Twin Cities Metro Area Freight Connectors Study

FREIGHT CONNECTORS

Final Report

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MINNESOTA DEPARTMENT OF TRANSPORTATION

ENGINEERS
PLANNERS
ECONOMISTS

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SEH

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Acknowledgements

Because this study entailed significant original research, the consultant team was guided by a Technical Advisory Committee (TAC) comprised of Mn/DOT planners, engineers, and representatives from local units of government. The consultant team held four meetings during the course of the study to share interim results and receive feedback on key data issues and suggestions for developing the connector assessment process. We would like to acknowledge the TAC members for their input and guidance to the study process. The members of the TAC included:

- Matthew Pahs, Mn/DOT - Office of Freight & Commercial Vehicles (OFCVO)
- John Tompkins, Mn/DOT - OFCVO
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- Kim Lindquist, Community Development Director – Rosemount
- Timothy J. Plath, PE, PTOE, Transportation Engineer - City of Eagan
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INTRODUCTION

"*Freight connectors*" are roadways that tie together elements of an intermodal freight transportation system. Connectors link major freight activity nodes to arterial highway systems, and enable efficient networks serving ports, rail intermodal yards, airports, and other freight intensive nodes. When designed, maintained, and operated with freight, connector routes can facilitate the best use of individual modes, as well as, improve the overall efficiency of regional highway networks.

In 2005, the Minnesota Department of Transportation (Mn/DOT) completed the *Minnesota Statewide Freight Plan* (Freight Plan) calling attention to needs in Minnesota to support current and future freight movements. The Freight Policy quoted below recognizes the importance of intermodal connections for efficient access to global markets:

> "*Provide an integrated system of freight transportation in Minnesota - highway, rail, water, air cargo, and intermodal terminals - that offers safe, reliable, and competitive access to statewide, national, and international markets.*"[1]

The Freight Plan also presents a policy framework providing directions, strategies and performance measures for improving freight mobility and safety in Minnesota. The *Twin Cities Metro Area Freight Connector Study* (TCMA Freight Connector Study) was undertaken to provide additional detailed analysis required to support the implementation of several strategies found in the Freight Plan:

- "*1.4: Support efforts to develop a statewide interconnected 10-ton roadway system to serve major freight facilities.*"
- "*1.5: Pursue National Highway System Intermodal Connector designation for significant connectors.*"
- "*3.1: Address performance (speed and safety) needs on roads with significant truck volumes, particularly in the Twin Cities.*"
- "*4.1: Develop and monitor key freight system performance measures and indicators; set targets, as appropriate.*"

Additional recommendations in the Freight Plan were directed specifically toward improvements to highway access for important freight activity centers. One recommendation suggested that previous work undertaken by Mn/DOT to develop performance metrics for key freight connectors in Minnesota be expanded by defining the term "adequate performance" for freight connectors. A further recommendation suggested that Mn/DOT designate roadways serving key intermodal facilities to be included in the inventory of National Highway System (NHS) Intermodal Connectors. In response to these recommendations, Mn/DOT contracted with the

team of Wilbur Smith Associates and SEH to conduct the Twin Cities Metro Area Freight Connector Study.

The overall study effort consisted of five primary tasks:

- Task 1: Freight Cluster Identification and Connector Selection
- Task 2: Freight Data Inventory and Analysis
- Task 3: Needs Analysis - Data Collection and Field Observations
- Task 4: Connector Profiles
- Task 5: Connector Enhancement Strategies and Recommendations

The study process has been well documented in the previous Technical Memorandums that are available on the Freight Connector Study website at:
http://www.dot.state.mn.us/ofrw/TCMAconnectors.html

Background and Purpose

One of Mn/DOT's guiding principles is that the agency will manage the state's transportation system based upon measurable performance: *"Develop challenging indicators and benchmarks for all levels of government, measure results and use the outcomes to guide decisions and direct our work."[2]* In most public agencies freight planning is a new, and developing practice area. The Freight Plan produced in 2005 established several freight performance measures and indicators that refer to "appropriate" roadway access to major arterial roadways, or "adequate" infrastructure condition. However, neither "appropriate" nor "adequate" was defined with regard to highway connector routes to major freight generators.

The TCMA Freight Connector Study was undertaken to define and quantify the "adequacy" of connector routes from an infrastructure and performance perspective. The study approach used data analysis and stakeholder input to develop a methodology that planners at the state and local level can use to assess freight connector performance. More specifically, the purpose of the freight connector analysis was to:

- Determine the role of connector routes in supporting the transportation and economic needs of specific geographic areas, industry clusters, or key nodes of freight activity.
- Develop specific goals for freight connector performance, i.e. define "adequate" for the purpose of providing a measurable performance standard for intermodal freight connectors.
- Develop a template for assembling existing, but disparate data sets in a manner that will allow planners to analyze and prioritize connector routes.

- Develop supporting data to designate key connector routes identified in the Freight Plan as National Highway System (NHS) Intermodal Connectors.
- Identify potential strategies across the disciplines of design, construction, maintenance, and operations to improve freight connector performance.

A Proposed Road Map for Assessing Freight Connector Adequacy

Figure 1: Freight Connector Assessment Road Map

As previously discussed, a key objective of this study was to define freight connector adequacy using a data driven, performance based process. This study, and several previous analyses conducted by Mn/DOT have made great strides in achieving that objective. However, the process for examining connector adequacy is one that should be viewed as dynamic, and likely to change. A good first step toward a broader program to support freight connectors is to establish benchmarks against which a large population of connectors can be measured.

Figure 1 suggests a template for moving the process forward in a concise manner to quantify adequacy on many more routes.

Step 1
Freight Cluster Definition
- Land use data
- