor definitions; but not if the change would require setting new rules inconsistent with the methodology used elsewhere in the metropolitan area, or if the proposed change was based on predictions, anticipated developments, or qualitative assessments.

Figure 3-14: County Review Process Methodology

| Change Made If… | Change Not Made If… |
|---|---|
| • New truck volume provided | • Corridor not on defined road network (e.g. local or private roads) |
| • Re-analysis of the data revealed anomalies | • Segment, as redefined, would not have qualifying truck volumes |
| • Corridor is affected by methodological changes to defining volumes (i.e. maximum volume method) | • Corridor would be extremely short (well under 1 mile) |
| • More logical corridor definition proposed (e.g. corridor ended at interstate despite no interchange) | • Re-analysis would have involved land use or qualitative factors only without changing scores |
| • Involved removal of truck corridor where the rationale for keeping the corridor was not clear-cut (e.g. non-supportive land use, and barely qualifying volumes) – as there may be data anomalies | • Involved predictions, anticipated developments, or qualitative assessments not supported by data |

Figure 3-15 shows the tiered corridors before and after the county meetings.

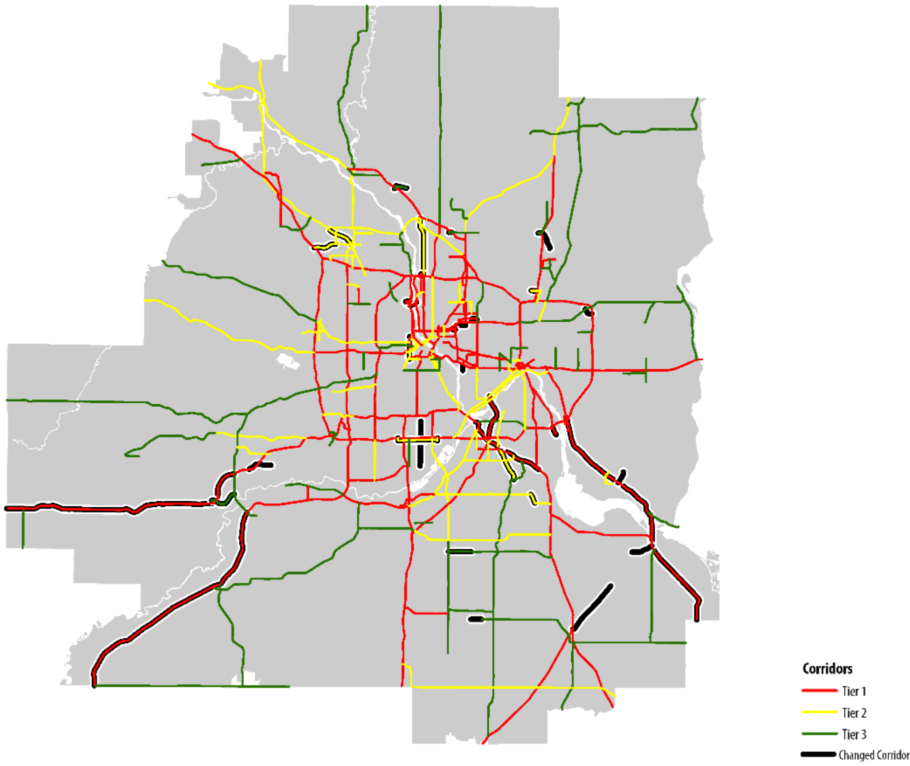
Figure 3-15: Tiered Corridors, Pre- (left) and Post- (right) County Meetings



Source: CPCS

The portions of the Tier One to Three corridors that changed tiers are highlighted in Figure 3-16.

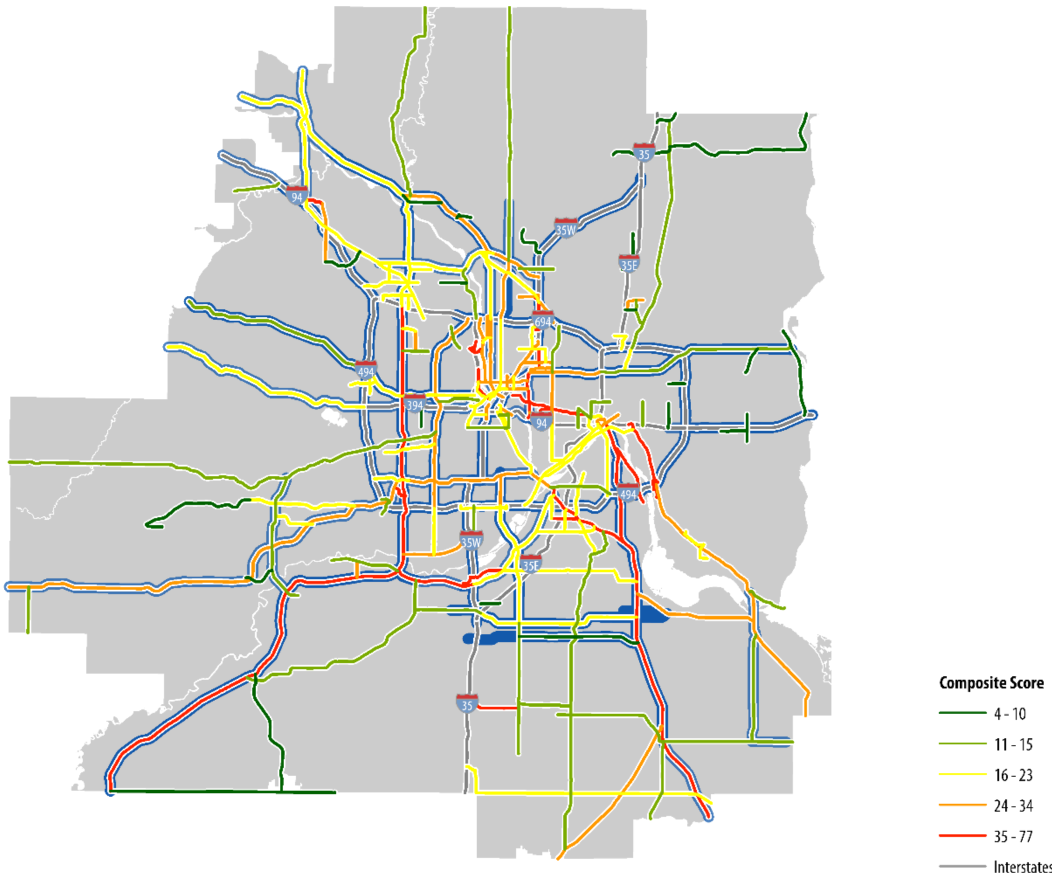
**Figure 3-16: Changes to Tiered Corridors Before and After County Meetings**




Source: CPCS

In addition, the key truck routes identified through the industry consultations (outlined in blue in Figure 3-17) were mapped alongside the key corridors as identified through the data. As shown in the map, there is strong correlation between the corridors identified through industry outreach and those identified through the quantitative process. The consultations thus serve as an additional check on and confirmation of the validity of the quantitative process.

**Figure 3-17: Key Corridors Identified during Stakeholder Consultations**




Source: CPCS analysis and stakeholder feedback

# 4 Performance Issues on Key Truck Corridors

### Key Chapter Takeaways

- Tier one corridors were assessed based on their safety and delay characteristics. Truck delay was calculated using speed data obtained from ATRI, while truck crash data were obtained from MnDOT's online CMAT program
- The top non-interstate corridors for truck delay and truck-related crash sites were identified and ranked
- From among the top safety and delay hotspots, ten sites (including two demonstration sites) were identified for in-field analyses, ensuring variety in terms of functional classification and geographic location. Field visits helped identify possible problem areas and high-level solutions.

## 4.1 Truck Delay

### 4.1.1 Methodology

The methodology for computing truck delay is described in Appendix C. Truck delay was computed using hourly average truck speeds available from ATRI, in combination with the truck volumes developed (as described in Chapter 3) using a hybrid of ATRI and MnDOT HCAADT data.

The volume data are weighted according to the distribution of ATRI truck pings across a 24-hour period. In other words, the delay calculations reflect not only the variation of truck speeds across the day, but also the variation of truck volumes across the day. Delay is thus greatest in those hours that feature both a low truck speed and a high truck volume.

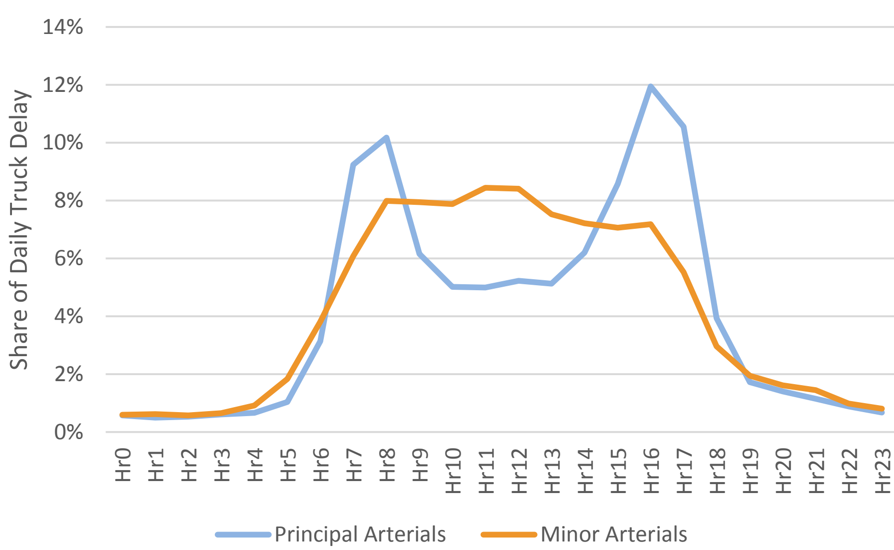
### 4.1.2 Daily Truck Delay Profile by Hour

The average weekday delay across all non-interstate Tier One corridors is shown in Figure 4-1. In the graph, "Hr0" refers to the period from 12 AM to 1 AM.; "Hr1" to the period from 1 AM to 2 AM, and so on.

It should be noted that all analysis in this working paper applies exclusively to non-interstate Tier One corridors. The extent to which similar conclusions may apply for other tiers is not clear, as data for these other corridors were not available from ATRI within the project budget.

The nature of the hourly truck delay profile differs by type of corridor. On principal arterials, peak periods for delay are the AM and PM commuter rush hour, while for minor arterials delay is spread out evenly across the middle of the day.

Figure 4-1: Average Weekday Truck Delay on Tier One Corridors, Hourly Profile




Source: CPCS analysis of ATRI data

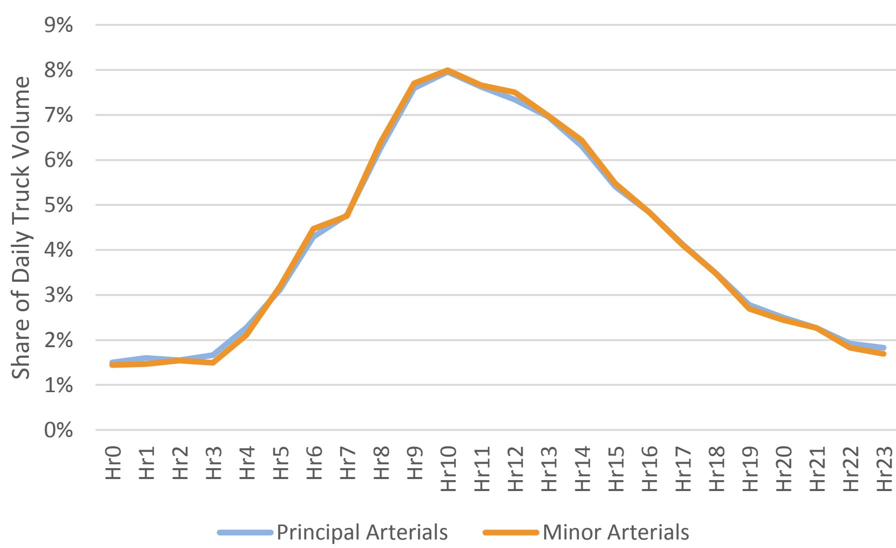
It appears that many of the principal arterial corridors are regionally important, not only for truck travel, but also for passenger travel. This includes corridors such as US-169, US-212, and US-52, among others. For these roads, heavy commuter traffic has a significant impact on truck delay. Conversely, many of the Tier One minor arterials are located in predominantly commercial or industrial areas, which may be relatively less impacted by commuter traffic.

### 4.1.3 Daily Truck Volume Profile by Hour

Truck delay is a function of both truck volume and truck travel speeds. In other words, high truck delay is driven by either high truck volumes or low travel speeds, or a combination of the two factors.

Figure 4-2 shows the daily distribution of truck volumes by hour. Importantly, the peak truck period differs from the more familiar peak commuting periods. Truck volumes peak in the ten o'clock (AM) hour, and overall approximately 50% of truck volumes are observed between 9 AM and 4 PM, i.e. the "midday" period from the perspective of commuter traffic.

Figure 4-2: Average Weekday Truck Volume on Tier One Corridors, Hourly Profile



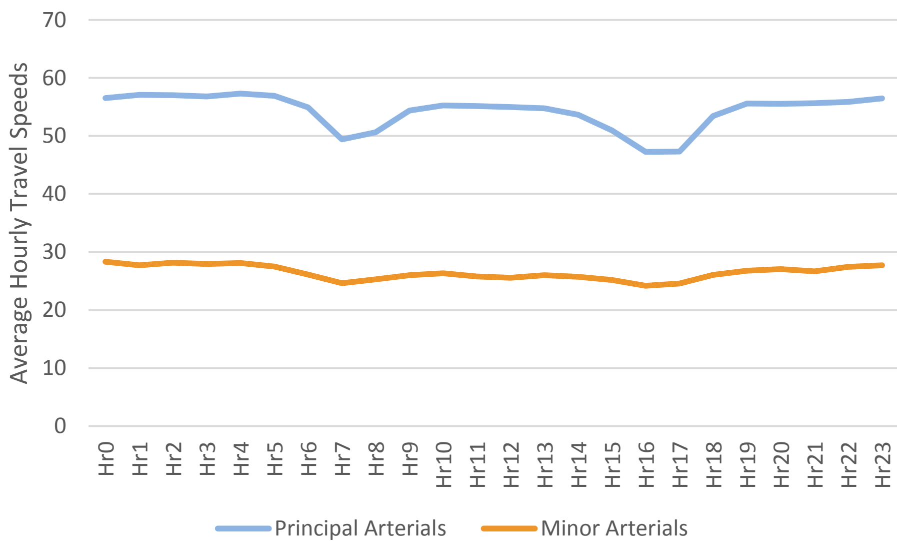

Source: CPCS analysis of ATRI data

The volume profile for principal arterials and minor arterials is virtually identical. It is also worth noting that the daily volume distribution was found to be fairly consistent across all of the top delay hotspots, suggesting that there is not a significant amount of variability by geographic location or type of road.

### 4.1.4 Average Truck Travel Speeds by Hour

Figure 4-3 shows the average truck travel speeds by hour of day.

**Figure 4-3: Average Weekday Truck Travel Speeds on Tier One Corridors, Hourly Profile**




Source: CPCS analysis of ATRI data

As expected, principal arterials have a higher travel speed, at around 58 mph in the overnight hours. This drops to around 55 mph in the midday period and around 47 mph in the PM peak. Minor arterials have an overnight speed of 28 mph, dropping to 26 mph midday and a low of 24 mph in the PM peak.

Although the apparent drop-off in speeds is lower for minor arterials compared to principal arterials, it is important to note that every mile-per-hour drop in speeds does not cause an equal amount of delay. Specifically, the lower the baseline speed, the more delay is caused by each mile-per-hour decrease in speed, because of the inverse relationship between speed and time. For example, for a hypothetical one-mile segment, a drop from 50 mph to 45 mph results in a delay of 8 seconds per truck, whereas a drop from 25 mph to 20 mph results in a delay of 36 seconds per truck.[6]

In the above figure, in all cases the speed listed is the average travel speed, which includes the effects of trucks being stuck in traffic, stopped at signalized intersections, accelerating or decelerating, or stopped waiting to make a turn. It does not, however, include trucks that are stopped at a single location for more than five minutes, so as to factor out trucks making deliveries and those stopped for reasons of rest or vehicle breakdown.

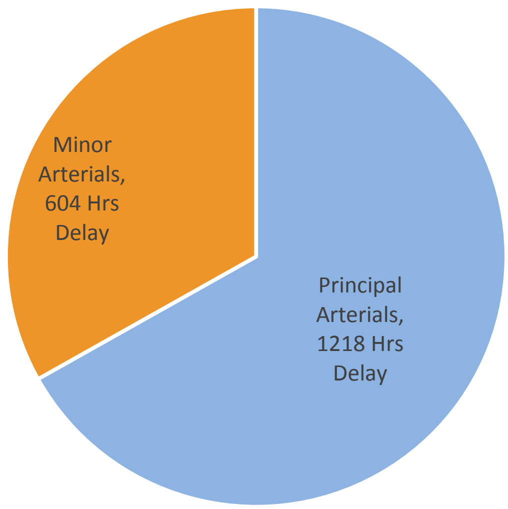
### 4.1.5 Summary of Truck Delay

The distribution of delay between principal and minor arterials is shown graphically in Figure 4-4. Approximately two-thirds of overall truck delay is on principal arterials, and one-third on minor arterials. On a centerline basis, there are 227 miles of principal arterials among Tier One

[6] (1 mile / 20 mph – 1 mile / 25 mph)*(60)*(60) = 36 seconds
(1 mile / 50 mph – 1 mile / 45 mph)*(60)*(60) = 8 seconds

corridors, and 108 miles of minor arterials. Thus, the delay distribution is roughly proportional to the mileage distribution, suggesting that on average principal and minor arterials do not differ significantly, with respect to delay per mile of road.

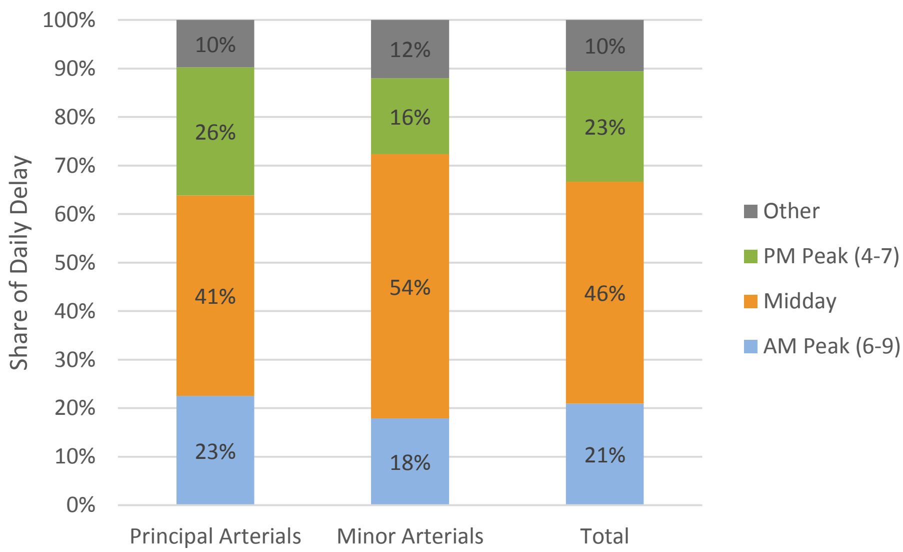
Figure 4-4: Distribution of Weekday Delay, Principal and Minor Arterials




Source: CPCS analysis of ATRI data

Figure 4-5 shows the temporal distribution of delay for principal and minor arterials. Overall, 46% of delay occurs in the midday period, and around 44% in the AM and PM commute peak periods. Principal arterials have a greater proportion of truck delay in the overall AM and PM peak periods (about 49%) compared to minor arterials (about 34%). As noted, this is associated with increased competition for road space on principal arterials from commuter traffic.

Figure 4-5: Temporal Distribution of Delay, Principal and Minor Arterials

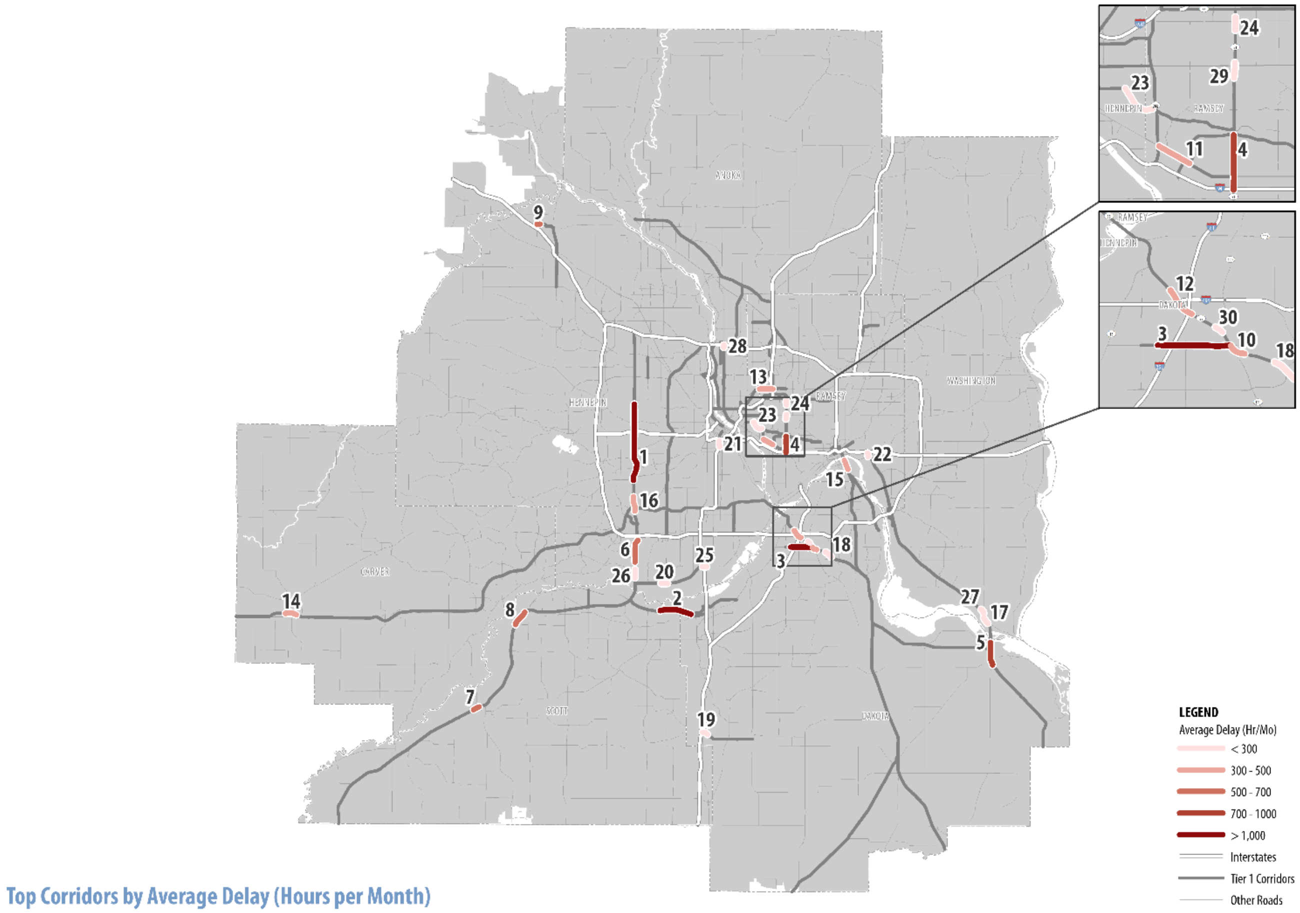



Source: CPCS analysis of ATRI data

### 4.1.6 Top Delay Hotspots

Figure 4-6 shows the top thirty delay hotspots on tier one corridors, based on the methodology described in Appendix C. As the map indicates, many of these hotspots are clustered in a few geographic areas, such as in Eagan, in Minneapolis and St. Paul, and along the US-169 corridor in southern Hennepin/northern Scott County, among other locations.

**Figure 4-6: Top 30 Delay Hotspots on Non-Interstate Tier One Corridors**




Source: CPCS analysis of ATRI data

The top corridors are shown in table form in Figure 4-7. These correspond to the hotspots shown in Figure 4-6. The table shows hours of (all-day) delay per day, per month, and per year; minutes of delay per truck (average across the day); as well as hours of peak delay per day. In this case, peak refers to peak commuting times, consistent with the charts in the previous section (i.e. 6-9 a.m. and 4-7 p.m.).

Figure 4-7: Truck Delay by Delay Hotspot

| Rank | Corridor | Hrs Delay per Day | Hrs Delay per Month | Hrs Delay per Year | Min Delay per Truck | Hrs Peak Delay per Day | % of Delay in AM/PM Peak |
|---|---|---|---|---|---|---|---|
| 1 | US-169 in Hennepin Co. | 135 | 3,037 | 36,446 | 3.2 | 77 | 27/30 |
| 2 | TH 13 in Savage | 109 | 2,442 | 29,298 | 2.4 | 48 | 14/30 |
| 3 | Lone Oak Rd. (CSAH 26) in Eagan | 46 | 1,042 | 12,506 | 2.0 | 16 | 19/16 |
| 4 | Snelling Ave. (TH 51) in St. Paul | 40 | 890 | 10,674 | 3.0 | 14 | 15/19 |
| 5 | US 61 in Hastings | 32 | 713 | 8,556 | 1.3 | 10 | 14/19 |
| 6 | US 169 in Hennepin Co. | 27 | 615 | 7,383 | 0.4 | 19 | 1/69 |
| 7 | US 169 in Scott Co. | 25 | 562 | 6,746 | 0.8 | 8 | 16/15 |
| 8 | US 169 in Scott Co. | 24 | 534 | 6,413 | 0.7 | 8 | 18/15 |
| 9 | Diamond Lake Rd. in Rogers* | 24 | 534 | 6,410 | 0.6 | 9 | 26/10 |
| 10 | TH 55 in Eagan | 21 | 461 | 5,535 | 0.6 | 7 | 20/13 |
| 11 | University Ave. in St. Paul | 20 | 439 | 5,268 | 2.5 | 5 | 12/14 |
| 12 | TH 55 in Eagan | 18 | 408 | 4,894 | 0.7 | 6 | 18/16 |
| 13 | County Road C (CSAH 23) in Roseville | 17 | 378 | 4,535 | 1.1 | 6 | 18/16 |
| 14 | US 212 in Norwood Young America | 16 | 371 | 4,447 | 0.8 | 5 | 15/16 |
| 15 | US 52 in St. Paul | 15 | 335 | 4,020 | 0.3 | 8 | 39/13 |
| 16 | Highway 169 in Edina | 15 | 328 | 3,942 | 0.3 | 11 | 21/57 |
| 17 | Point Douglas Dr. S in Washington Co. | 13 | 292 | 3,508 | 0.6 | 4 | 16/17 |
| 18 | Courthouse Blvd. W in Eagan | 12 | 265 | 3,186 | 0.4 | 5 | 35/17 |
| 19 | Juniper Way in Lakeville | 11 | 249 | 2,993 | 0.4 | 4 | 18/15 |
| 20 | Old Shakopee Rd W in Bloomington | 11 | 251 | 3,007 | 0.8 | 4 | 17/16 |
| 21 | TH 65 in Minneapolis | 10 | 229 | 2,751 | 0.4 | 5 | 19/30 |
| 22 | US-61 in St. Paul | 10 | 215 | 2,586 | 0.5 | 4 | 22/17 |
| 23 | Kasota Ave. in Minneapolis | 9 | 200 | 2,398 | 0.5 | 2 | 15/8 |
| 24 | Snelling Ave. N in Roseville | 8 | 184 | 2,203 | 0.9 | 2 | 12/16 |
| 25 | 98th St. W in Bloomington | 8 | 178 | 2,141 | 0.7 | 3 | 12/19 |
| 26 | US-169 in Bloomington | 8 | 173 | 2,075 | 0.1 | 6 | 2/78 |
| 27 | US-61 in Washington Co. | 7 | 148 | 1,771 | 0.3 | 2 | 17/15 |
| 28 | University Ave. NE in Fridley | 6 | 145 | 1,742 | 0.4 | 2 | 22/14 |
| 29 | Snelling Ave. N in Lauderdale | 6 | 144 | 1,730 | 0.7 | 2 | 16/22 |
| 30 | TH 55 in Eagan | 4 | 100 | 1,198 | 0.3 | 2 | 12/22 |

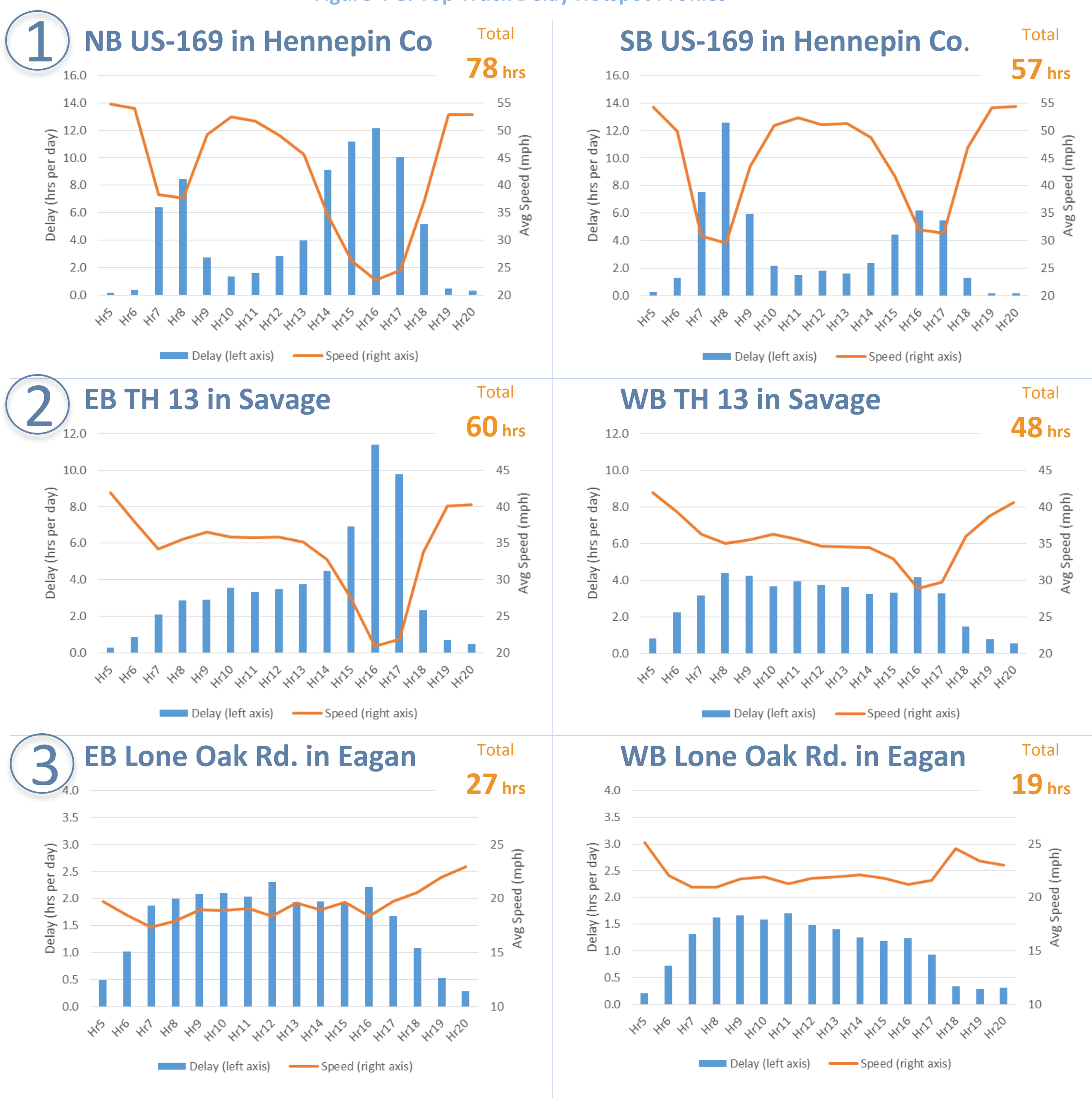
Source: CPCS analysis *indicates potential anomaly

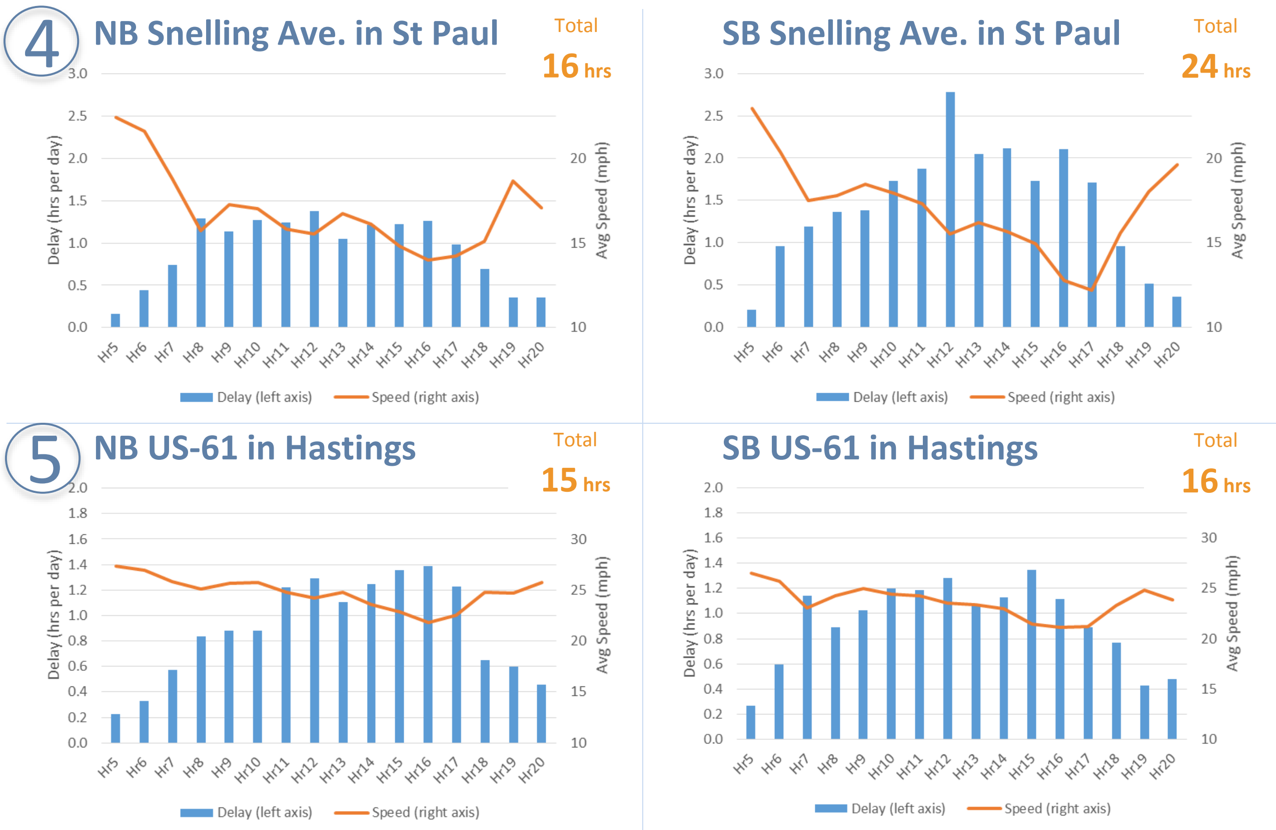
Of note, the study team also studied variation in monthly delay to identify cases where certain months had little to no delay. One such anomaly was noted among the top fifteen bottlenecks in the table above – for Diamond Lake Road in Rogers, the October 2015 delay is much lower than the average for the four 2016 months combined, potentially indicating seasonal/anomalous issues.

### 4.1.7 Delay Hotspot Profiles

The top five hotspots are profiled in greater depth below in Figure 4-8. For each hotspot, the chart shows hourly truck delay (blue columns) along with truck hourly speeds (orange line). The top-right corner lists the total truck delay per day across all hours.

Figure 4-8: Top Truck Delay Hotspot Profiles






Source: CPCS analysis of ATRI data

## 4.2 Safety on Key Truck Corridors

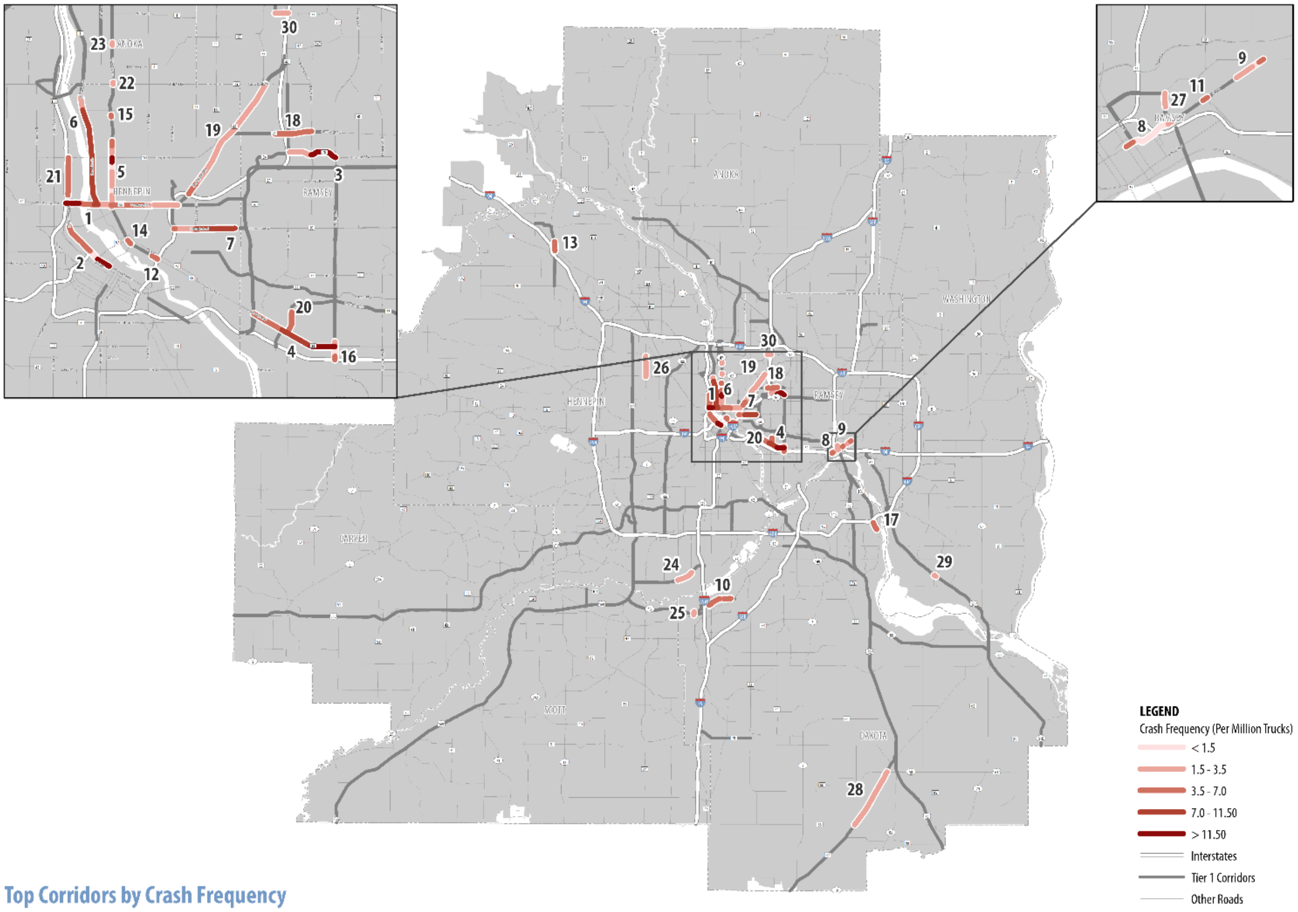
### 4.2.1 Methodology

The crash hotspot methodology is described in Appendix C. The data source for truck crashes was MnDOT's Crash Mapping Analysis Tool (CMAT) online database. Truck crashes were defined as crashes for which at least one participant vehicle was a truck (regardless of fault). Crashes were analyzed for the time period 2010-2015. Crash frequency was determined by weighting the absolute number of truck-related crashes by the volume of trucks on the corridor (using the same truck volumes described in Chapter 3).

### 4.2.2 Top Crash Hotspots

Figure 4-9 shows the top thirty crash hotspots on tier one corridors, based on the methodology described in 4.2.1. As the map indicates, the large majority of these hotspots are clustered in the central part of the metro, particularly in and around Minneapolis and St. Paul. It is notable that many of the segments in these areas are shorter than average; thus, if crashes were compared on a per-VMT basis, geographic discrepancies would likely be even greater than was observed.

**Figure 4-9: Top 30 Crash Hotspots on Non-Interstate Tier One Corridors**




Source: CPCS analysis

The top crash hotspots are shown in table format in in Figure 4-10Figure 4-11. The labeled hotspots in the map in many cases consist of multiple segments; maximum crash density in the table reflects the worst-performing segment (i.e. the segment with the highest crash density).

Figure 4-10: Maximum Crash Density by Delay Hotspot

| Rank | Corridor | Max Crash Density (Crashes per mil. Trucks) |
|---|---|---|
| 1 | Broadway St in Minneapolis | 22.2 |
| 2 | Washington Ave in Minneapolis | 18.8 |
| 3 | County Road B2 in Roseville | 14.3 |
| 4 | University Ave in St Paul | 14.0 |
| 5 | University Ave in Minneapolis | 11.9 |
| 6 | Marshall St NE in Minneapolis | 10.9 |
| 7 | Hennepin Ave in Minneapolis | 9.3 |
| 8 | TH 5/7th St in St Paul | 6.1 |
| 9 | TH 5/7th St in St Paul | 5.8 |
| 10 | Cliff Rd in Burnsville | 5.5 |
| 11 | TH 5/7th St in St Paul | 5.3 |
| 12 | University Ave in Minneapolis | 5.2 |
| 13 | Brockton Rd in Osseo | 4.9 |
| 14 | University Ave in Minneapolis | 4.9 |
| 15 | University Ave in Minneapolis | 4.9 |
| 16 | Snelling Ave in St Paul | 4.9 |
| 17 | TH 156 in St Paul | 4.7 |
| 18 | Cty Road C in Roseville | 4.7 |
| 19 | New Brighton Blvd in Roseville | 4.6 |
| 20 | Transfer Rd in St Paul | 3.7 |
| 21 | Washington Ave in Minneapolis | 3.6 |
| 22 | University Ave in Minneapolis | 3.6 |
| 23 | University Ave in Minneapolis | 3.1 |
| 24 | Old Shakopee Rd in Bloomington | 2.9 |
| 25 | CR 5 in Burnsville | 2.9 |
| 26 | Zachary Ln in Plymouth | 2.8 |
| 27 | Northfield Blvd in Dakota County | 2.7 |
| 28 | US-61 in Washington County | 2.4 |
| 29 | US-52 in St Paul | 2.4 |
| 30 | 5th St NW in Brighton | 2.1 |

Source: CPCS analysis

## 4.3 Field Visits

### 4.3.1 Field Observation Corridor Identification

The purpose of the field visits was to gain an on-the-ground perspective for truck mobility and safety issues on the tier one corridors. To this end, study team member Rani Engineering, based in the Twin Cities, visited each of eight target sites and undertook a high-level investigation of issues that contribute to mobility or safety problems.

Sites were selected in accordance with the following principles:

- Site belongs to non-interstate Tier One corridors
- Site has known issues related to delay or safety (as measured and described in this working paper), or was identified as a problematic location through industry consultations (as described in Working Paper 2)
- Site was confirmed by the TAG, and is not the known subject of any other detailed corridor studies – including not being among the locations identified by MnDOT in its Congestion Management Safety Plan (CMSP) studies, as validated by MnDOT
- Site selection follows a case-study principle, and seeks to include problem locations on a range of Principal and Minor Arterials and roadway types

The purpose of the MnDOT CMSP filter was to avoid duplicative work on trunk highway locations where known problems are already being addressed or solutions have been proposed.

Because of the limited scope of this portion of the study, the purpose of the field visits is not to identify or recommend detailed solutions, nor to present a full accounting of all truck issues in any single corridor. Rather, the field visits serve three fundamental functions:

- to ground the largely quantitative focus of this study by linking data analysis to observed on-the-ground issues
- to bring attention to potential "under-the-radar" truck issues that are not already the subject of detailed studies or projects
- to support and provide context to the study team's analysis on truck mobility and subsequent recommendations in the metro (the subject of Chapter 5 of this working paper)

The selected field visit sites are shown in Figure 4-11. Initially, demonstration corridor visits were conducted in two locations (prior to undertaking the full safety and delay analysis). The purpose of these visits was to establish what type of information and analysis would be most valuable to Met Council and to the TAG. The findings of the demonstration visits were presented at the third TAG meeting in St Paul in October, 2016. The TAG made some recommendations on adjustments to the focus of the field visits; specifically, they recommended that these should focus less on checklist-type information and more on using professional judgment to link apparent issues and problems (such as high delay) with specific infrastructural design features in the field. Related to this change in focus, the selected corridors were shorter in length than the initial trial corridors. The reports from these trial field visits are included in Appendix C.

Figure 4-11 can be related to the map in Figure 4-12 as well as to the demo locations listed from 4.4.1 to 4.4.8.

Figure 4-11: Locations for Field Visits

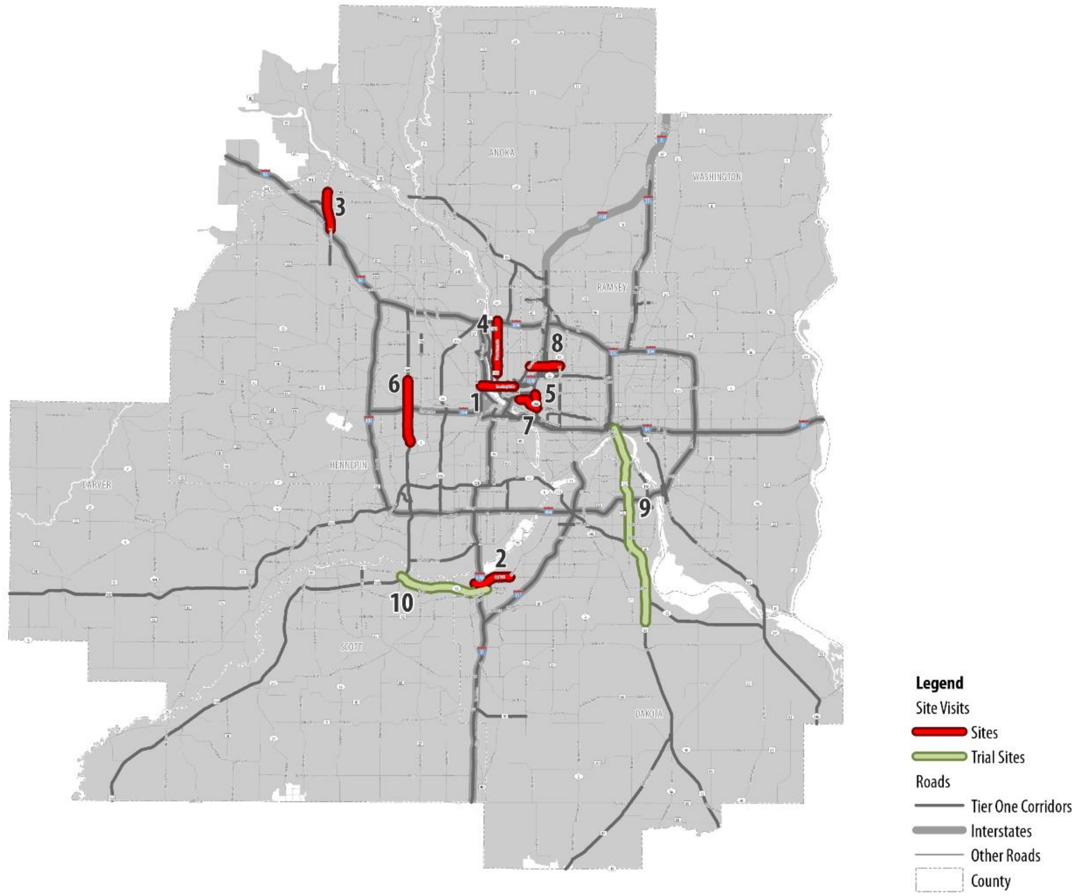
| | Corridor | Location | From – To | Miles | Notes |
|---|---|---|---|---|---|
| 1 | Broadway St/Ave | Minneapolis | I-94 to Johnson St NE | 2.3 | Top crash site, incl. KAB[7] |
| 2 | Cliff Rd (CSAH 32) | Burnsville | Dupont Ave (near I-35W) to TH 13 | 2.7 | Top crash site |
| 3 | Brockton Ln N (CSAH 101) | Rogers | Linden Dr to Diamond Lake Rd | 1.9 | Top crash site incl. rollovers |
| 4 | University Ave | Mpls/Fridley | Lowry Ave to I-694 | 3.9 | Top crash site, access issues identified |
| 5 | TH 280 | St Paul | Kasota Ave to Hennepin Ave | 1.1 | Safety issue identified (ramps) |
| 6 | US-169 | Hennepin Co. | TH 7 to 27th Ave N | 5.1 | Top delay site |
| 7 | Kasota Ave/Elm St | Minneapolis | TH 280 to 17th Ave S | 1.6 | Top delay site |
| 8 | Co Road C | Roseville | New Brighton Rd to Snelling Av | 2.2 | Top delay and crash site, incl. KAB |
| 9* | US-52 | Dakota Co. | I-94 to 145$^{th}$ St E | 15.2 | Access issue identified |
| 10* | TH 13 | Savage | TH 169 to I-35 W | 6.1 | Top delay site |

*demonstration corridor visit locations

The field visit locations are shown in map form in Figure 4-12.

[7] In the notes column, KAB indicates the top three levels of the Federal Highway Administration's KABCO scale, the method used to evaluate injury severity (KAB covers fatal, incapacitating and nonincapacitating injuries but not "possible injury" or "no injury"). In this study, a simple visual scan was performed of whether crashes were disproportionately likely to cause injury rather than be property-damage only; sites were not ranked quantitatively on this basis. The notes column also includes reference to safety and access issues that were described in Working Paper 2, reflecting industry consultations).

**Figure 4-12: Locations for Site Visits**




Notably, US-169 was investigated based on TAG feedback for having inflated congestion rankings due to possibly attracting traffic from I-494 or from TH 100, both of which have been under construction for periods that overlapped with the data years. From MnDOT's available information, the I-494 work was conducted between I-394 and I-694 from April to November 2016,[8] and TH 100 work between I-494 and Barry St. in St Louis Park from August 2014 to November 2016.[9] We cross-checked the various ATRI months against these schedules. While we do not have the data to determine whether TH 100 diversions had an impact on US-169 construction, we did find greater delay for May and August 2016 than for March, suggesting that I-494 diversions potentially did have an impact. However, even in March (outside of the construction period) there was considerable truck delay in the PM peak period, and there was also high truck delay in October 2015. Based on this evidence and the general importance of

[8] MnDOT, I-494: Plymouth

[9] MnDOT, Hwy 100: St. Louis Park, Edina, Bloomington

US-169 as a truck route (confirmed through industry consultations earlier in the study) it was recommended to include US-169 in the field analysis.

TH-280 is the subject of a reconstruction project near the I-35 W interchange ramps;[10] however, the planned work is unrelated to the issue identified initially in industry consultations, thus this corridor was also included.

Also of note, subsequent to the initial demonstration corridor visits it was determined that TH 13 in Savage/Burnsville was the subject of a recent corridor study that provided guidance for transportation improvements along this corridor.[11]

## 4.4 Field Visit Reports

Field visits were conducted to identify truck mobility or safety issues and geometric constraints and were conducted in early December 2016. The study team conducted the visits on days without meaningful precipitation or snow accumulation to avoid possibly biasing the findings.

### 4.4.1 Corridor 1: Broadway Street / Broadway Avenue in Minneapolis

**Site Description**

Broadway Street from I-94 to Johnson Street is a four-lane urban collector street that runs east/west. The 2.3 mile corridor is undivided for most of the way, with a few intersections containing concrete medians, and has 13 signalized intersections. There are three grade separated and one at-grade railroad crossings. The west end, from I-94 to NE Main Street, is commercially zoned. The remainder of the corridor is mostly residential with a few blocks on the north side commercial.

**Geometric Constraints/ Safety Issues**

During the corridor drive-through, it was noticed that signal timing along the route was mostly good, however, there seemed to be a few signals that were not synchronized. Given the number of traffic signals and the higher volumes of the major roadway, consideration for freer movement of traffic on this road should be provided.

- Investigation into updating signal timing for possible coordination of signals might be warranted.

In the residential and commercial areas between NE Buchanan Street and NE Marshall Street, a total of 21 blocks, street parking is allowed on both sides of Broadway except from 7 a.m. to 9 a.m. and 4 p.m. to 6 p.m. Monday through Friday. These parking times should be strictly enforced to reduce merging and slowdown problems, which are a potential safety hazard.

[10] MnDOT, Hwy 280 & Surrounding Area Projects: St. Paul (I-94) to Roseville (I-35 W)
[11] MnDOT, Hwy 13 Corridor Study: Savage, Burnsville

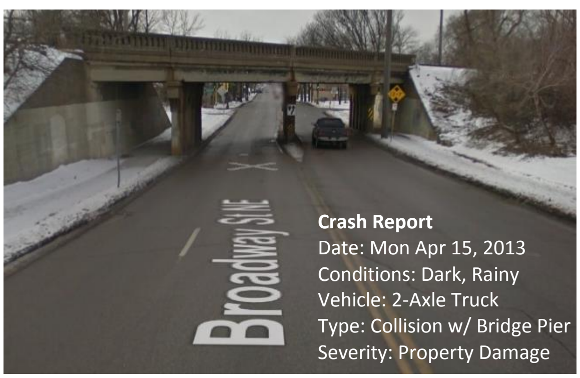
- Further investigation may be warranted to verify enforcement of prohibited street parking times, as well as to identify possible areas to eliminate parking.

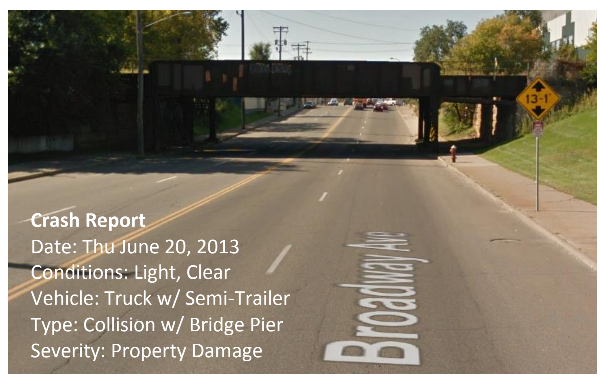
The speed limit of the roadway is 30 mph and lane widths are as narrow as nine feet for some blocks along residential areas. These lane widths are not sufficient for this highly-used truck route.[12]

The bridge that provides the grade separated railroad crossing between NE Buchanan Street and NE Lincoln Street, (at which Broadway Street passes under), is unsafe to reasonably accommodate two-way truck traffic. At this bridge, the width of the road, for both directions, narrows to approximately 17 feet wide due to a bridge pier in the middle of the road. This is a high truck volume and accident site. The bridge itself also provides only 13'-7" vertical clearance above the road, which is below the FHWA urban collector minimum of 14'-0", and is in degraded condition. (Bridges shown in Figure 4-13).

- A major reconstruction project of a new bridge and road widening could solve this unsafe condition.

**Figure 4-13: Shallow Bridges along Broadway Ave.**




Source: CPCS analysis of MnCMAT data. Photos Google Street View. Left: Broadway near Buchanan; right: Broadway near W. River Rd.

Due to the relative narrowness of this road corridor, there is not enough room for designated left turn lanes. The road is divided by a double yellow stripe. The intersections at Old Central Avenue and N Washington Avenue are the only two of the 13 signalized intersections with dedicated left turn lanes. At certain intersections, there are protected green arrow left turns. However, their timing and use was not analyzed for the corridor drives.

[12] From the National Association of City Transportation Officials (NACTO): "Lane widths of 10 feet are appropriate in urban areas and have a positive impact on a street's safety without impacting traffic operations. For designated truck or transit routes, one travel lane of 11 feet may be used in each direction." NACTO, Urban Street Design Guide

- A more in-depth traffic study should be undertaken to analyze the effects of having no left turn lanes and only certain intersections with left turn arrows. The study could also include analyzing different intersection configurations and possible elimination of certain signalized intersections to help increase the flow of trucks and reduce potential crashes.

### 4.4.2 Corridor 2: Cliff Road (CSAH 32) in Burnsville

**Site Description**

Cliff Road from Dupont Avenue to Minnesota TH 13 is a four-lane, undivided urban street, except for a portion from Dupont Avenue to just past I-35W, where the road is two-lane with a few concrete medians. The route is 2.7 miles long and has three traffic signals at the eastern end, including TH 13, and one at-grade railroad crossing. It is bounded by commercial and industrial warehousing zones. Between the railroad tracks towards the west end and Riverwood Drive, approximately 1.4 miles long, the route is uphill from west to east and there is only commercial zoning on the south side of the road.

**Geometric Constraints / Safety Issues**

Historical data indicates that Cliff Road between S 12$^{th}$ Avenue and Riverwood Drive experiences a higher than normal crash rate. In this section, there are two lanes in each direction and a fifth lane marked on the eastern half for a left turn lane for EB traffic to turn NB on 12$^{th}$ Avenue, and a left turn lane for WB traffic to turn SB on Riverwood Drive on the western half. There is a driveway about mid-block on the south side of the road that currently allows turns onto WB Cliff Road, which must cross two lanes of traffic and the left turn lane.

- This driveway could be made into a right in/right out only driveway to avoid the conflict points.

Between the Riverwood Drive and Nicollet Avenue, there are 12 driveways to commercial buildings that access Cliff Road on the south side of the road. For this stretch of road, traffic is separated by only a double yellow stripe. WB left turning traffic into these driveways must wait to turn into the driveways in a thru lane, and left turning traffic out of the driveways must wait for a safe clearance to cross EB traffic and join WB traffic.

- Major reconstruction of this section of the corridor could expand the road to either five lanes with a left turn lane (such as at River Ridge Blvd intersection to the east of the railroad tracks), or left turn lanes with acceleration lanes and dividing median.

***Issues Identified***

- Uphill gradient west-to-east from I-35 W
- Large number of private commercial driveways with limited visibility due to bend in road
- Limited dedicated left-turn lanes
- High-speed thoroughfare with many access points

### 4.4.3 Corridor 3: Brockton Lane N (CR 13) in Rogers

**Site Description**

The Brockton Lane truck corridor is located in the Minneapolis suburb of Rogers. It is a two mile, two lane Minor Arterial on the Twin Cities Functional Classification System running north/south with Linden Drive at the south end and Diamond Lake Road S at the north end. The road is mainly rural with some commercial and residential areas in the very south end, and commercial zoning in the north. There is one at-grade railroad crossing approximately 175 feet from Linden Drive to the south and 125 feet from Highway 81 to the north, as well as three traffic signal controlled intersections. There are several other at-grade side street and driveway turnoffs along the route.

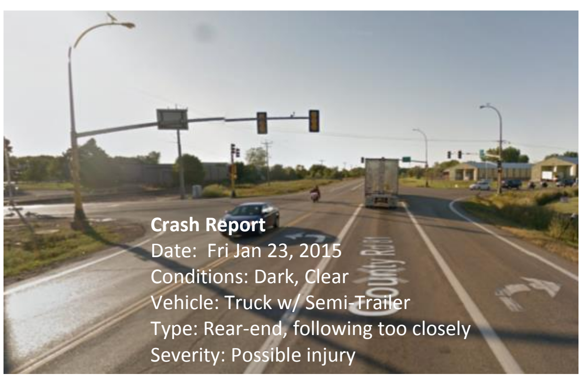
**Geometric Constraints / Safety Issues**

For most of the route from Highway 81 to Diamond Lake Road S, the two-way lane widths were between 11.5 feet and 12.5 feet with approximately a one foot gravel shoulder on both sides. After the shoulder on each side, the road dropped off severely approximately one to six feet down. Recovery from the shoulder would appear to be difficult and could result in a rollover.

The NB Brockton Lane/124th Avenue N intersection has a widening of the roadway meant to function as a right turn lane. The unstriped turn lane is approximately 7 feet at its widest point. This turn lane is not sufficiently wide to allow vehicles trailing a turning vehicle to safely pass by without encroaching upon the oncoming traffic lane.

Another location of interest is Brockton Lane at CSAH 101 (Figure 4-14).

**Figure 4-14: Brockton Lane at CSAH 101**




***Issues Identified:***

- Intersection of CSAH 101-CR 81 is a high crash site – 9 truck-related crashes 2010-2015. Long stretch without traffic signals, skewed intersection.
- Advance sign alerting of intersection, but may be hard to see signal color in poor/inclement weather

Source: CPCS analysis of MnCMAT data. Photos Google Street View. Left: Broadway near Buchanan; right: Broadway near W. River Rd.

### 4.4.4 Corridor 4: University Avenue in Minneapolis/Fridley

**Site Description**

University Avenue from I-694 at the north end to Lowry Avenue at the south end is a four-lane Minor Arterial with dividing median. It is approximately four miles long and has several traffic signals. The whole of the corridor can be described in two distinct halves. South of 37th Avenue NE, the zoning is primarily industrial with a major semi-truck and rail freight yard on the east and west sides. There are three blocks of residential zoning at the Lowry Avenue end. The north half on the other side of 37th Avenue NE is residential, and for the entire length, there are no cross street intersections or driveways except at five major signalized intersections.

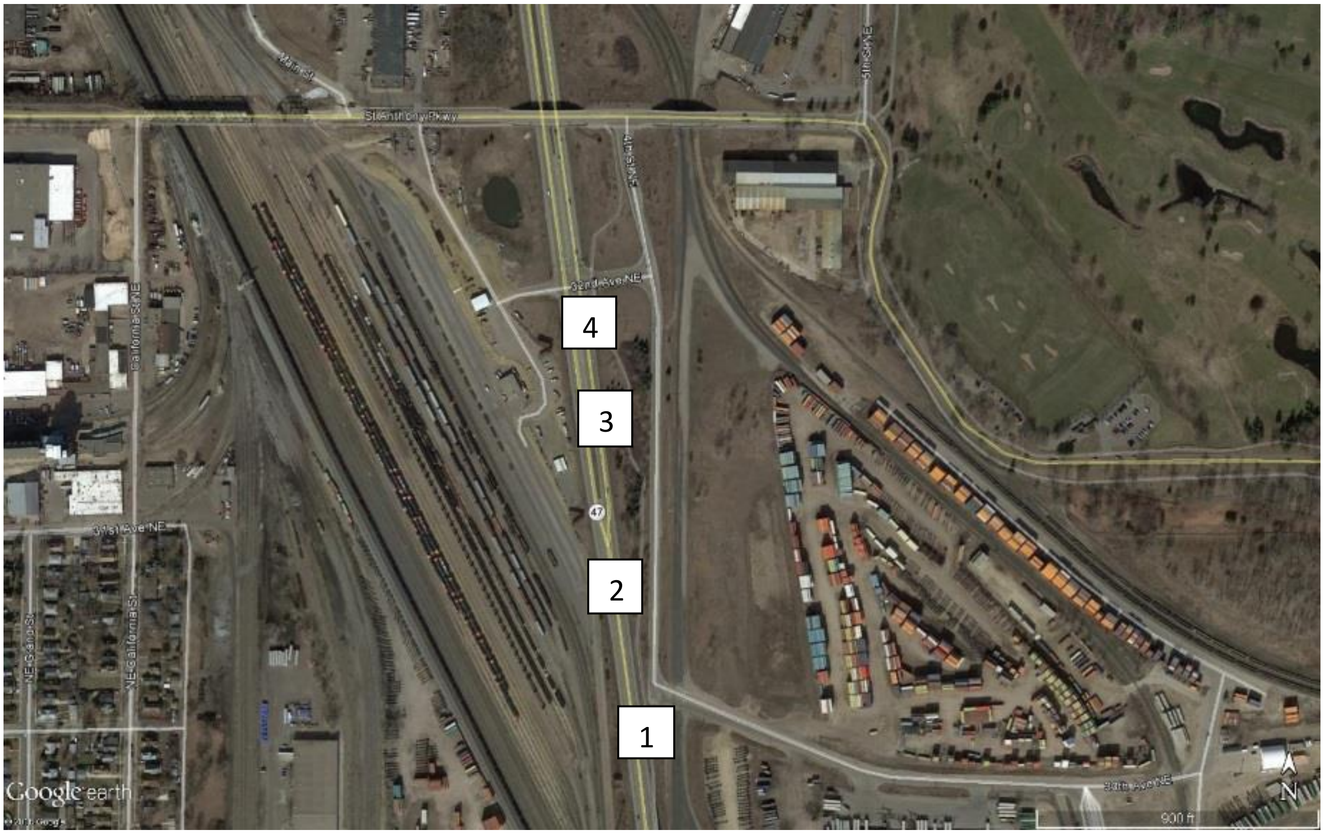
**Geometric Constraints / Safety Issues**

The geometric and safety issues on this corridor are in the southern half. From Lowry Avenue to NE 27th Avenue, street parking is allowed during certain times of the day, essentially narrowing the four lanes to two. Street parking is allowed on the SB side anytime except 7 a.m. to 9 a.m., Monday thru Friday, and on the NB side anytime except 4 p.m. to 6 p.m. Monday thru Friday. These parking times must be strictly enforced to reduce merging and slowdown problems.

- Further investigation may be warranted to possibly eliminate the street parking altogether.

There is only one entrance off University Avenue at 32nd Avenue NE for truck traffic to get to the CP Rail Shoreham Yard on the east side (see Figure 4-15 below). This is also a high train traffic area, and the current geometry of the 32nd Avenue NE/4th Street NE access drive for semis has it crossing the railroad tracks 0.3 mi south from the access road intersection with University Avenue. This 32nd Avenue NE intersection off University Avenue is controlled with a traffic signal with turning lanes for both NB and SB semis. It was witnessed during the site drive that semi-trucks were backed up all the way down 4th Street NE, through the 32nd Avenue NE intersection, and past the turn lanes on University Avenue for both NB and SB, to where the waiting semis were extending into the through lanes of University Avenue. (See Figure 4-16 below.) During this observation, the bridge over the railroad tracks 0.2 miles west of University Ave on St. Anthony Parkway was closed for construction. 32nd Avenue NE is part of the detour adding additional traffic that will be removed when the bridge construction is completed (scheduled for mid-summer 2017).

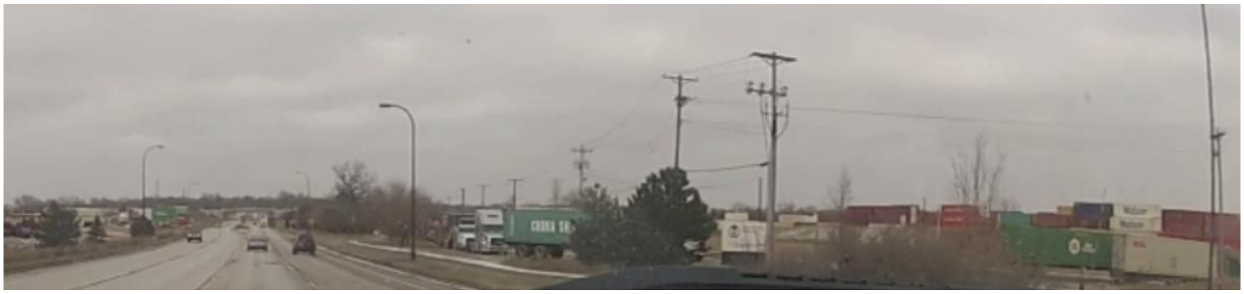
Figure 4-15: University Avenue near Intermodal Facility Aerial View




Source: Google Maps

- This area needs further investigation to look at train and truck traffic and how to best access the intermodal facility when the bridge construction is completed

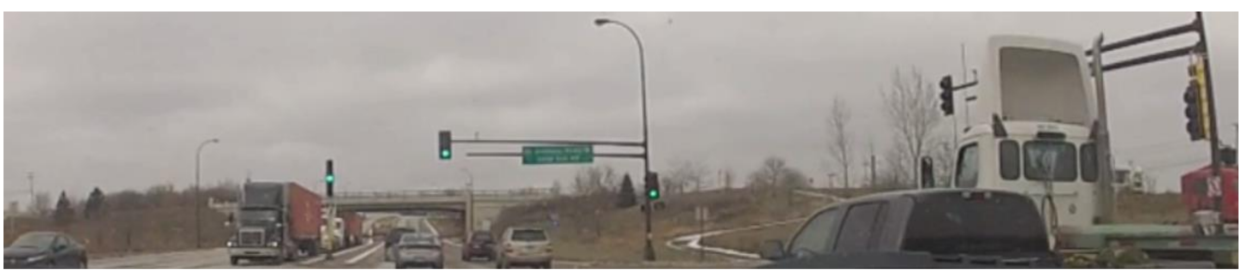
**Figure 4-16: University Avenue near CP Yard, Photos of Truck Queuing**



*1. Trucks queuing along 4th St NE (directly east of University Ave). Looking north*

*2. Trucks queuing along University Ave. waiting to turn right onto 32nd Ave NE. Looking north*

*3. NB trucks queuing at intersection of University Ave. and 32nd Ave NE waiting to turn right. Looking north*



*4. SB trucks queuing at intersection of University Ave. and 32nd Ave NE waiting to turn left. Looking north*

Source: Screencaps of Rani field visit videos

### 4.4.5 Corridor 5: TH 280 in St Paul

Minnesota TH 280 between Kasota Avenue and Hennepin Avenue is a north-south running four-lane Principal Arterial freeway. It has three interchange exits in the short 1.1 mile corridor. The corridor is surrounded by residential neighborhoods on the east side and commercial areas on the west side. The corridor is relatively short, so constraints and safety issues were found primarily at the interchanges.

### Geometric Constraints / Safety Issues

The Kasota Avenue exit at the south end of the freeway section is a folded diamond design due to railroad tracks on the north side of Kasota. The SB on and off ramps are acceptable, as well as the NB off ramp. The NB on ramp is a clover loop that is uphill and appears to have a short acceleration and merge lane for a truck.

- The geometry of the interchange is limited primarily because of the railroad tracks. TH 280 carries over Kasota Avenue and the tracks with a bridge. Further investigation of the bridge width would be needed to see if the acceleration and merge lane could be extended northward.

The middle exit off TH 280 is Como Avenue. It does not directly serve an intersecting cross street, but joins parallel side streets on both sides. Like the Kasota interchange, it is also a half clover leaf with acceleration and deceleration lane issues for the on and off ramps. See Figure 4-17 below.

- One possible solution to this awkward interchange is to eliminate it. Existing routes provide parallel side street access to the Hennepin Avenue interchange a half mile north.

**Figure 4-17: TH 280 and Como Avenue Interchange Aerial View**


Source: Google Maps

On the north end of the corridor is the Hennepin Avenue interchange. This interchange was recently re-constructed with a standard diamond design with sufficient acceleration and deceleration ramps and merges.

### 4.4.6 Corridor 6: US-169 in Hennepin Co.

**Site Description**

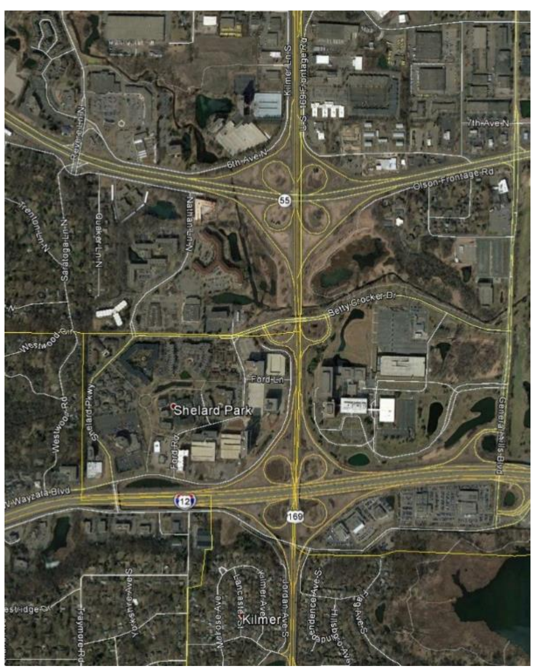
US Highway 169, from 27th Avenue N at the north end to Minnesota TH 7 at the south end, is a four-lane divided Principal Arterial freeway with interchange and grade separated crossroads. The corridor is approximately 5.1 miles long. Commercial and industrial zones are located along the route. Interchanges with US 169 and major highways occur at Trunk Highway 55, I-394, and TH 7. This corridor carries one of the highest traffic volumes in the metro area and is a site of major delay and accidents.

Of note, US 169 has undergone several major construction projects in recent years, as well as attracted traffic volumes from I-494 and TH 100 construction projects, that has most likely impacted delay and accident patterns for this corridor.

**Geometric Constraints / Safety Issues**

Within this 5.1 mile long corridor, there are 7 full interchanges, one half interchange, and two at-grade right in/right out access points, averaging two interchange access points per mile. The half interchange is at W 36th Street where there is only a SB off ramp and a NB on ramp. The two major interchanges at Highway 55 and I-394 are clover leafs where merging lanes are combined and short. They are approximately two-thirds of a mile from one another (see Figure 4-18 below). Between many of the exits, merge lanes continue into each other creating conflict points of delay and accidents.

Figure 4-18: US-169 Interchanges at Highway 55, W 36th St, and I-394 Aerial View




Source: Google Maps

- Because there are so many entry and exit points onto US 169 within such a short distance, there is not much opportunity for traffic to get up to speed. There are a greater number of conflict points with merging in this corridor. A more in depth traffic study could be initiated to investigate the possibility of eliminating several interchange access points.

The two at-grade access points lead to residential side streets. These exits are at W 16th Street/Independence Avenue and Jordan Avenue S/W 28th Street, both south of I-394. The W 16th Street/Independence Avenue access point is a site of many accidents. The Jordan Avenue S/W 28th Street exit is a delay site. Both have very short on and off ramps, as well as acceleration and merge lanes. The impact to trucks occurs when vehicles trying to get on or off the US 169 mainline cannot get up or down to proper speed to safely merge and, in turn, cause accidents and delays to all traffic.

- The W 16th Street/Independence Avenue exit (Figure 4-19) could possibly be eliminated to reduce accidents and delays.

**Figure 4-19: US-169 Interchange at W 16th St/Independence Ave Aerial View**


Source: Google Maps

- The Jordan Avenue S/W 28th Street exit (Figure 4-20) could possibly be reconfigured through a major reconstruction to reduce delays.

Figure 4-20: US-169 Interchange at W 28th St/Jordan Ave Aerial View


Source: Google Maps

### 4.4.7 Corridor 7: Kasota Ave/Elm St in Minneapolis

**Site Description**

Elm Street/Kasota Avenue is a two-lane urban street bounded mainly by industrial warehouses and office and construction supply buildings. This signed truck route serves an important function as the only access corridor for a number of facilities involved in rail transportation/transloading and warehousing/distribution. On the Elm Street portion of the road, there are residential areas on the north side, however there is no access for them onto Elm. Semi-truck traffic is above normal due to the warehouses, and the office building parking lots are at capacity daily and parking overflows into the street on the Kasota portion of the road. There are no traffic signals along the corridor, and there is a four-way stop sign at Elm Street and 17th Avenue.

**Geometric Constraints / Safety Issues**

Driveway turnout radii from the warehouses on the south side of Elm Street are potentially too small. It was noted on the site drive that a semi had to turn onto EB Elm Street by extending out into oncoming traffic.

- Although, data does not show long delays or accidents on Elm Street, this is a safety issue that can possibly be remedied with larger radii for the driveways, as well as possibly alleviating any delay.

There is an at-grade railroad crossing approximately 350 feet west of the SB interchange of TH 280. Trains at this crossing occurring during peak times of traffic coming to or leaving work are a potential source of delay and backup.

The asphalt pavement on the Elm Street section is in marginal condition with transverse and longitudinal cracking.

On street parking limits visibility of turning vehicles and is a safety concern.

### 4.4.8 Corridor 8: County Road C in Roseville

**Site Description**

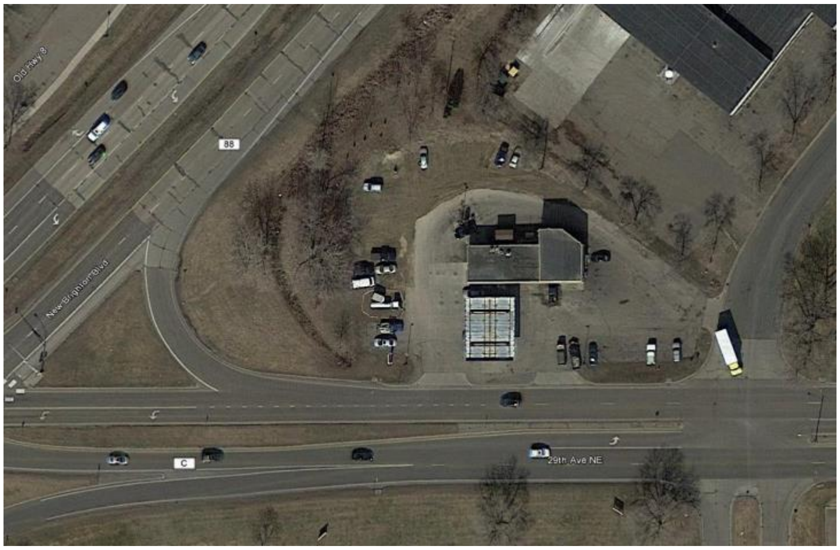
County Road C (CR C) is a four-lane Minor Arterial with a dividing median running most its length. I-35W intersects CR C at approximately half-way, with commercial zoning on the east half and a mix of industrial and commercial zoning on the west half. The western half receives significant fuel tanker traffic due to two petroleum plants, one on the north side and one on the south side of CR C, between Walnut Street and Long Lake Road.

**Geometric Constraints / Safety Issues**

The intersection of CR C and New Brighton Blvd is a skewed intersection. The turn for WB CR C traffic to NB New Brighton is a sharp uphill merge with a very short acceleration lane. There are backups in the afternoon when traffic volumes increase. See Figure 4-21 below.

- Currently, there is a yield sign for traffic turning from WB to NB. There appears to be room to extend this acceleration lane to allow traffic to get up to speed. Changing the sign from yield to merge could ease backups.

**Figure 4-21: County Rd C and New Brighton Rd Intersection Aerial View**




Source: Google Maps

There is an at-grade railroad crossing between Walnut Avenue and Long Lake Road approximately 1400 feet east of the entrance to the petroleum storage plant. On each side of the road at the tracks, there is a pull off lane for trucks carrying hazardous materials, which are required to stop prior to crossing any railroad tracks. The acceleration lanes of these pull offs in both directions are less than 175 feet long. Due to the proximity to the petroleum plant, semi tanker truck traffic is higher than normal, and during times of heavier traffic volumes, semi tanker trucks have difficulty getting back into flowing traffic and will cause slowdowns. See Figure 4-22 below.

- Challenges to extending the acceleration lane along the north side include, relocating utility poles and a hydrant, and a retaining wall. There is potential to extend the lane approximately 75 feet before meeting the retaining wall, however relocating the utilities may require property acquisition from the petroleum plant.

- There does appear to be adequate right-of-way to extend the EB acceleration lane.

**Figure 4-22: County Rd C Rail Crossing Aerial View**


Source: Google Maps

The exit of the petroleum plant for WB semi tanker trucks has no acceleration lane and is another point of backup during heavy volumes. See Figure 4-23 below.

- There are utility poles and a little used parking lot where an acceleration lane could be constructed.

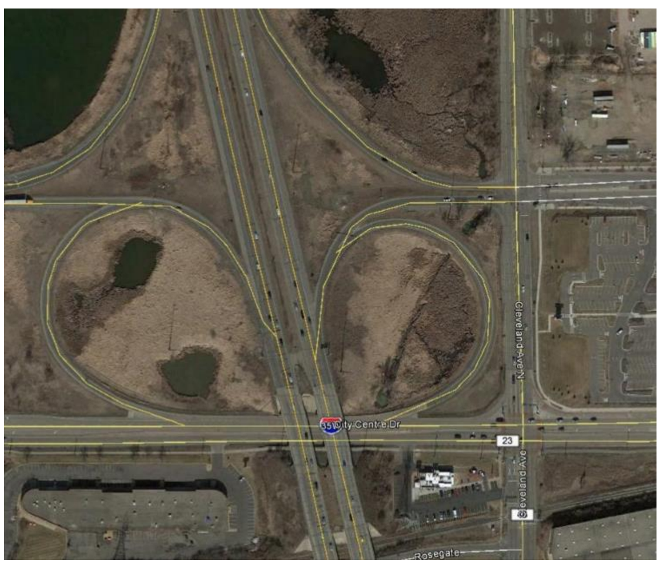
Figure 4-23: County Rd C and Petroleum Plant Aerial View

Source: Google Maps

Due to railroad tracks to the south of CR C, the interchange of I-35W and CR C (Figure 4-24) has a unique geometry. Vehicles entering NB I35W from EB CR C are required to take two left turns. First from CR C to Cleveland Avenue, then to the on ramp for NB I35W. The left turn lane on CR C is 160' long. Backups on NB Cleveland Avenue often prevent vehicles from turning left from EB CR C.

- Potential solutions include changes to signal timing or updates to interchange geometrics. Existing buildings and elevation changes will pose challenges to updating geometrics.

Figure 4-24: County Rd C and I-35 W Aerial View



Source: Google Maps

### 4.4.9 Corridor 9: US 52 between I-94 and 145th Street E

US-52 was one of the locations selected for demonstration corridor field visits. This site was selected because of its high importance to freight transportation as well as having been cited in industry interviews.

**Description of Corridor**

US Highway 52, from I-94 in St. Paul at the north end to Minnesota TH 42/145th Street E at the south end, is a four-lane divided highway with primarily interchange and grade separated crossroads, as well as several at-grade intersections and driveways in the southern half of the corridor. The corridor is approximately 15.5 miles long. Industrial zoning is located for 1.5 miles in the north half and for 2 miles in the south half. The middle portion of the corridor is bounded by residential and commercial zones. There are no traffic signals along the route and traffic is free-flowing. Below is a summary of potential safety issues or constraints for truck traffic in the roadway corridor:

**Bridge Clearances**

There are a total of 14 bridges that cross over US 52 in this corridor. Eleven of the bridges are interchange overpasses, and three are pedestrian bridges. None of these bridges have posted bridge heights indicating restrictions.

**Bridge and Pavement Weight Limits**

There are twelve bridges that traffic flows over along the corridor. None of them have posted weight limits. There are also no posted weight limits for the pavement of the roadway.

**Turning Radii**

There are six at-grade intersections/driveways in the southern third of the route that enter/exit onto US 52, starting at Inver Grove Trail. Two of them, including Inver Grove Trail, are private driveways to residences, a third one is abandoned, and the last is to an electrical substation. It would not be expected for heavy truck traffic to use these turnouts, therefore turning radii are not a factor. The other two at-grade intersections occur at TH 55 and 140th Street. Their turning radii appear to be sufficient for trucks.

**Merge/Acceleration Lanes**

All of the interchanges merging onto US 52, both northbound and southbound (NB, SB) have long acceleration lanes. The six at-grade intersections/driveways described above in the previous section have no dedicated acceleration and merging lanes for turning traffic onto US 52. There does appear to be sufficient space to construct acceleration and merging lanes at them all.

### 4.4.10 Corridor 10: MN TH 13 between MN TH 169 and I-35W

TH 13 was the second location selected for demonstration corridor site visits. Subsequent to the demo visit being carried out, it was discovered that this location is already the subject of a more detailed study carried out by MnDOT.[13]

**Description of Corridor**

Minnesota TH 13 from I-35W to Minnesota TH 169 is a four-lane divided highway with several overpass and at-grade cross streets, as well as several driveways on the north side that enter/exit TH 13 westbound (WB). The highway is zoned by primarily industrial areas along the north side, and commercial areas along the south side. Three of the at-grade intersections are signalized. Below is a summary of potential safety issues or constraints for truck traffic of the roadway corridor:

**Bridge Clearances**

There are two bridge overpass crossings along the route, one at CR 5 and the other a railroad crossing approximately 665 feet east of Xenwood Avenue. Neither bridge has posted heights of the bridge.

**Bridge and Pavement Weight Limits**

There are two bridges that traffic flows over, one over I-35W and one for the eastbound (EB) fly-over of TH 13 where it turns southbound (SB). Neither bridge has posted weight limits. There are no known or posted weight limits for the pavement of the roadway.

**Grades**

There is a section of roadway approximately 1.25 miles long, starting approximately 1500 feet east of Washburn Avenue and ending at I-35W, where the grade is greater than 4 percent for EB traffic. The rest of the highway section is less than 4 percent grade.

**Turning Radii**

There are two at-grade intersections where turning radii for trucks appear to be too small. One is at the Washburn Avenue right turns (RT) onto TH 13, both EB and WB. This intersection is signalized. The other is at the RT from SB Yosemite Avenue onto TH 13 WB, which is an unsignalized intersection.

**Merge/Acceleration Lanes**

The at-grade intersections and driveways on TH 13 have short to no dedicated acceleration and merging lanes for all turning traffic onto TH 13 EB and WB. Figure 4-25 below gives a summary of approximate merge lengths and whether there possibly is room to install them.

[13] MnDOT, Hwy 13 Corridor Study: Savage, Burnsville

Figure 4-25: Intersection Merge / Acceleration Lanes Summary

| Cross Street | Type | Merge Zones / Accel. Lanes | Room for Acceleration Lanes? |
|---|---|---|---|
| **I-35W** | Interchange | Ok | - |
| **CR 5** | Interchange | Ok | - |
| **Washburn Ave.** | At-Grade, Signalized | No | Yes |
| **Chowen Ave.** | At-Grade, Unsignalized | No | Yes |
| **Lynn Ave.** | At-Grade, Signalized | 100' WB<br>No EB | Yes |
| **Sigan Containers D/W** | Driveway, North side | 130' | Maybe |
| **Quentin Ave** | At-Grade, Signalized | No | Maybe |
| **Vernon Ave** | At-Grade, Unsignalized | No | No |
| **Yosemite/Xenwood Aves** | At-Grade, Unsignalized | 230' WB<br>230' EB | Yes |
| **Dakota Ave** | At-Grade, Unsignalized | 300' WB<br>No EB | Yes |
| **TH 13/101 Interchange** | Partial Interchange, Signalized | Ok | - |
| **Zinran Ave** | At-Grade, Unsignalized | N/a | N/a |
| **TH 101/169** | Interchange | Ok | - |

## 4.5 Truck Freight Mobility Toolkit

Based on reviews of the freight delays and safety challenges facing the regional truck highway corridors, there are no 'silver bullets' that consist of one or two technology deployments that will eliminate both delays and all truck crashes. There are, however, basic roadway design solutions combined with selected technologies that could have a positive impact. One could argue that improved zoning in years past could have eliminated some of the challenges faced today. One could also argue that increased rights of way should have been secured many years ago, allowing roadways to be widened today without encroaching on residences and commercial property. Unfortunately, those arguments would be in vain. The freight challenges facing the non-interstate Tier One corridors are not unusual and are being experienced all over the United States and abroad. The solutions will require innovative and collaborative efforts by both public and private sectors. The solutions required to reduce freight transport delays and the reduction of crashes will be many and varied. There is no single solution that will work for every scenario.

Several technology solutions are provided here that can be used within the study area of this report, in various locations, and can be considered in broader locations within the domain of the Metropolitan Council. The recommendations in this report should be considered as a collection of solutions that can be likened to a 'technology toolbox'. While they may be appropriate for discrete locations within the Tier One corridors, they should be considered as potential solutions at any additional locations of interest to the TAG. To be sure, it is not intended that these solutions are identified exclusively for every congestion and safety challenge identified throughout the corridors studied for this report. The selection of any particular 'tools' in this collection of technology solutions will depend greatly upon budgetary concerns, anticipated construction projects in the near future, political realities, economic trends in the region, etc. There are several factors outside the purview of this report that should be considered when programming the necessary solutions to address the region's congestion and safety challenges. However, the following technologies have been included in this report because of their success in addressing similar challenges across the United States and overseas.

The technology solutions provided contain a description of the technology, the potential challenge that the technology can address, and a rough estimate of the cost of the technology. This is intended to introduce potential technology deployment solutions and is not intended to serve as a detailed technology planning and specifications description.

### 4.5.1 Technology: Virtual Weigh Site

***Description:*** Virtual weigh sites (Figure 4-27) are a cost-effective substitute for permanent weigh stations on any road in a particular jurisdiction. A significant difference between the virtual weigh site and the fixed or unmanned weigh site is that the virtual weigh site has a nearly invisible footprint. That is to say that there is no exit ramp, there is no building, there is very little evidence that a virtual weigh site exists unless someone notices a loop detector in the roadway or a license plate camera mounted on a pole on the side of the roadway. Virtual weigh sites do not require commercial vehicles to stop, slow down, change lanes or any other behavior not consistent with 'regular driving'.

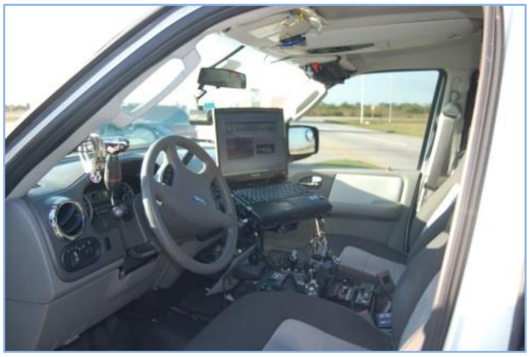
**Figure 4-27. VWS Roadside Technology**

The typical virtual weigh site system is designed to detect possible overweight vehicles on roadways. The system is designed to screen all commercial vehicles using the roadway and to categorize them as either 'potential violators' or 'non-violators.' Law enforcement personnel can then focus their attention on potential violators.

**Figure 4-26. Officers' Smartphone Access VWS Information**

Virtual weigh systems are automated. WIM technology determines vehicle weights. Each truck traversing the outfitted roadway will trigger cameras to take an image of the truck's license plate. Optical character recognition (OCR) software will convert the license plate image into numbers which can be stored as data. Additionally, if the WIM sensor indicates the truck is overweight, an appropriately configured virtual weigh site can trigger a side view camera to capture a digital image of the overweight vehicle. The system will then marry these three pieces of data and send an image, via wireless communication, to the motor carrier enforcement computer located in a central office where it can be stored and can be accessed (via secure internet access) by an enforcement officer's laptop computer as seen in Figure 4-28 (or smartphone– see Figure 4-26) at a roadside location. The image may consist of the digital photo of the vehicle superimposed with WIM data and the license plate number as seen in Figure 4-29.

Figure 4-28. Officers' Laptops Access VWS Information

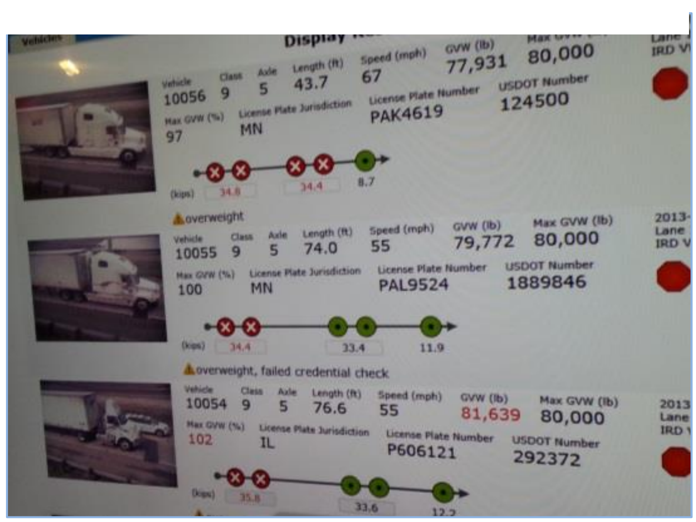


Virtual weigh systems can have many configurations and also employ various types of technologies depending upon the needs and budget of the jurisdiction's commercial vehicle enforcement program. Technologies can include:

- Weigh-in-Motion
- License Plate Reader
- Transponder Reader
- Optical Character Recognition (USDOT Number Reader)
- Container Character Recognition
- CCTV
- Height Detection System
- Three Dimensional Imaging
- Thermal Imaging

The data collected by these systems can provide speeds, vehicle weight, time of day, vehicle identification, motor carrier identification, vehicle height, vehicle length, indication of brake malfunction, status of motor carrier operating credentials, determination of stolen vehicle (license plates), support of Amber Alerts/Silver Alerts or criminal BOLO (be on the lookout) information.

Figure 4-29. Sample VWS Data



***Applications***: MnDOT currently has 6 WIM sites in the project study area[14] and has also made use of portable WIM systems on a trial basis.[15] Within the non-interstate Tier One corridors studied in this report, it was noted that certain jurisdictions levy a fee for commercial vehicles to travel on their roads. Ostensibly, these fees are to offset any damage that heavily loaded trucks may cause. With the application of a virtual weigh site, it can be quickly determined which trucks have little to no impact (no more than a passenger car) and which vehicles may cause severe damage. In addition, the virtual weigh site can be used by enforcement to minimize the number of overweight vehicles and thereby increase roadway safety. The benefits of utilizing virtual weigh site technology in this region are many. Those jurisdictions that require all trucks to pay fees whether they are overweight and causing roadway damage or not, are discouraging trucks from traveling on some roads and causing undue congestion on alternative routes. The existence of weigh-in-motion technology by itself does not penalize those vehicles that are violators because it cannot identify the truck nor the trucking company committing the violation. The virtual weigh site technology can serve to open up roadways to those trucks that are operating legally (thereby reducing congestion on other roadways) and allow the jurisdiction to accurately target and fine those vehicles and companies that are causing the damage to the roadways that the jurisdictions are attempting to prevent.

***Approximate Cost:*** The cost for fixed weigh station facilities, including purchasing the right of way and construction, can easily exceed $15 million. By comparison, the average virtual weigh sites can cost as little as $100,000 depending upon the configuration. The costs to deploy virtual weigh sites are entirely dependent upon the purpose of the system, technological configuration and the available communications network. Some of the more basic systems can cost less than $100,000 (with basic WIM and an onsite data collection device) and can approach $700,000 for a sophisticated fully equipped site (Taylor, 2014). Annual maintenance costs can range between $9,000 and $63,000.

[14] MnDOT, Traffic Forecasting & Analysis: Collection Methods

[15] MnDOT Local Road Research Board, "Portable Weigh-in-Motion System Evaluation." January 2015.

### 4.5.2 Technology: Signal Coordination


***Description:*** Traffic signal coordination allows for platoons of vehicles to flow through roadway systems with minimal delay. According to a Virginia DOT sponsored study listed on the US DOT RITA ITS Benefits website titled 'Quantifying the Benefits of Coordinated Actuated Traffic Signal Systems: A Case Study', coordinated actuated traffic signal systems produced a 30% reduction in corridor travel times compared to actuated isolated systems. The 'green wave' can immediately minimize delay experienced by trucks. Traffic signal coordination can consist of simple signal timing along a corridor or it can consist of sophisticated traffic actuation systems that may include inductive loop detectors, video detection, acoustic sensors, microwave sensors, infrared sensors, etc.


***Applications:*** Traffic signal coordination is one of the solutions that make sense along any congested corridor. While this study looks at specific corridors, the benefits of intelligent signal timing are not limited nor suggested solely for the Tier One corridors identified. Congestion and subsequent delay along the non-interstate Tier One corridors were mentioned as a source of frustration for truck drivers. Deploying traffic signal coordination systems will enhance freight movements by reducing stops/starts of commercial vehicles along the corridor. Better flow of commercial vehicles along a particular corridor will also be beneficial to passenger vehicle traffic as well by reducing the occurrence of the cars being "stuck" behind the commercial vehicle that is working its way back up to the posted speed limit after stopping at a traffic signal. With respect to prioritizing locations for deployment of traffic signal coordination systems, local/regional traffic engineers should be consulted for identification of those Tier One corridors that experience the highest passenger vehicle congestion. Alleviating passenger vehicle traffic on those freight corridors will also facilitate the movement of commercial vehicles. Ideally, all congested corridors should be equipped with signal coordination systems.

***Approximate Cost:*** According to the FHWA ITS Benefits Cost Online Database, an actuated controller for a single intersection is approximately $12,000. Converting a series of intersections to a coordinated system costs an additional $3,000 per intersection along the corridor.

### 4.5.3 Technology: Dynamic Message Sign/Highway Advisory Radio/CB Wizard

Figure 4-31. Dynamic Message Sign with Active


***Description:*** Dynamic message signs (DMS) (Figure 4-31) and highway advisory radio (HAR) (Figure 4-30) can provide valuable information to the traveling public and can include weather information, travel time information, traffic alerts, construction and special event notices, etc. In addition, HAR can provide truck specific information without confusing passenger vehicles such as information about truck specific detour routes. The information provided for the DMS is usually generated by the regional transportation management center (RTMC) or traffic management center (TMC) for the respective roadway. Likewise for the HAR system, besides the RTMC or TMC, information can also come from transit dispatch centers (regarding incidents or heavy congestion) and verified traffic sources like WAZE and other community based traffic sources. Systems like "CB Wizard" can also be used to repeat truck related information on a selected CB channel (typically channel 19). While CB radio reliance for trucking operations by the trucking industry has diminished with the advent of special smart tablet apps and on-board computer systems, many commercial vehicles still maintain/utilize CB radios for communications with other truck drivers in cases of traffic congestion, updates on enforcement activities, communications with fellow truck drivers on the nation's roadways, a tool for emergency distress calls, and in some cases CB radios are utilized by shippers to communicate with drivers to advise where deliveries should be made (e.g., which bay to park, where to queue up on the client's property, etc.) While CB radios are no longer the primary means of communications for trucking operations, the industry recognizes that there is no better device to communicate with others that are not utilizing a company's proprietary (closed system) communications technology. The CB Wizard (Figure 4-32) can be leveraged to communicate with the majority of truck traffic regardless of what advanced systems may be utilized on-board the truck. According to a Maryland SHA report, The CB Wizard alert system is described as an unmanned CB radio transmitter designed to automatically broadcast messages to truckers entering the zone of interest, a construction area or terminal facility for example. The messages are pre-recorded or recorded on site, and transmitted every 30, 60, or 90 seconds (depending upon the user preference). The CB Wizard system monitors CB transmissions on a particular channel and when it detects a lull, it broadcasts its pre-recorded message. The approximate range of the CB Wizard is 1 to 4 miles.

Figure 4-30. Highway Advisory Radio Notification Signage

Figure 4-32. CB Wizard

***Applications:*** The routes along the non-interstate Tier One corridors in the region are highly susceptible to major delays based on crashes, work zones, and non-recurring congestion. While the technologies described above cannot eliminate these causes of delay, they can accomplish two useful functions – reduce frustration and provide an opportunity to for drivers to adapt their travel plans to the current traffic conditions. The first useful function is very similar to what is experienced in the transit industry. When passengers have to wait extended periods of time that they aren't used to, they become very frustrated. When these passengers are given real-time information telling them of the delays, they are pleased to know what the new wait will be. Even when the extended delays are the same in both scenarios, they tend to lose the frustration when they are advised of the delay rather than just waiting and not knowing how long they'll have to wait. This same type of information, when provided to truckers, can minimize frustration levels and also give drivers the option to change plans, change routes, or pull off the road.

***Approximate Cost:*** Pedestal mounted dynamic message signs are approximately $80,000. Highway advisory radio system costs range between $15,000 to $35,000. CB Wizard Systems range in price from $4,000 for handheld units to $7,000 for trailer mounted units.

### 4.5.4 Technology: Vehicle Height Detection

Figure 4-33. Height Detectors on Weigh Station Ramp


***Description:*** A height detection system will consist of a laser detector/optical sensor which is aimed across the roadway at a certain height and includes a method of communication to alert the driver, or enforcement personnel, when a vehicle exceeding an established height drives past. See Figure 4-33 as an example. When a vehicle breaks the laser beam, it can trigger a series of safety measures which include warning the driver, providing the driver with an alternate and safe route diversion, or alerting motor carrier enforcement that a triggering event has occurred. While there are no federal height restrictions in federal law or regulation, most states impose enforceable state height limits ranging from 13.6 feet to 14.6 feet (USDOT, FHWA, 2014b). Height detection systems can be valuable in areas with low overpasses or where tunnels are present. In addition, these systems can prove valuable in areas where high wind related crashes regularly occur, such as overturned trucks on bridges.

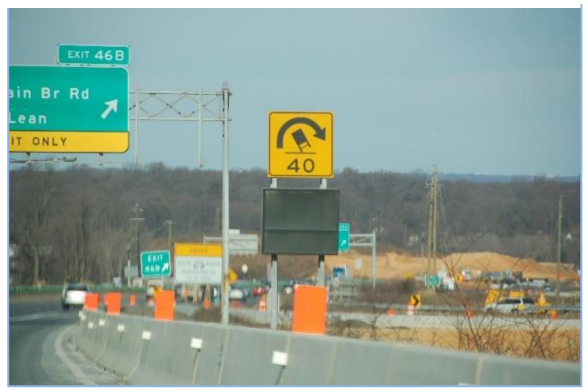
***Applications:*** At least one roadway in the study area (W. Broadway Ave.) has an underpass that falls below the minimum federal height guidelines, as you can see in Figure 4-34. Because the corridors in the study have been used for so many years, drivers' familiarity with the route could result in their disregarding bridge vertical clearances in those instances where their loads may be a bit higher than usual. A warning system at this location (and any others like this one in the metropolitan region that are 13'-1" or less) could prevent some major crashes and regional delays.

Figure 4-34. Screenshot of W. Broadway Ave.


***Approximate Cost:*** The cost to furnish and install the two poles, light source, optical sensor and associated equipment is approximately $30,000 (Hanson, 2014). Yearly maintenance costs are approximately $2,700.

### 4.5.5 Technology: Truck Rollover Warning System

Figure 4-35. Sample Rollover Warning Systems





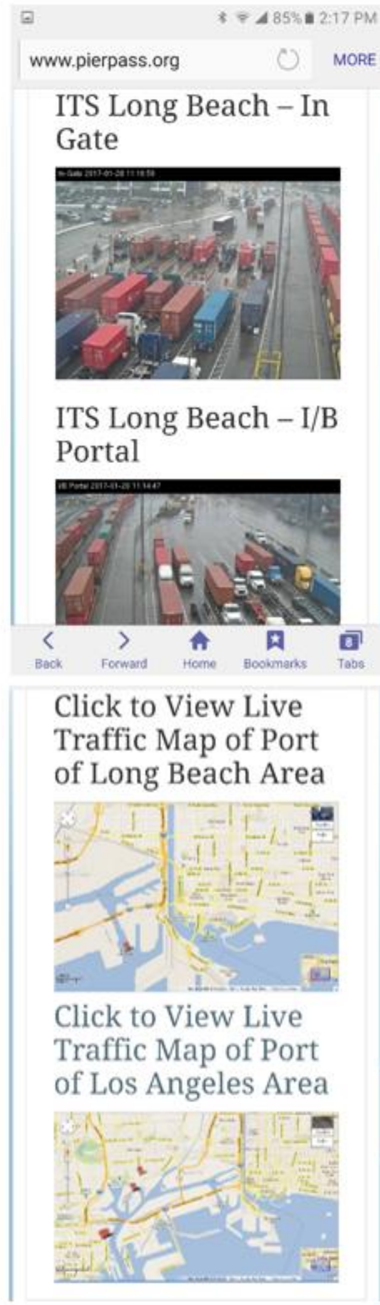
***Description:*** Truck rollover warning systems are designed to warn or alert drivers that they may be approaching a curve at a dangerously high rate of speed. There are several types of systems (see Figure 4-35) and their objectives and levels of complexity vary. Some systems merely sense a truck and then flash warning lights for each and every truck regardless of their speed. Some systems are more complex and collect data on the weight of the truck, the height of the truck, the speed of the truck and then calculate if the truck is exceeding the safe speed limitations of the ramp. Some of these systems actually calculate the data collected on the truck and post a recommended safe speed for the truck to navigate the curve safely. Research was previously conducted in the Washington DC area at three sites that were prone to truck rollovers. This research included the installation of three truck rollover warning systems. Following installation of the systems, there were no truck rollovers at any demonstration site for the entire three year evaluation period.

***Applications:*** During the course of research for this study, it was discovered that two locations along US-52 – at the I-494 and I-94 interchanges – rank among the top ten truck rollover locations in the state. This system could be helpful to minimize, if not eliminate, those problems at the locations identified.

***Approximate Cost:*** According to the US DOT ITS Costs and Benefits online database, truck rollover systems costs can vary between $50,000 and $500,000 per site depending upon the complexity and intelligence of the system.

### 4.5.6 Technology: Real-time Gate Status

Figure 4-36. Viewing Real-time Gate Information on a Smartphone




***Description:*** Providing real-time gate status is an example of a public and private sector partnership to address a problem that impacts both sectors. (Figure 4-36). Primarily, this system provides information to the trucking industry and dispatchers to alert them to congestion in and around terminal facilities. Typically, a live closed circuit television (CCTV) feed is provided to the trucking industry so that well informed scheduling decisions can be made. In some cases, estimated wait times can also be provided. By giving trucking companies the opportunity to see the gate queues and have an understanding of the anticipated delays, delivery decisions can be made and scheduled accordingly. Information like this can lead to less congestion at the terminals and a safer environment on public roads by minimizing/eliminating queues that adversely impact the traveling public on adjacent roadways (truck queues that can back out onto public roadways). These CCTV feeds can be included in existing 511 traveler information systems or can be a stand-alone video feed hosted by the terminal operator to serve its trucking constituents.

***Applications:*** During the course of research for this study, it was discovered that the intersection of University Ave NE and 32nd Ave NE is a bottleneck for container trucks entering the CP Shoreham Yard. The truck queues back up along University Ave NE in both directions, blocking general traffic through lanes. This is a situation that is very dangerous for the traveling public, and also dangerous for the trucks forced to block traffic on a road signed for speeds at 45 MPH. Developing such a system also facilitates the terminal operator's ability to expedite certain loads by minimizing the truck traffic that is blocking a specific truck that needs to move quickly to the front of the queue. As with the other recommended solutions in this section of the report, this Real Time Gate Status solution is not limited to a single location or corridor. This technology solution is applicable at terminals throughout the region. These locations could include Port of Savage terminals in Scott County as well as other river barge terminals that are experiencing gate delays and congestion. This same technology also applies to railroad intermodal hubs in the region.

***Approximate Cost:*** Costs for developing a system like this are based on several unknown factors. Much depends upon the willingness of terminal operators to share their existing video feeds, or the willingness of terminal operators to allow CCTV cameras and feeds to be deployed by a public agency on private property (in cases where no CCTV feeds currently exist). Costs could include adding a feed into an existing 511 traveler information system or costs associated with a terminal operator hosting a site of their own. The true costs will come from open discussions between the public and private sectors and the willingness to share resources for the benefit of the traveling public as well as the terminal operations.

### 4.5.7 Technology: Terminal Truck Queuing System

Figure 4-37. Truck Queuing System with DMS


***Description:*** A Terminal Truck Queuing System is another example of a public-private sector partnership that can make a big difference to terminal operations and public safety. The concept is similar to a reservation system for trucks but not nearly as prescriptive. In essence, it is a waiting room for trucks that is more convenient for all concerned. As seen in Figure 4-37 and Figure 4-38these photographs were taken in Australia at one the intermodal terminals; trucks are given a space to sit and wait until they can be accommodated in the terminal. This can be done in a variety of ways. In one of the examples, trucks sit lined up in a queue and when the green light comes on, two trucks may proceed to the terminal gates while the rest of the trucks remain staged in the queuing area. In another case, trucks are issued numbered time slots when they are dispatched to the terminal. When space for their assigned numbered time slot opens up, those trucks may proceed to the gate. This type of Terminal Truck Queuing System accomplishes multiple objectives. It eliminates the chaos of long queues at the gate entrance. It minimizes backed up trucks trying to enter the terminal and clogging up the surrounding roadway system as they wait. In addition, terminal operators have long realized that crowded terminals increase container turn times, decrease safety, and serve as an increased and unnecessary security risk. An effective terminal truck queuing system can eliminate much of the truck idling associated with waiting in long lines to enter the terminal gateway and minimize diesel engine emissions that contribute to poor health for truck drivers, terminal operations personnel, and the surrounding community. The public-private partnership concept comes in with the dual task of developing a queuing notification system as well as locating nearby space large enough for trucks to park. Creativity is key.

Figure 4-38. Truck Queuing System


***Applications:*** During the course of research for this study, it was discovered that the intersection of University Ave NE and 32nd Ave NE is a bottleneck for container trucks entering the facility. The truck queues back up along University Ave NE in both directions, blocking general traffic through lanes: a situation that is very dangerous for the traveling public and also dangerous for the trucks forced to block traffic on a road signed for speeds at 45 MPH. If a Terminal Truck Queuing System is deployed at this location (and others), there will be no reason for trucks to queue up on University Ave because they will not be able to enter the facility until space is available and they are summoned from the queuing location. As with the other recommended solutions in this section of the report, a Terminal Truck Queuing System solution is not limited to a single location or corridor. This technology solution is applicable at terminals throughout the region. These locations could include Port of Savage terminals in Scott County as well as other river barge terminals that are experiencing gate delays and congestion. This same technology also applies to railroad intermodal hubs in the region.

***Approximate Cost:*** Costs for developing a system like this are unknown. Much depends upon the type of system chosen. Costs can be as little as placing a sign with a remotely operated red/green light affixed or it can be as costly as purchasing adjacent land and preparing the surface for the added weight of multiple parked trucks.

# 5 Study Findings and Recommendations

## 5.1 Study Findings

This study identified and prioritized the most significant regional truck corridors by applying a data-driven approach that took advantage of the best available data on truck volumes and movements in the Twin Cities region. The data used in the study were enhanced through interviews with industry professionals and regular input from a Technical Advisory Committee comprised of representatives from the seven counties, MnDOT, several cities, and private-sector stakeholders. The study's key findings are described below.

Finding #1: The efficient movement of freight is vital to the economic competitiveness of the Twin Cities metropolitan area and truck corridors comprise a key component of the regional freight transportation system, along with rail and intermodal facilities, riverport terminals and air cargo facilities.

Finding #2: As a subset of regional highways, interstate highways are the most important regional truck corridors with respect to maintaining efficiency in truck mobility and in sustaining this region's economic competitiveness with other US metro regions. The Interstate system is "industry's backbone" and is of critical importance to the efficient and reliable movement of freight; however, other US routes, MnDOT TH, county highways and some city arterials are also important roadways providing direct access to freight facilities and were included in the evaluation and designation of key regional truck corridors.

Finding #3: The Twin Cities region serves as a distribution and agricultural consolidation hub for much of the Upper Midwest and is home to a number of significant manufacturers and distributers. The economic success of these industrial firms within a competitive environment depends on fast, efficient, safe and reliable truck transportation.

Data analysis as well as industry stakeholder interviews were conducted to gain a better understanding of regional freight commodity movements and to learn about regional and local issues experienced by freight business operators.

Finding #4: The view expressed by freight stakeholders was that the regional highway system works well in general, but congestion and access issues are more pronounced in several areas.

The uncertainties of non-recurring congestion especially impact business bottom-lines, by making it difficult to access freight terminals in a consistent and timely manner (e.g., at

Canadian Pacific's Shoreham Intermodal Yard). According to the FWHA, non-recurring congestion is due to incidental causes such as crashes, disabled vehicles, construction work zones, adverse weather events, and planned special events.[16]

Finding #5: Compared to many US cities, freight industry clusters in the Twin Cities region are highly dispersed; as a result, the key truck freight corridors identified in this study were not confined to a few consolidated industrial areas, but were necessarily designated across the entire metropolitan area.

## 5.2 Recommendations for Future Actions

Four strategies are recommended for Met Council and its transportation agency partners to incorporate the findings and conclusions of this study and to advance planning activities that focus on improving regional truck mobility. These strategies include the following:

**Strategy #1 – Incorporate the regional truck corridor study and "key corridors" into the regional and state freight planning process.**

**Strategy #2 – Utilize study findings to inform freight project prioritization and funding.**

**Strategy #3 – Improve regional freight data collection efforts to address data gaps and to improve urban truck mobility.**

**Strategy #4 – Monitor conditions along truck corridors over time.**

The strategies and their associated actions are described in detail below:

### Strategy #1: Incorporate the regional truck corridor study and "key corridors" into regional and state freight planning processes

Met Council and its transportation agency partners should consider the following actions to incorporate the "key corridors" into the regional and state freight planning processes:

**Action 1.1: More fully incorporate freight and freight projects into the regional planning and programming process.**

In general, Met Council should utilize the findings and experience gained in conducting this study to consider developing a set of strategic recommendations for integrating freight into the

[16] Federal Highway Administration. https://ops.fhwa.dot.gov/program_areas/reduce-non-cong.htm.

Transportation Policy Plan (TPP). In addition, Met Council could highlight highway projects that benefit freight in the regional Transportation Improvement Program (TIP). Met Council should integrate key corridors, and consider integrating freight industry clusters, freight performance measures, and freight needs and issues identified by this study in the TPP. Specific actions to consider include the following:

- In the Freight Investment Directions, amplify the freight system information to convey not only the infrastructure "supply" (e.g. the regional multimodal freight system), but over time also include the "demand" on the regional highway system—applying truck count data and other information. A concise way to accomplish this would be to include the final key truck corridors map from this study, with a brief explanation of the process through which Met Council and its partners identified the corridors. Other information could also be overlaid on the regional truck corridors map including congested areas, safety hotspots, and other findings. The TPP could explain how the key freight corridors information informs "investment directions" for the regional highway system truck freight.

- Within the broader TPP documentation, including the Highway Investment Direction and Plan chapter, the regional truck corridors should be identified within the regional highway system and future improvement locations that address freight, congestion, safety, or other infrastructure issues may also be included in the Plan.

- Met Council could highlight the highway projects which specifically benefit freight transportation in the TIP, to form a nexus with the analytical approach used to identify key truck corridors and freight needs.

**Action 1.2: Integrate study findings into MnDOT's freight planning process.**

Freight and operations staff from MnDOT's Central Office and Metropolitan District played a key role, along with local agencies, in identifying the regional truck corridors and associated system issues and needs. Going forward, Met Council should develop a strategy for integrating the findings of this study into MnDOT's ongoing freight planning efforts. This strategy may include the following:

- Integrate the regional truck corridors into the future updates to MnDOT State Freight Plan, and indicate how the information for the study informs the establishment of the critical urban freight corridors (in the Minneapolis-St. Paul urbanized area) and critical rural freight corridors in the rural portions of the Twin Cities Metropolitan Region.

- Integrate the industry approach utilized in the study that focused on manufacturing, transportation and logistics, natural resources and consumer goods freight clusters and the corridors and other multimodal transportation facilities that serve them. This type of industry-based analysis has been missing from most freight planning activities nationally which have tended to be too focused on independent and separate modes. Met Council's focus on key freight industry sectors could provide an economic framework for future MnDOT studies.

- Include regional freight issues and freight needs identified in the study in the next Minnesota State Freight Plan, especially if projects are eligible for National Highway Freight Program (NHFP) dollars.

**Action 1.3: Utilize the key corridors to identify CUFCs and CRFCs.**

By utilizing the corridor designations and associated data, Met Council in collaboration with MnDOT can recommend Critical Urban Freight Corridors (CUFCs) locations in the region, within the mileage allocations established with MnDOT. In addition, the key corridor designations and data can be used to allocate highway segments for Critical Rural Freight Corridors (CRFCs), for portions of the metropolitan area that fall outside of the official urbanized areas. Notably, CUFC and CRFC designations can be revised over time to adjust to future funding needs.

Key considerations in defining CUFCs and CRFCs may include the following:

**What is the underlying vision?**

- *Descriptive* – goal is to identify most important freight corridors – corridors may be re-designated as shipping patterns change
- *Cost-effective funding* – goal is to get money to the most important freight corridors – corridors may be re-designated as roadway issues are addressed
- *Functional* – goal is to classify corridors so as to apply different design or policy criteria – corridors may be re-designated as land use and policies change

**Key questions for designating CUFCs and CRFCs**

- Who should be involved in designating the critical corridors?
- How should the limited mileage be allocated within the region?
- What variables or factors should be considered for defining the importance of a critical corridor?
- How frequently should corridors be re-designated?

This study provided a base methodology which can be leveraged for designating critical corridors by addressing the overall regional vision that describes the key regional truck corridors that will sustain and improve the competitiveness of the region’s economy. This study also provided an overview of delay and safety issues on the Tier 1 corridors, which can support the cost-effectiveness goal.

**Action 1.4: Integrate freight planning considerations into the highway planning project development process**

Met Council and its transportation agency partners should consider evaluating truck issues (i.e., congestion, safety and infrastructure hot spots, as identified in the Delay and Safety chapter) in future truck corridor planning efforts. Possible actions might include:

- Providing outreach to industries in key truck corridors slated for improvement during project development to gain input on specific truck access issues.
- Ensuring that projects on key truck corridors minimize the impacts of special features like traffic roundabouts, improve low bridge clearances to current standards for freight, and fully accommodate turn radii and lane width needs for large trucks.
- Thinking differently about projects on key freight corridors in dense urban settings by limiting traffic calming or modifying complete streets concepts that may have unintended consequences to the efficient and safe movement of freight.

## Strategy #2: Utilize study findings to inform freight project prioritization and funding

In addition to the designation of "freight" projects into the TPP Highway Investment Direction and Plan, Met Council could further leverage the study findings and key corridors to increase the prominence of freight in funding prioritization. Actions could include:

**Action 2.1: Develop a prioritization framework for regional freight needs**

- Incorporating a prioritization approach would allow Met Council and its partners to focus on the most critical freight needs. An emerging best practice, exemplified in the Arizona State Freight Plan, is to prioritize the freight needs based on two filters: a strategic filter that determines which issues are most closely aligned with regional goals (e.g. goals and objectives from Thrive 2040) and a quantitative filter which prioritizes freight projects based on the data and methods applied in the study. This two-step approach would allow the region to narrow a potentially long list of projects into a shorter list aligned with regional transportation goals and then to empirically prioritize the short list issues / projects into a prioritized list. The prioritization criteria could mirror the methodology used to identify the key corridors, or could be adapted in consultation with the Technical Advisory Group and freight stakeholders.

- Another approach is to integrate freight performance measures into the overall regional prioritization framework (for freight and non-freight projects) with the aim of enhancing the prominence of freight, and the opportunity for freight projects to receive funding through the regional selection: for example, if projects on the key corridors or meeting other freight criteria were given additional points in the regional solicitation.

**Action 2.2: Identify funding for freight projects on key corridors**

There are several potential sources of funding for freight needs on key corridors (and other portions of the regional transportation system), including the National Highway Freight Program Funds, FASTLANE grant program, TIGER grant program, and other state and local sources, including the regional solicitation. Met Council's Transportation Advisory Board could consider increasing funding for freight related projects within the Regional Solicitation, for example, allocating a greater percentage of federal highway funds to truck corridor needs in the region.

Another possible approach is to consider whether projects are potential candidates for public-alternative funding mechanisms, including public-private partnership (P3) arrangements. P3s are project delivery mechanisms that often include a financing component which can be secured through revenue from access charges (e.g. for use of a new rail line or access road), other tolls, taxes, or fees on vehicles, tires, or miles traveled. Some key questions for consideration would include:

- Is the project large enough to warrant the administrative costs,
- What is the service life of the project,
- Does the project have a clear and predictable revenue stream, and
- Can the project's performance and/or benefits be clearly defined and measured?

## Strategy #3: Improve regional freight data collection efforts to address data gaps and to improve urban truck mobility

The study team encountered at least two significant data gaps during the course of the study, including truck volume data and commodity data for local truck movements. Additional data on last mile truck movements would also be desirable for future studies. The following actions are recommended to improve regional freight data collection efforts:

**Action 3.1: Coordinate truck counts with regional transportation agencies.**

The chief data gap identified by this study is the lack of consistent data on truck volumes. The study utilized classification count data from MnDOT, and on a limited basis, some counts made available from Counties. Yet, the team ultimately had to synthesize truck volumes using the ATRI GPS data and the classification counts. Because the ATRI data represent a large sample but not the "universe" of trucks on the road, the "relative volumes" obtained from the ATRI data had to be scaled up to synthetic "absolute volumes" by extrapolating from locations where both data sources were available. Additionally, although the ATRI data cover a very wide range of industries and operations, some concerns were raised by TAG members that the ATRI data may be underrepresenting certain truck movements, such as near aggregate sites or for local trips. On the other hand, the ATRI data have the advantage of recent collection (2015), comprehensiveness in terms of geographic and functional coverage, and ultimately cost of acquisition.

The ATRI volumes ultimately produced a reliable and consistent foundation for the study using the best data available, but because the data were synthesized and based on a sample, the total picture could be improved. The data products provided to Met Council can be used to identify locations where existing available truck counts may vary significantly from scaled ATRI volumes (These locations may be good candidates for future re-counts. Additionally, highways identified as key corridors (especially Tier One) but where no truck count data were available, would be good candidates for future counts.

One particular challenge encountered by the study team was integrating truck counts provided by the counties with those obtained from MnDOT. The following actions should be considered to improve future coordination of truck count data:

- Collect data during similar timeframes throughout the year to account for peak seasonal commodities and other market conditions that may vary over the course of the data collection interval.
- Develop a regional strategy (in consultation with counties and other data collecting agencies) to ensure that counts are collected on major truck routes throughout the region, focusing on the gaps identified by this study in count locations, and balancing for functional classification and other considerations.

Given their experience with an existing mandate to publish metro-wide truck data, MnDOT will be in the best position to ensure the quality and coordination of truck count data.

**Action 3.2: Improve knowledge of economic linkages, including commodities hauled locally.**

Using a combination of data sources, including the ATRI GPS data, land use data, and business establishment data, the study team developed clusters for four major economic sources of freight-dependent industries: manufacturing, transportation and logistics, natural resources (including agriculture), and consumer goods, and mapped the data for the study. These maps can be used to infer, in a general sense, which industries rely most on specific corridors. Yet, this information could be further enhanced with data on specific freight commodities moved by truck. There are several actions that would enhance this knowledge base:

- Conduct more specific studies on freight-dependent industries in the region, including consultations and analysis of regional supply chains. Conflate the findings to corridors (e.g. corridor “X” is critical for supply chain “Y”).
- Work with regional carriers/shippers to collect an anonymous and aggregated set of commodity flows by truck (at TAZ level or higher).

- Examine the ability to synthesize a regional commodity truck origin-destination matrix by utilizing a truck GPS TAZ O-D table (from ATRI or INRIX, for example), in combination with TAZ-level industry employment or other economic data, to conflate industry mix and truck trip generation rates by TAZ. This exercise could be completed as a separate study. The methods to develop an O-D table using GPS data are well-documented in transportation research literature (including the Transportation Research Record). Conflating origins and destinations to industries (and commodity classes) could shed more light on which industries are utilizing key truck corridors. If this approach were successful, it could be incorporated in the regional transportation demand model to more accurately project future highway corridor needs specific to freight.

# Strategy #4: Monitor conditions along truck corridors over time

For the key regional truck corridors identified in this study, Met Council may work with its partner agencies, including MnDOT, counties and cities, to monitor system performance. Met Council should consider the following actions to monitor the corridors:

**Action 4.1: Identify performance measures or indicators to monitor conditions**

Met Council should identify performance measures or indicators to monitor conditions on the key corridors over time. It is recommended to begin with the performance measures and data utilized in this study and to expand the range of measures, where feasible, and especially if automated technologies allow for the capture of additional data. For this study, the key performance measures and data items applied included:

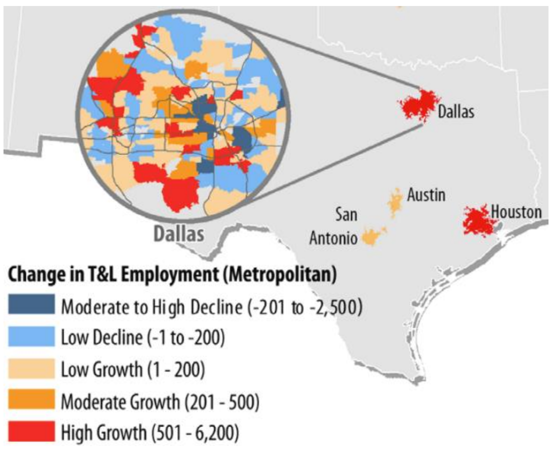
1. Heavy commercial annual average daily traffic (HCAADT) volumes
2. Truck percentage of total annual average daily traffic
3. Average truck delay (based on GPS speed data)
4. Truck-involved crashes, measured as a rate per million trucks per segment (which can be easily converted to million vehicle miles traveled if aggregating to corridors or longer segments)

**Action 4.2: Identify tools or data sets to measure performance over time**

Existing or proposed traffic system management and operations (TSM&O) infrastructure in the region, including loop detectors, remote sensing technologies, weigh-in-motion (WIM), Bluetooth scanners, cameras, and other technologies may already be available on some of the identified corridors. These technologies are increasingly capable of counting and classifying vehicles, inferring regional travel patterns, and monitoring congestion and performance. Met Council and MnDOT should consider developing an inventory of freight monitoring technologies on the key corridors of the region and developing strategies to deploy those assets to monitor conditions and measure performance. This activity may also facilitate MnDOT and partner agencies to deploy freight monitoring technologies on key corridors, focusing on critical locations where the data are sparse (e.g. in conjunction with action 2.1 for coordinating truck counts).

**Action 4.3: Consider periodic updates to corridor designations**

Truck travel patterns may change over time, potentially affecting the composition of regional truck corridor designations. These changes could be prompted by shifts in market conditions, traffic congestion, industrial development, and related freight demand (among other influences). For example, many US metropolitan areas have experienced a shift in transportation and logistics jobs from urban cores to peripheral areas, altering the patterns of freight trip generation. Publicly available time-series data can be used to illustrate shifts over time. **Error! Reference source not found.** emonstrates how transportation and logistics jobs have moved to the urban periphery in a donut-like pattern in the Dallas-Fort Worth metro region. The Maricopa Association of Governments, the MPO for Phoenix, has recently integrated National Establishment Time Series (NETS) data into its travel demand modeling structure to help estimate future changes in land use and the resulting effects on freight demand. Among other approaches, including those suggested below, Met Council could examine land use data to help understand the dynamics of freight generation over time in the Twin Cities region. Met Council should periodically update the corridors, possibly every 5 to 10 years. The bellwether indicators that might prompt an update would be a) significant changes to the data observed through performance monitoring (3.1), or b) suggestions from regional freight stakeholders such as MFAC. As Met Council and MnDOT stay apprised of regional freight trends and in contact with regional shippers and carriers, the agencies will have the pulse of the industry and the knowledge of changes in system performance to inform their next steps.




Source: CPCS analysis of County Business Patterns Data, US Census

## 5.3 Potential Follow-Up Studies

The recommendations highlighted in this Final Report suggest a number of potential studies. Met Council and MnDOT are in a unique position, as the regional highway planning agencies in the Twin Cities, to jointly lead or coordinate future research and related studies that would build on the results of this study. Figure 5-1 summarizes potential follow-up studies for consideration by Met Council and MnDOT.

Figure 5-1: Table of Potential Follow-Up Studies for Consideration

| Table of Potential Follow-Up Studies, for Consideration |
|---|
| Periodic updates of the key regional truck corridors identified in this study and of Critical Urban and Rural Freight Corridors, supported by the study data and findings. |
| Increased coordinated truck counts / vehicle classification counts on key truck corridors in the metro, including investigating the use of new and emerging technologies for truck freight performance monitoring |
| Explore the ability to synthesize a regional commodity truck origin-destination matrix at the TAZ level. Truck GPS data can be combined with TAZ-level industry data (e.g., employment data) to infer regional freight flows by industry. If successful, integrate into regional travel demand model. |
| As an alternative or supplement to the previous point, work with regional carriers/shippers to collect an anonymous and aggregated set of commodity flows by truck (at TAZ level or higher) |
| Develop an inventory of "truck freight monitoring" technologies (including new and emerging technologies) for application on key regional truck corridors and develop strategies to deploy those assets to monitor conditions and measure performance |

# Appendix A:
## List of Stakeholders Interviews Guide

The following figure, Figure A- 1, lists the freight industry stakeholders consulted during development of this working paper. Several additional stakeholders were interviewed that did not agree to disclose their individual or company names and were therefore not included in this table.

**Figure A- 1 Freight Industry Stakeholders Interviewed**

| Stakeholder | Contact |
|---|---|
| 3M | Mike West |
| Aggregate Industries | Mark Bintzler |
| Andersen Windows | Mark Hammel |
| Bay and Bay Transportation | Aaron Thompson |
| Calhoun Trucking | Brent Bois |
| CHS | Chuck Trivet |
| Dedicated Logistics | Scott Carlson |
| Flint Hills Resources | Don Kern |
| Land O' Lakes | Jim Carver |
| Manning Transfer | Mike Manning |
| Medtronic | Arnold Kpoto |
| Midwest Motor Express | Joe Greenstein |
| Midwest Shippers Association | Bruce Abbe |
| St. Paul Port Authority | Kathryn Sarnecki |
| Styer Transportation | Mel Simon |

Source: CPCS

The following questions were developed to guide and focus the discussion with stakeholders. Not all stakeholders responded to each question.

**Shipping Behaviors**

*Please comment on the following:*

- *Commodities shipped (e.g., raw materials (natural resources), consumer goods, manufactured goods, other)*
- *Frequency of shipment (e.g., # of truck trips per day/week/month)*
- *Equipment used (e.g., bulk, container, LTL, TL, parcel, private fleet, other)*
- *Orientation of inbound and outbound supply chain (local, state, regional, national, international)*

- *Notable origins and destinations of these trips (e.g., where in the 7 County Twin Cities region, to/from points outside the region (Greater MN/out-of-state), trips to/from port facilities, etc.)*

**Use of Key Routes**

*Please comment on the following:*

- *Most heavily relied upon routes and corridors for long-distance movements (i.e., Interstates or other non-Interstate principal routes)*
- *Most heavily relied upon routes and corridors for local delivery within 7 county metro (e.g., those connections critical to getting to the Interstate, or first-/ last-mile routes critical to getting to points of drop-off/pick-up)*
- *Key considerations affecting choice of route (time, cost, reliability, availability of alternative routes or lack thereof, route restrictions), including ranking these*

**Key Route Issues and Obstacles**

*Please comment on the following (related to the routes noted):*

- *Physical Issues and Obstacles*
    - *Congested locations*
    - *Safety hot-spots*
    - *Geometric issues (e.g., tight turning radii, lane drops, clearance restrictions)*
    - *Other infrastructure issues (e.g., bridge weight limits, truck route restrictions)*
    - *Truck parking*
- *Regulatory Issues and Obstacles*
    - *Delivery restrictions*
    - *Route restrictions (e.g., trucks prohibited)*
    - *Hours of service requirements*
- *Which area, regulatory issues or physical issues, is more important?*

**Other Comments**

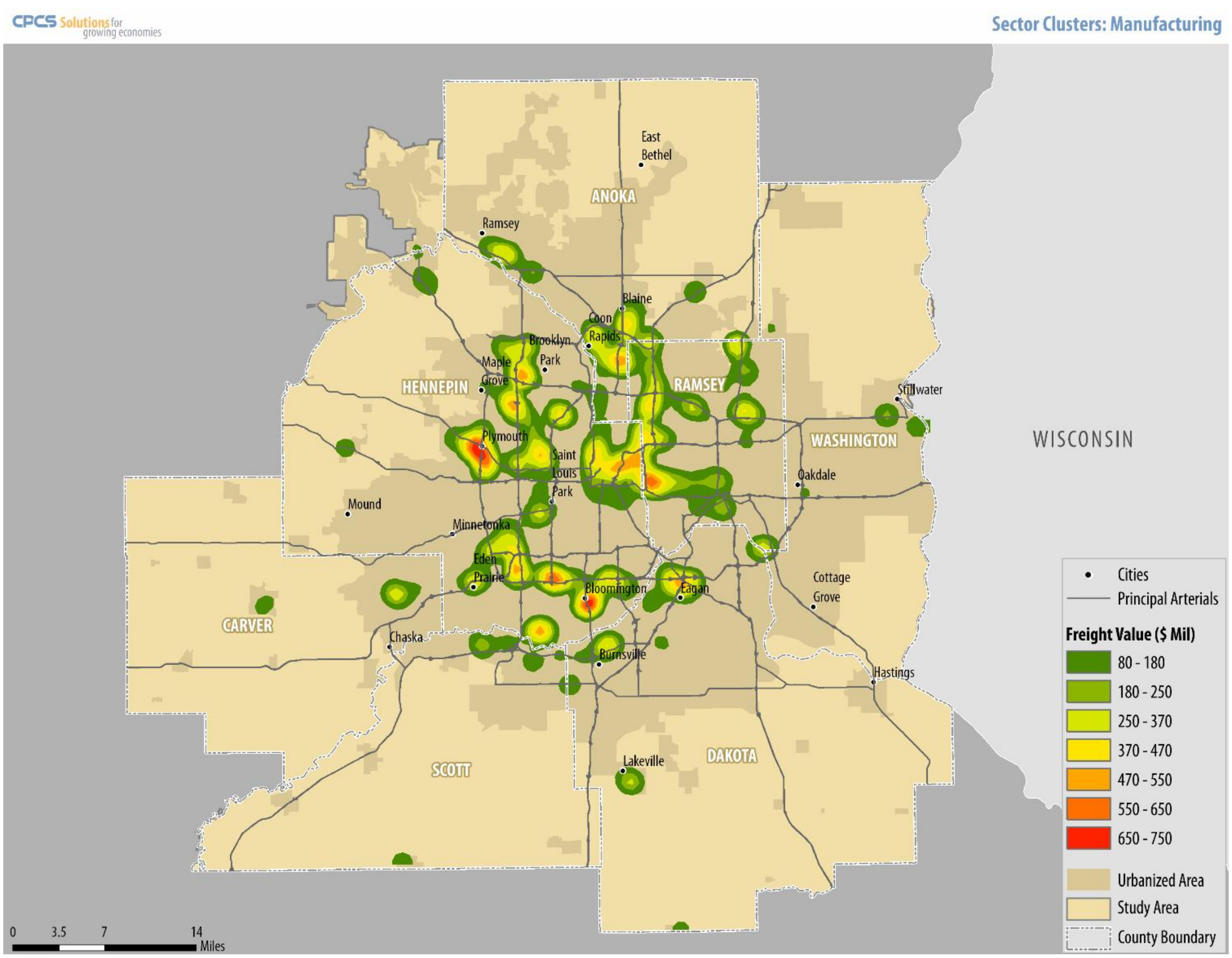
- *How well are your current needs served by the system? What technological, policy, or other trends do you see impacting the freight or highway system?*
- *What is the most important transportation-related policy change or infrastructure investment that government transportation agencies could make that would benefit your business or industry?*
- *Please comment on any other issues that may be pertinent to this study.*

# Appendix B:
## Freight-Generating Industry Sector Maps and Relevant NAICS Codes

This Appendix shows additional freight cluster maps for the four identified freight-generating industry sectors. There is an additional map for agriculture/food establishments, which is not a separate sector but includes parts of the four key sectors (e.g. food manufacturing, farm products distribution, etc.). The additional focus on agriculture in particular reflects discussions with Met Council about the particular importance of this industry group to the Twin Cities area.

Figure B- 1 shows manufacturing clusters. The most notable cluster is in Plymouth.

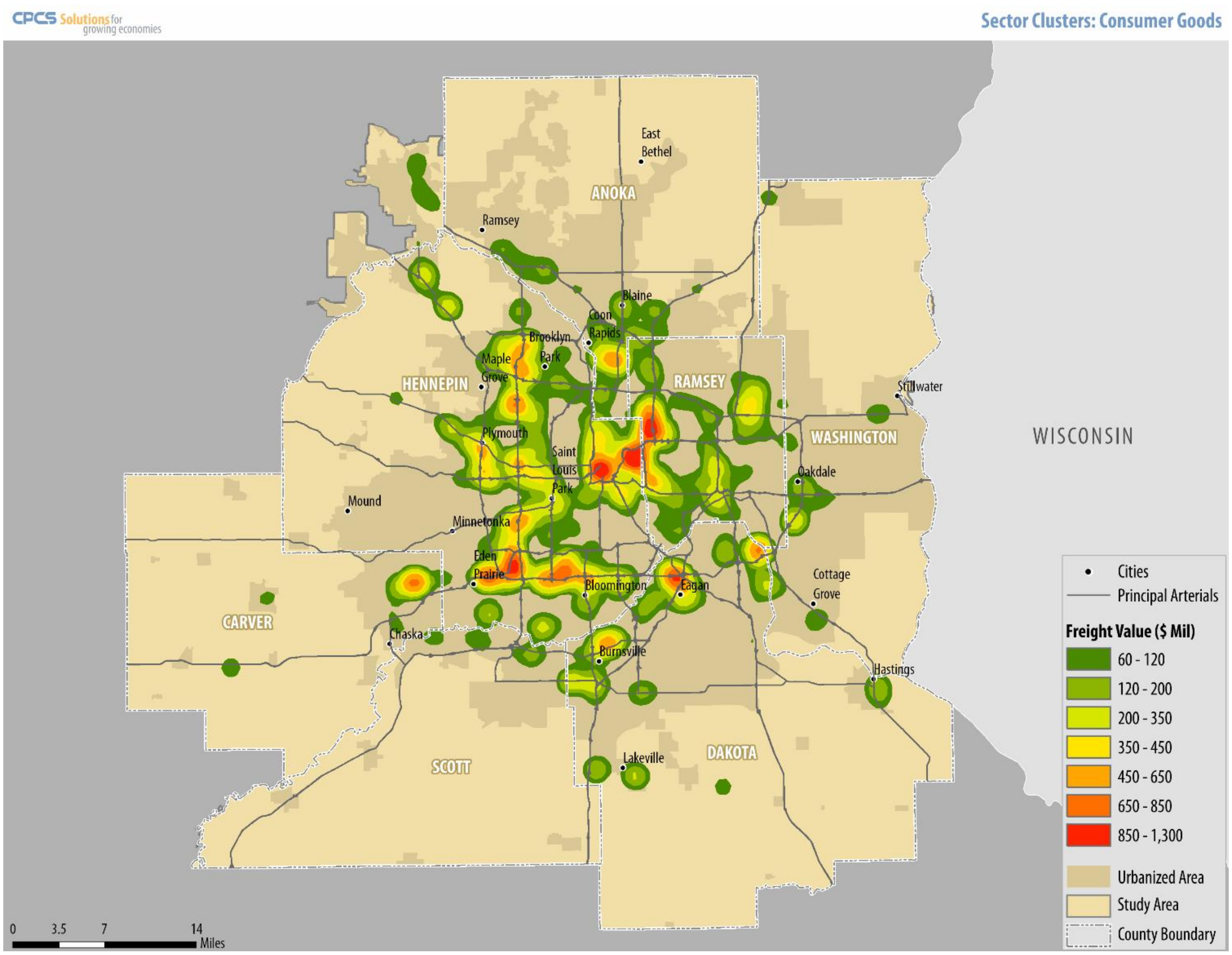
Figure B- 1 Clusters of Manufacturing Activities



Source: CPCS Analysis of Infogroup Data, 2015

Figure B- 2 shows consumer goods clusters. These are concentrated around Minneapolis as well Edina/Eden Prairie and Eagan.

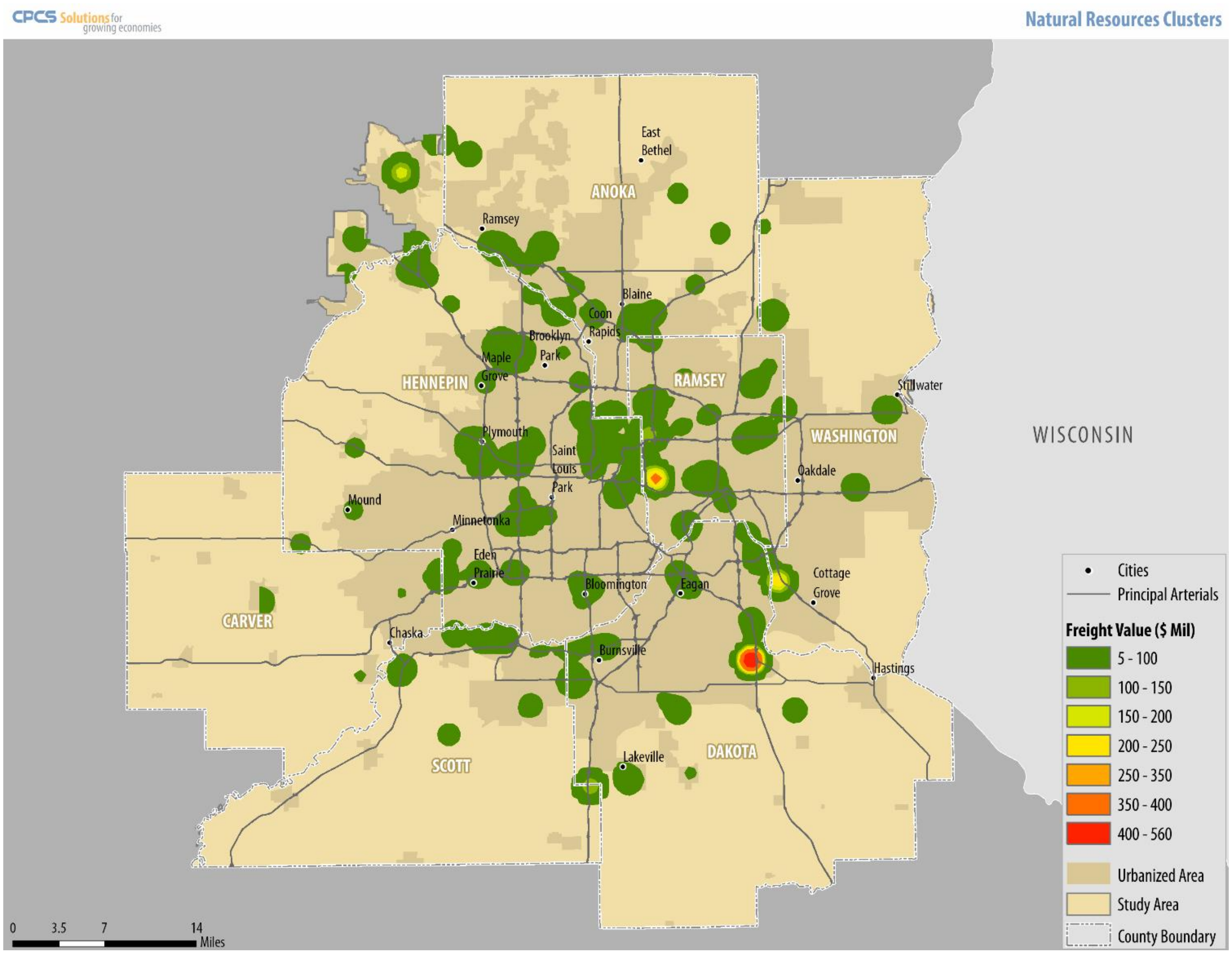
Figure B- 2 Clusters of Consumer Goods Sectors




Source: CPCS Analysis of Infogroup Data, 2015

Figure B- 3 shows natural resources clusters. The largest cluster is in Rosemount, around Flint Hills Resources.

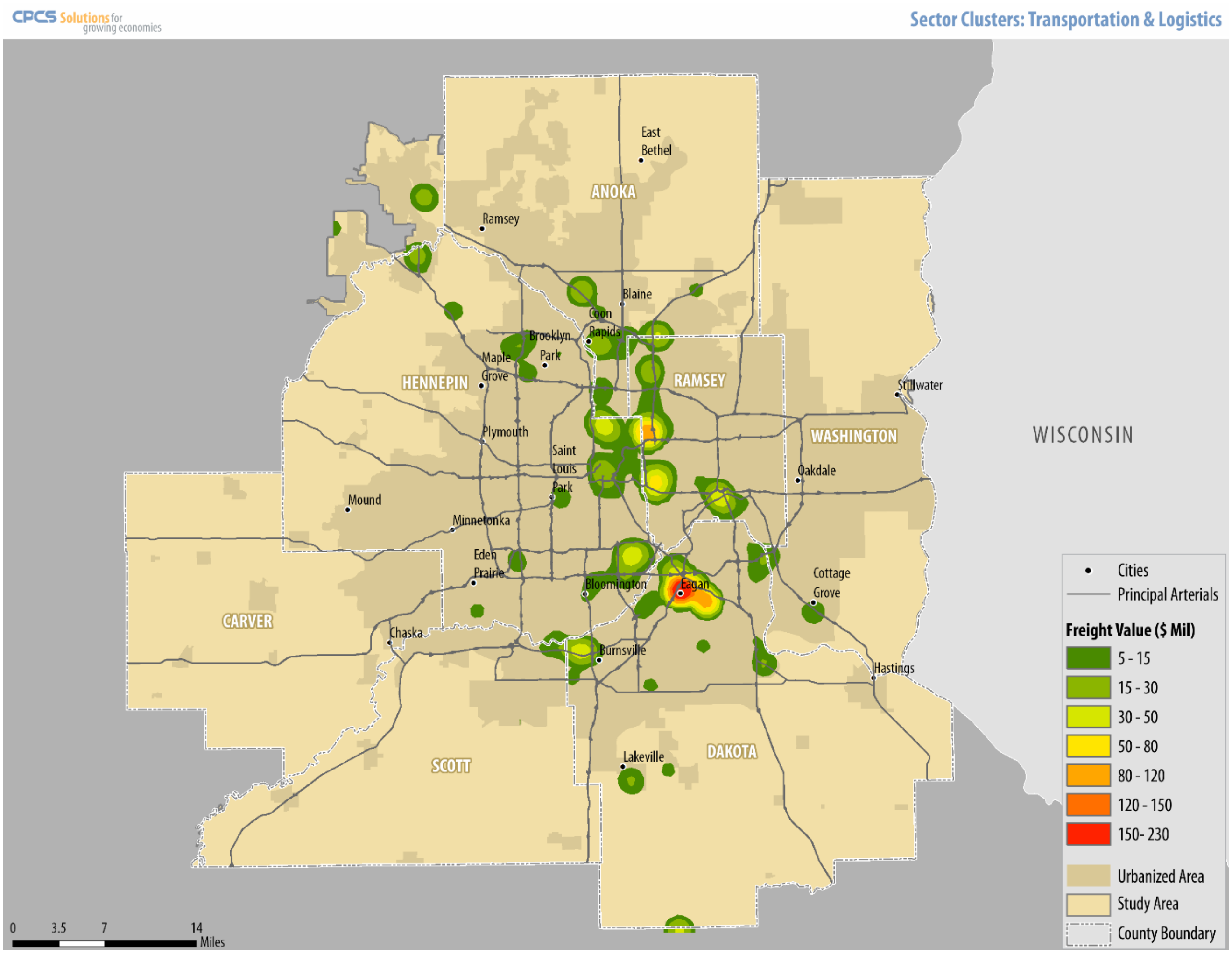
**Figure B- 3 Clusters of Natural Resources Sectors**




Source: CPCS Analysis of Infogroup Data, 2015

Figure B- 4 shows transportation and logistics clusters. The dominant cluster is around Eagan, which is the site of USPS and UPS facilities.

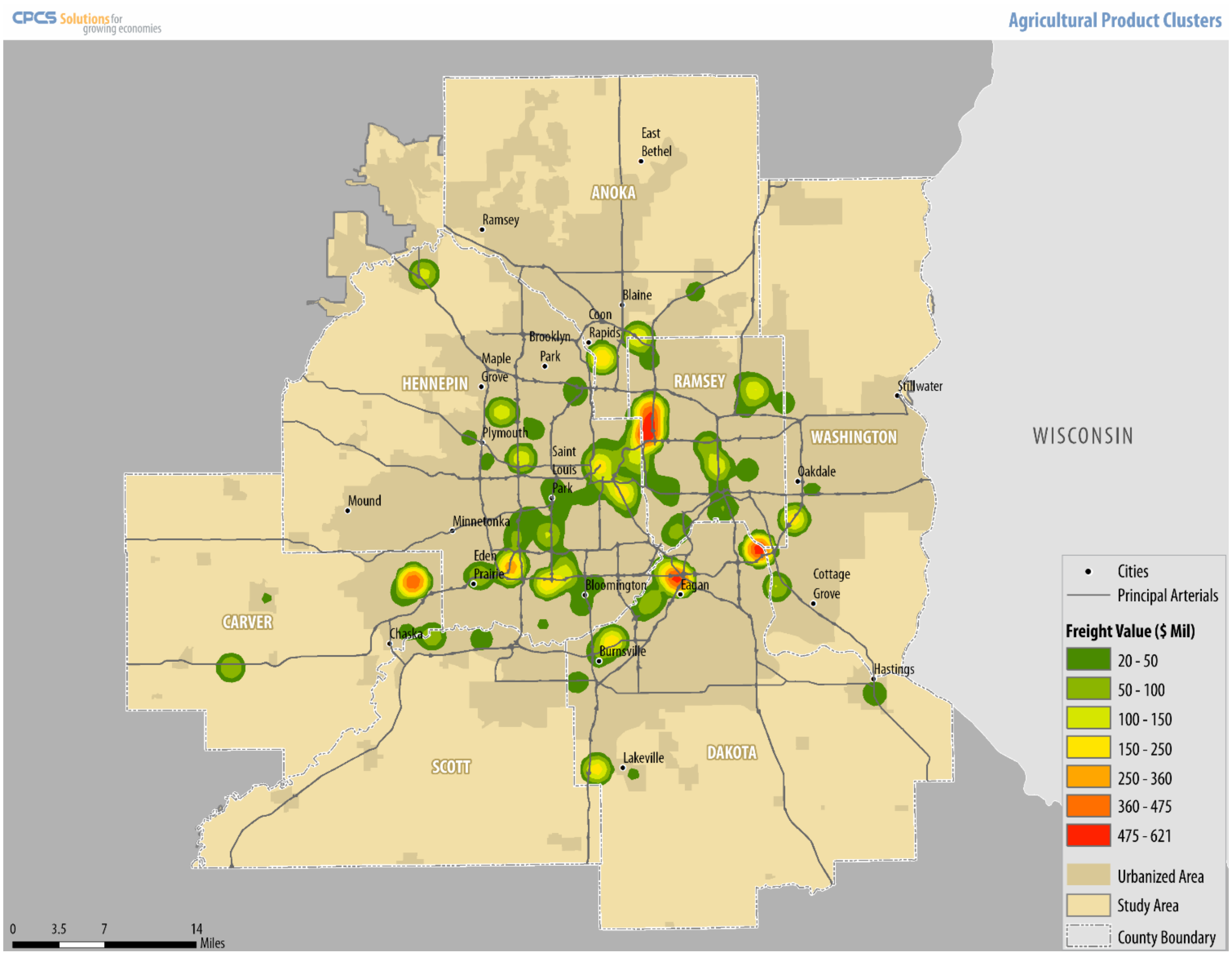
**Figure B- 4 Clusters of Transportation and Logistics Activities**




Source: CPCS Analysis of Infogroup Data, 2015

Figure B- 5 shows agricultural/food products clusters, which are located in the northeast part of Minneapolis north of the Mississippi River. It should be noted that this map does not focus on actual farm land uses (and at any rate these are not "clustered" due to their lack of geographic concentration), but rather various steps along the agricultural/food products supply chain prior to end use retail (i.e. not including grocery stores and restaurants). The top clusters are driven predominantly by bottling plants, bakeries/food manufacturing plants, and food/grocery wholesalers.

**Figure B- 5 Clusters of Agricultural/Food Products Processing, Manufacturing and Wholesaling**




Source: CPCS Analysis of Infogroup Data, 2015

Figure B- 6 describes the composition of each key sector, in terms of constituent NAICS codes.

Figure B- 6 Sector Composition

| NAICS | NAICS Description | Sector |
|---|---|---|
| 311 | Food Manufacturing | Consumer goods |
| 312 | Beverage and Tobacco Product Manufacturing | Consumer goods |
| 4231 | Wholesale Motor Vehicle & Parts | Consumer goods |
| 4232 | Wholesale Furniture & Home Furnishings | Consumer goods |
| 4236 | Wholesale Household Appliances and Electrical & Electronic Goods | Consumer goods |
| 4239 | Wholesale Misc. Durable Goods | Consumer goods |
| 4241 | Wholesale Paper & Paper Products | Consumer goods |
| 4242 | Wholesale Drugs and Druggists' Sundries | Consumer goods |
| 4243 | Wholesale Apparel, Piece Goods & Notions | Consumer goods |
| 4244 | Wholesale Grocery & Related Products | Consumer goods |
| 4245 | Wholesale Farm Products | Consumer goods |
| 425 | Wholesale Electronic Markets and Agents and Brokers | Consumer goods |
| 441 | Motor Vehicle and Parts Dealers | Consumer goods |
| 442 | Furniture and Home Furnishings Stores | Consumer goods |
| 443 | Electronics and Appliance Stores | Consumer goods |
| 444 | Building Material and Garden Equipment and Supplies Dealers | Consumer goods |
| 445 | Food and Beverage Stores | Consumer goods |
| 446 | Health and Personal Care Stores | Consumer goods |
| 447 | Gasoline Stations | Consumer goods |
| 448 | Clothing and Clothing Accessories Stores | Consumer goods |
| 451 | Sporting Goods, Hobby, Musical Instrument, and Book Stores | Consumer goods |
| 452 | General Merchandise Stores | Consumer goods |
| 453 | Miscellaneous Store Retailers | Consumer goods |
| 454 | Nonstore Retailers | Consumer goods |
| 722 | Food Services and Drinking Places | Consumer goods |
| 313 | Textile Mills | Manufacturing |
| 314 | Textile Product Mills | Manufacturing |
| 315 | Apparel Manufacturing | Manufacturing |
| 316 | Leather and Allied Product Manufacturing | Manufacturing |
| 322 | Paper Manufacturing | Natural Resources |
| 323 | Printing and Related Support Activities | Manufacturing |
| 325 | Chemical Manufacturing | Manufacturing |
| 326 | Plastics and Rubber Products Manufacturing | Manufacturing |
| 327 | Nonmetallic Mineral Product Manufacturing | Manufacturing |
| 331 | Primary Metal Manufacturing | Manufacturing |
| 332 | Fabricated Metal Product Manufacturing | Manufacturing |
| 333 | Machinery Manufacturing | Manufacturing |
| 334 | Computer and Electronic Product Manufacturing | Manufacturing |
| 335 | Electrical Equipment, Appliance, and Component Manufacturing | Manufacturing |

| NAICS | NAICS Description | Sector |
|---|---|---|
| 336 | Transportation Equipment Manufacturing | Manufacturing |
| 337 | Furniture and Related Product Manufacturing | Manufacturing |
| 339 | Miscellaneous Manufacturing | Manufacturing |
| 4234 | Wholesale Professional & Commercial Equipment | Manufacturing |
| 4235 | Wholesale Metal & Mineral (Except Petroleum) | Manufacturing |
| 4237 | Wholesale Hardware, Plumbing & Heating Equipment | Manufacturing |
| 4238 | Wholesale Machinery, Equipment & Supplies | Manufacturing |
| 4246 | Wholesale Chemical and Allied Products | Manufacturing |
| 111 | Crop Production | Natural Resources |
| 112 | Animal Production and Aquaculture | Natural Resources |
| 113 | Forestry and Logging | Natural Resources |
| 115 | Support Activities for Agriculture and Forestry | Natural Resources |
| 211 | Oil and Gas Extraction | Natural Resources |
| 212 | Mining (except Oil and Gas) | Natural Resources |
| 213 | Support Activities for Mining | Natural Resources |
| 321 | Wood Product Manufacturing | Natural Resources |
| 324 | Petroleum and Coal Products Manufacturing | Natural Resources |
| 4233 | Wholesale Lumber and Other Construction Materials | Natural Resources |
| 4247 | Wholesale Petroleum & Petroleum Products | Natural Resources |
| 481 | Air Transportation | Transportation and Logistics |
| 482 | Rail Transportation | Transportation and Logistics |
| 483 | Water Transportation | Transportation and Logistics |
| 484 | Truck Transportation | Transportation and Logistics |
| 486 | Pipeline Transportation | Transportation and Logistics |
| 488 | Support Activities for Transportation | Transportation and Logistics |
| 491 | Postal Service | Transportation and Logistics |
| 492 | Couriers and Messengers | Transportation and Logistics |
| 493 | Warehousing and Storage | Transportation and Logistics |

Source: CPCS

# Appendix C: Delay and Safety Methodology

### 5.3.1 Delay Methodology

The data for the delay analysis was developed by ATRI, which collects point speeds from trucks via GPS “pings” from a nationwide sample of commercial vehicle fleets. For this study ATRI mapped the speeds and truck pings in the study area to a GIS network[17] of non-interstate Tier One corridors, as defined and described in Working Paper 3 of this study.

For any individual segment, truck delay is computed according to the formula:

$$Truck\ Delay\ = Truck\ Volume\ \times \left(\frac{Segment\ Distance}{Truck\ Speed} - \frac{Segment\ Distance}{Truck\ Target\ Speed}\right)$$

where:

- Truck volume is computed for each segment and hour, by dividing the number of pings by the likelihood of a truck ping occurring on the segment (which is a function of speed and the length of the segment). Since ATRI trucks represent a sample of all trucks on the roadway, volumes are inflated by a multiplier based on the corridor volumes from Working Paper 3.
- Segment distance is in miles
- Truck speed, in miles per hour, is the average travel speed for all trucks on the segment for the given hour (across a month’s worth of weekday observations)
- Truck target speed is the free-flow speed for the given segment, generally equal to the overnight speed. Specifically, it is taken as the 95$^{th}$ percentile average speed across all 24 hours of the day (i.e. the second highest hourly speed).

Delay, computed in the manner described above, provides an indication of the total extra time spent by trucks in traffic, above and beyond the time that it would take under free-flow conditions. For practical purposes, free-flow conditions may not be realistically achievable at all hours of the day due to factors such as “friction” from other road vehicles, at least assuming a continuation of current vehicle technologies. Furthermore, if there were a potential

[17] For the shapefile used in the study, segments are in general directional where a road is physically separated, and centerline where a road is not physically separated.

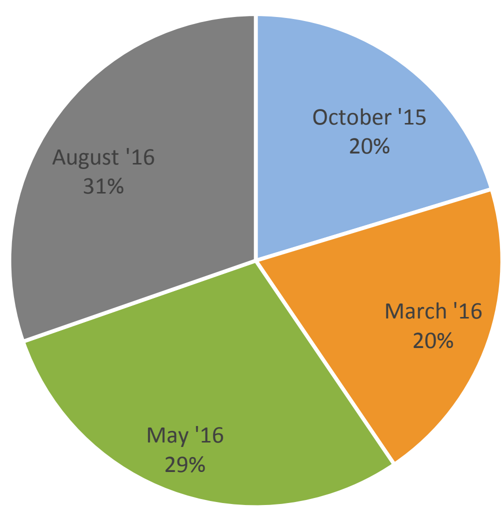
intervention that would improve truck travel speeds *at all hours of the day*, including the overnight period, such additional time savings are not reflected in the delay metric.

These caveats aside, the delay metric serves to rank locations by where interventions aimed at improving truck flow would save the greatest amount of time, and when applied at the micro-level, indicate particular hotspots or bottlenecks that cause delays to truck traffic.

**Aggregating Delay and Delay Hotspots**

Delay was computed separately for each road segment and then aggregated across all segments to identify bottlenecks. First, delay is averaged across four months' of data, taken to be representative of an entire year. For this study, the four months provided by ATRI were October 2015, March 2016, May 2016, and August 2016. As seen in Figure C- 1, the months of May and August had the greatest aggregate delay on Tier One corridors. By averaging across the four months, we mitigate against the impacts of seasonality (whether in terms of construction, competing commuter traffic, or high seasonality of truck traffic near facilities such as grain terminals).

Figure C- 1 Distribution of Truck Delay by Study Month




Source: CPCS analysis of ATRI data

Second, we ranked all segments by delay per mile, in order to establish locations with the greatest concentration of delay. We then applied an 85$^{th}$ percentile threshold and filtered out segments that do not meet the threshold.

Third, we used GIS software to spatially join segments passing the threshold that are within 0.5 miles of one another. We then ranked each of these delay "hotspots" by aggregate delay.

### 5.3.2 Crash Analysis Methodology

Truck crash data were obtained from MnDOT via its Crash Mapping Analysis Tool (CMAT).[18] Data were obtained for the years 2010-2015 (inclusive), for the following vehicle types:

- 2-axle truck
- 3+ axle single unit
- Truck with 1 trailer
- Truck tractor no trailer
- Truck w/ semi-trailer
- Truck w/ double-trailer
- Truck w/ triple trailer
- Unknown heavy truck

All crashes were included in the analysis if at least one of the above vehicles was involved. Excluded were crashes involving passenger vehicles (including pickup trucks) as well as other heavy vehicles such as buses (unless also involving one of the listed vehicles).

There were 14,548 crashes that met these criteria (in the 7-county metro area as well as Wright and Sherburne Counties). These crashes were then mapped to the Tier One corridors using the road name identified in the database as well as a distance threshold of 50 feet (to capture crashes on side streets immediately adjacent to the corridor at hand).

Crash density was established for each road segment through normalization by using average annual daily truck volume (as established in Working Paper 3 – note the annual total includes weekends).

$$Crash\ Density\ = \frac{No.\ Crashes\ \ over\ 6\ year\ analysis\ period}{\left(\frac{Truck\ volume}{day} \times \frac{365\ days}{year} \times \frac{6\ yrs}{analysis\ period}\right)}$$

Due to the relative infrequency of crashes, crash density is expressed on a per-million trucks basis. Effectively, the crash density is the number of truck-related crashes per every million trucks that traverse a centerline road segment.

The segments are not all of the same length. The study team considered expressing crash density according to the more familiar per-VMT basis; however it was concluded that this would be less effective for identifying crash hotspots, since some of the segments are extremely short.

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[18] MnDOT CMAT: https://www.dot.state.mn.us/stateaid/crashmapping.html

Thus, for example, two intersections with a similar number of crashes per million trucks would score very differently if one segment consisted of just the intersection, while the other segment extended (for example) to the next block. In order to properly compare crash hotspots on a per-VMT basis, the underlying road segments should be consolidated so as to be of a minimum length; however, such an exercise is beyond the scope of this study.

Similar to truck delay, we perform a geospatial analysis by identifying all locations with a crash density above the 85$^{th}$ percentile and spatially joining segments within 0.5 miles of one another that pass the threshold. However, whereas delay hotspots are ranked on the basis of total delay across all joined segments, crash hotspots are ranked on the basis of maximum delay for any single constituent segment. This, in effect, isolates the worst part of each hotspot.

# Appendix D: Field Visit Delay Maps

This appendix contains detailed maps of truck delay by segment for field visit sites for which truck delay was identified as an issue.

Figure D- 1 Truck Delay by Segment for US-169 (North)

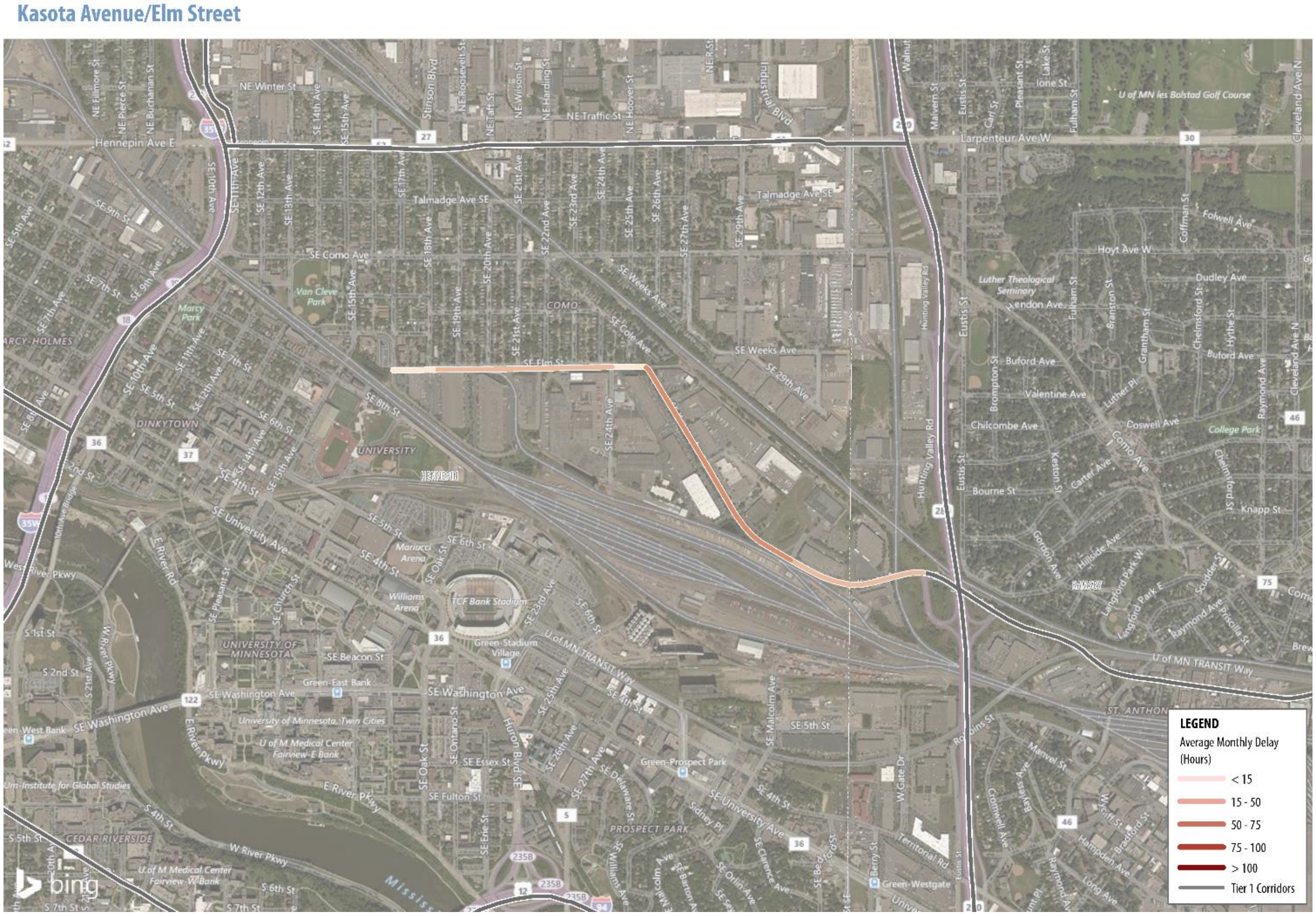

Source: CPCS analysis of ATRI data. Aerial layer: Bing Maps

**Figure D- 2 Truck Delay by Segment for US-169 (South)**

US-169 (South)


Source: CPCS analysis of ATRI data. Aerial layer: Bing Maps

**Figure D- 3 Truck Delay by Segment for Kasota Ave/Elm St**




Source: CPCS analysis of ATRI data. Aerial layer: Bing Maps

**Figure D- 4 Truck Delay by Segment for County Road C**

County Road C.


Source: CPCS analysis of ATRI data. Aerial layer: Bing Maps

# Appendix E: County Maps of Truck Freight Corridors

Figure E-1: Tiered Truck Corridors in Anoka County

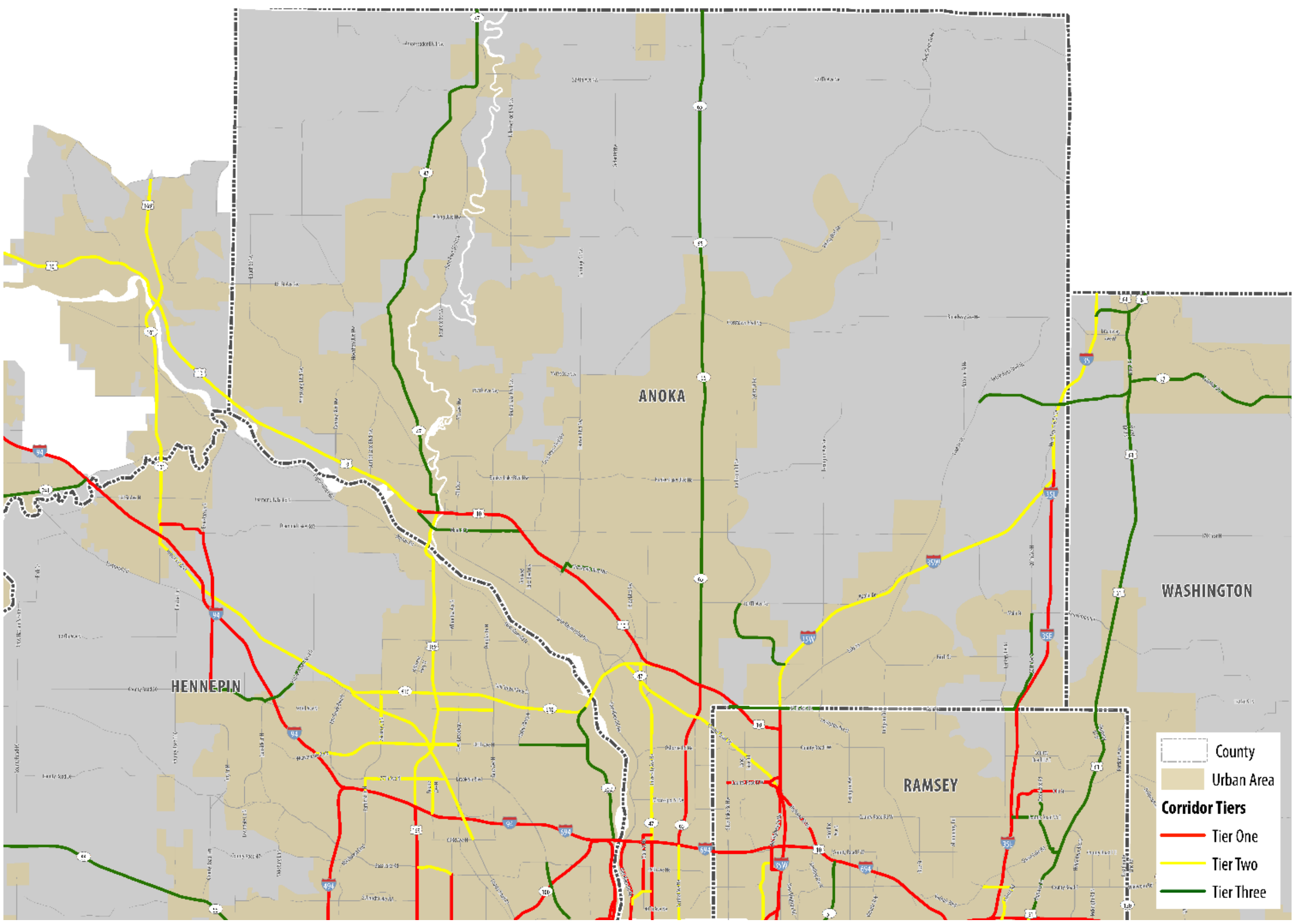


Figure E-2: Tiered Truck Corridors in Carver County

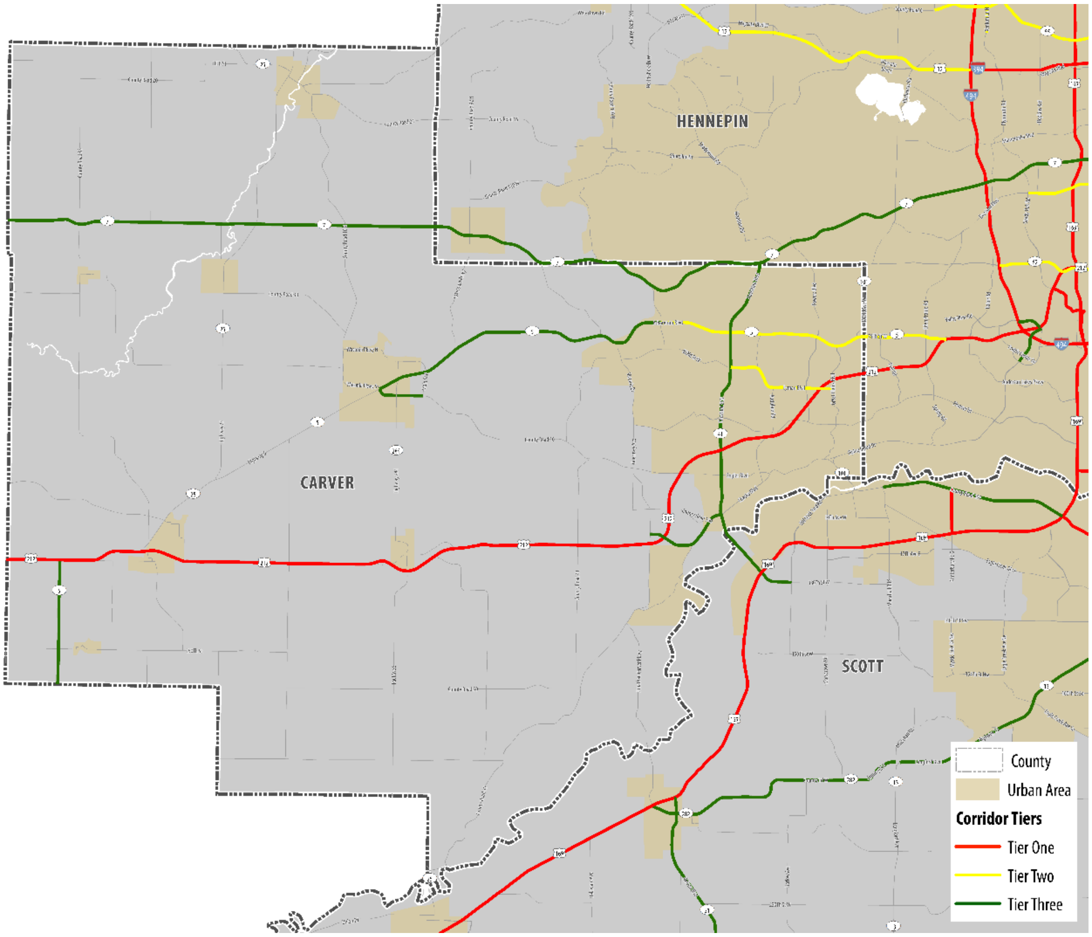


**Figure E-3: Tiered Truck Corridors in Dakota County**

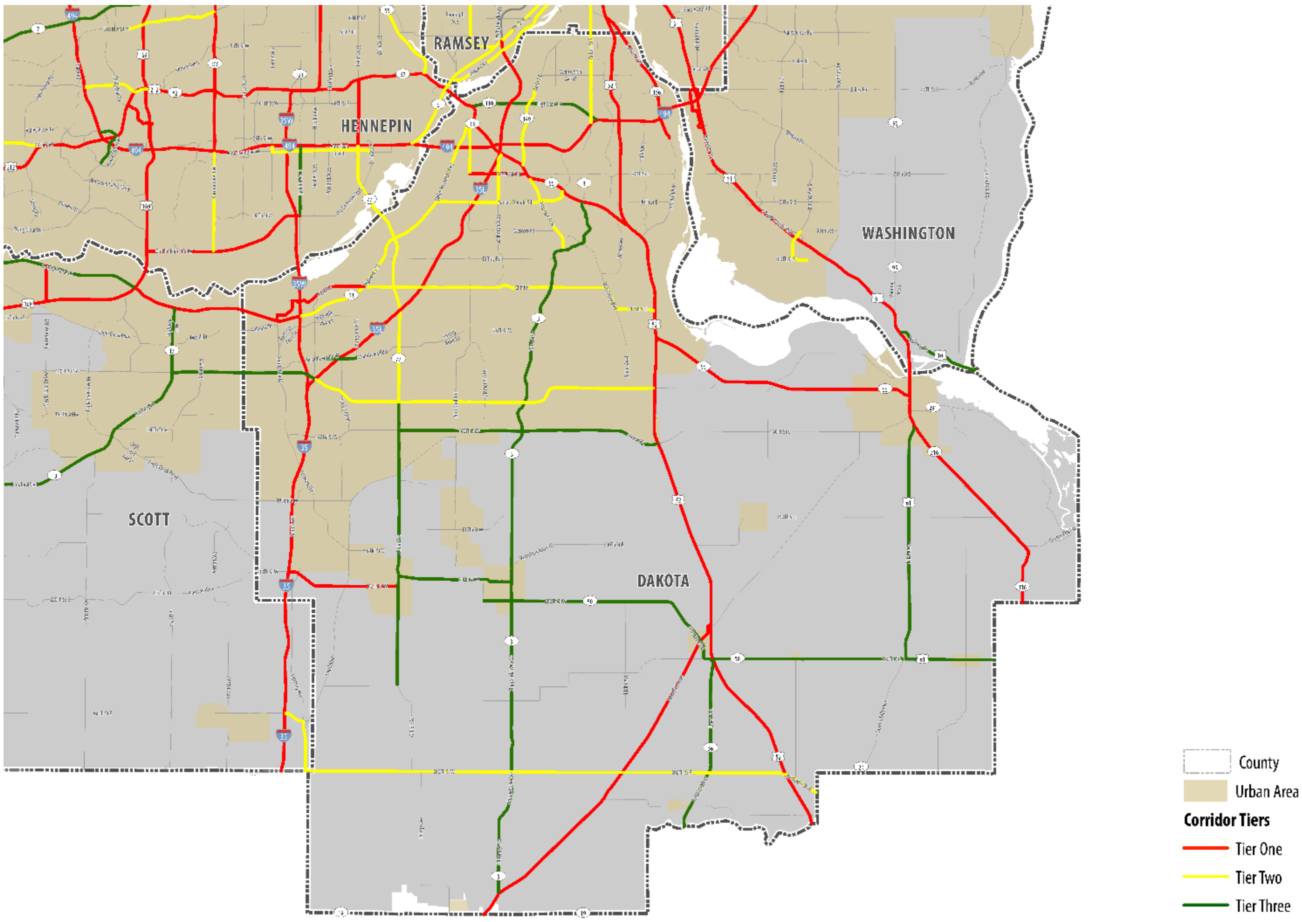


Figure E-4: Tiered Truck Corridors in Hennepin County

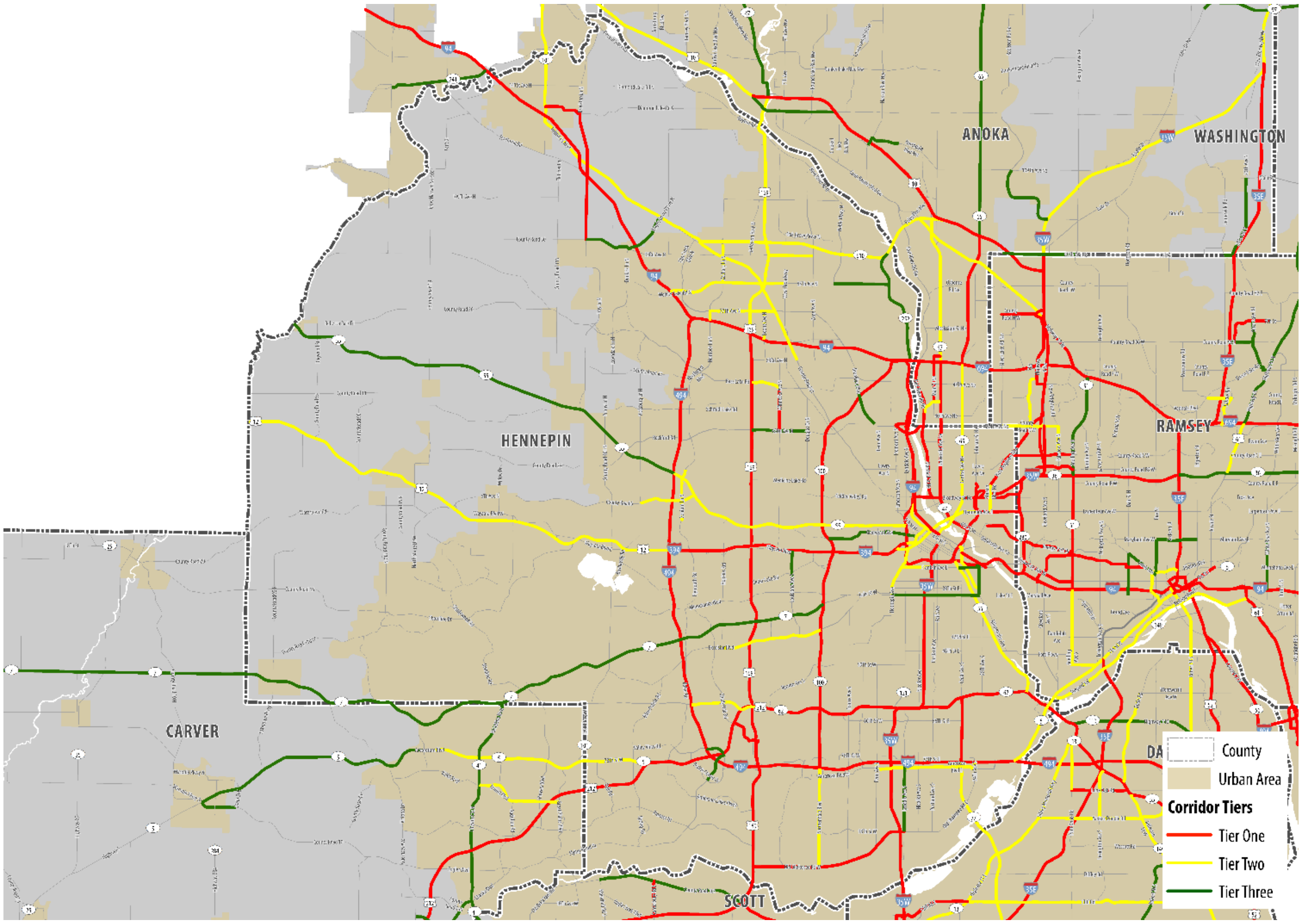


Figure E-5: Tiered Truck Corridors in Ramsey County

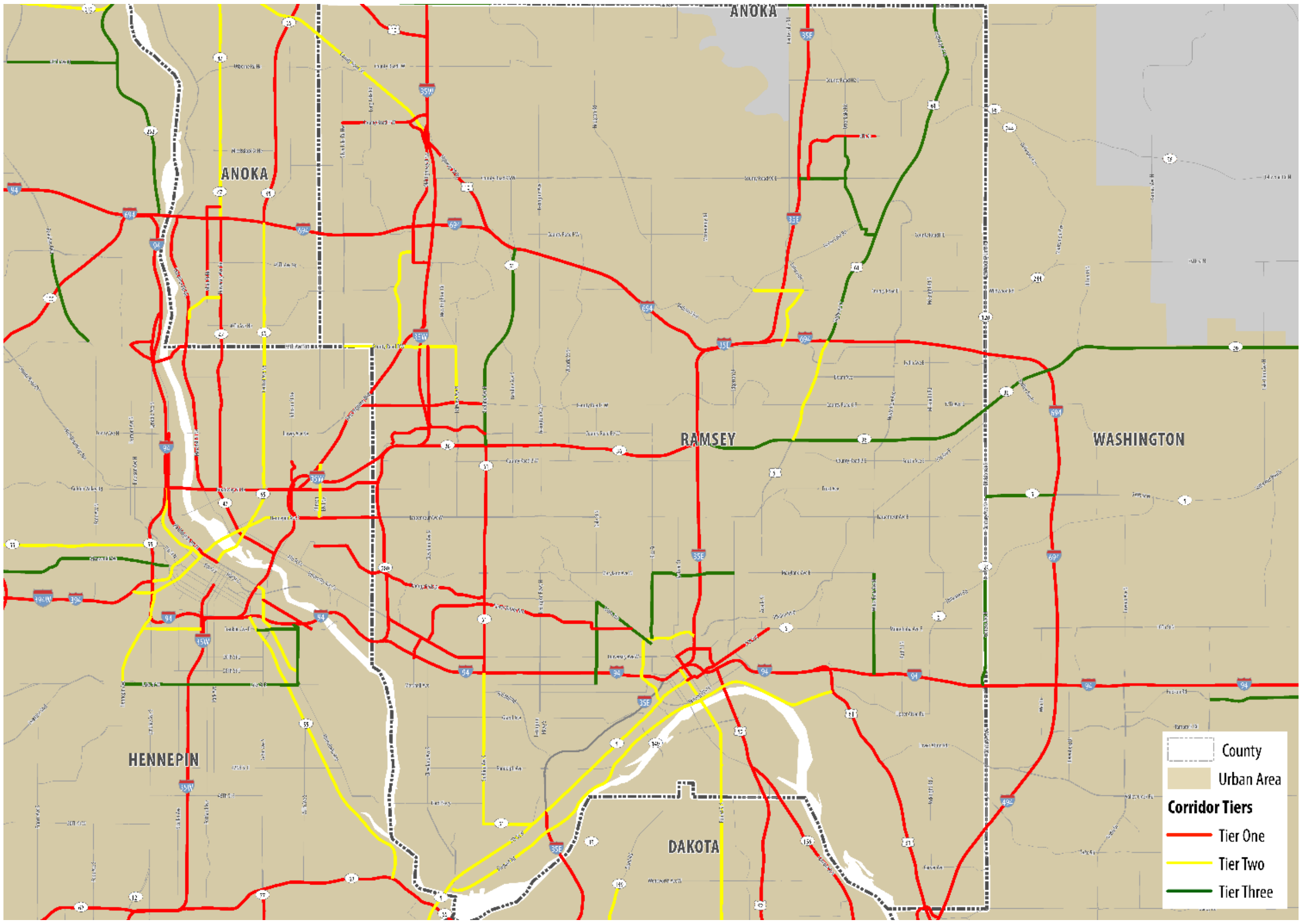


Figure E-6: Tiered Truck Corridors in Scott County

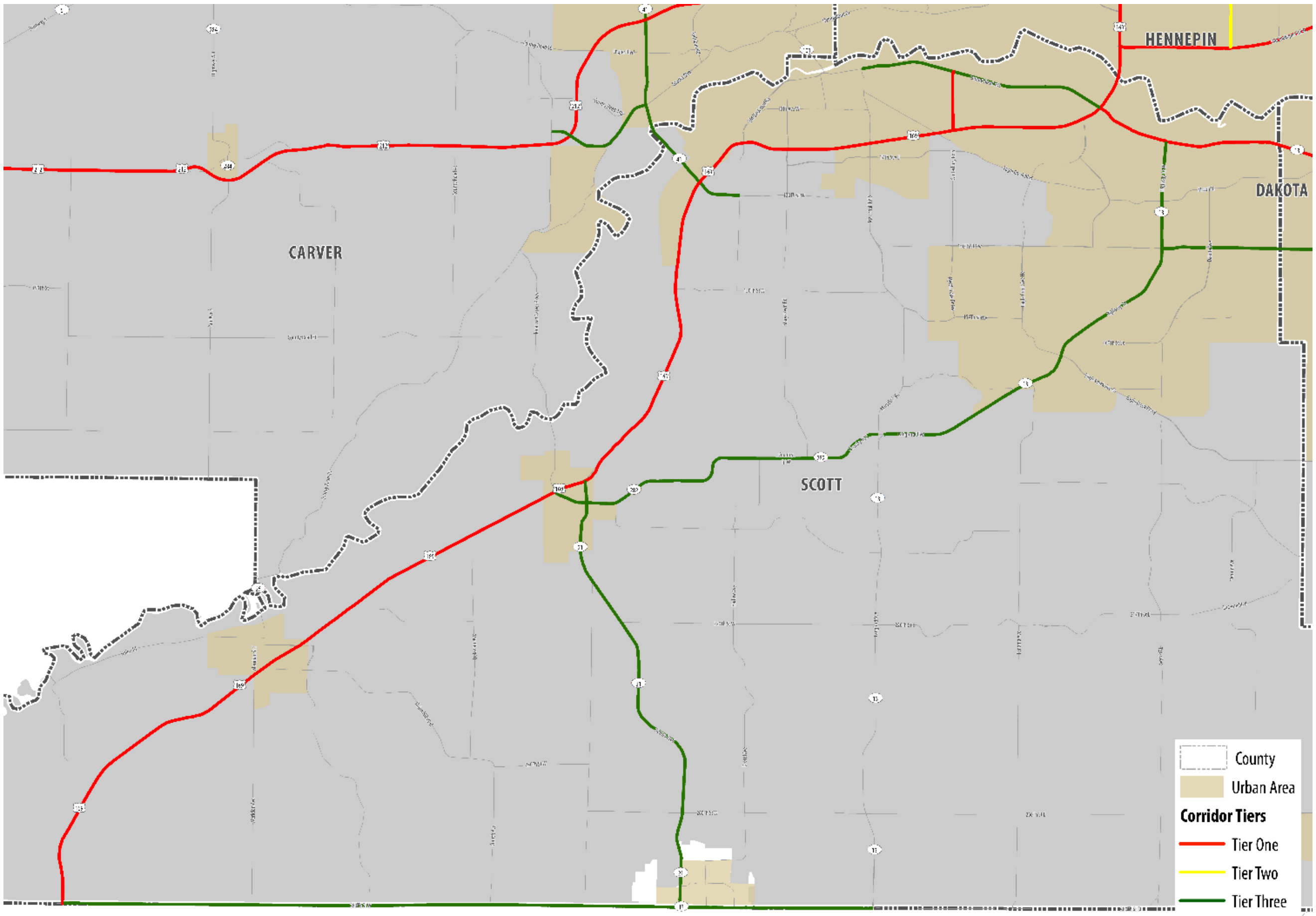
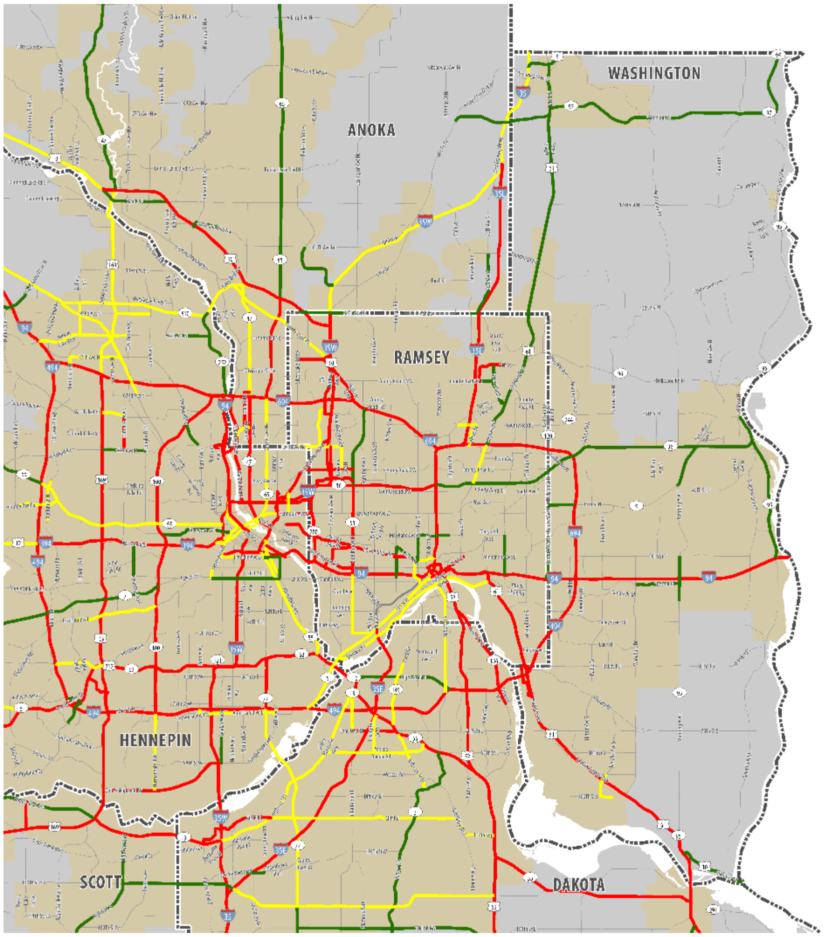


**Figure E-7: Tiered Truck Corridors in Washington County**



# Appendix F: Acronyms / Abbreviations

| | |
|---|---|
| AADT | Annual Average Daily Traffic |
| ATR | Automatic Traffic Recorder |
| ATRI | American Transportation Research Institute |
| BOLO | Be on the lookout |
| BTS | Bureau of Transportation Statistics |
| CCTV | Closed-Circuit Television |
| CMAT | Crash Mapping Analysis Tool |
| CMSP | Congestion Management Safety Plan |
| CP | Canadian Pacific Railway |
| CR | County Road |
| CRFC | Critical Rural Freight Corridor |
| CSAH | County State Aid Highway |
| CUFC | Critical Urban Freight Corridor |
| DMS | Dynamic Message Sign |
| DOT | Department of Transportation |
| EB | Eastbound |
| FAF | Freight Analysis Framework |
| FHWA | Federal Highway Administration |
| GPS | Global Positioning System |
| HAR | Highway Advisory Radio |
| HCAADT | Heavy Commercial Annual Average Daily Traffic |
| ITS | Intelligent Transportation Systems |
| Met Council | Metropolitan Council |
| MN | Minnesota |
| MnDOT | Minnesota Department of Transportation |
| Mph | Miles per Hour |
| MPO | Metropolitan Planning Organization |
| MSP | Minneapolis-St. Paul |
| NAICS | North American Industry Classification System |
| NB | Northbound |
| NE | Northeast |
| NHS | National Highway System |
| NPMRDS | National Performance Management Research Data Set |
| O-D | Origin-Destination |

| | |
|---|---|
| OCR | Optical Character Recognition |
| RITA | Research and Innovative Technology Administration |
| RTMC | Regional Transportation Management Center |
| SB | Southbound |
| SHA | State Highway Administration |
| TAG | Technical Advisory Group |
| TAZ | Traffic Analysis Zone |
| TH | Trunk Highway |
| TIGER | Transportation Investment Generating Economic Recovery |
| TMC | Traffic Management Center |
| TPP | Transportation Policy Plan |
| TSM&O | Traffic Safety Management & Operations |
| US | United States |
| VMT | Vehicle Miles Traveled |
| WB | Westbound |
| WIM | Weigh-in-Motion |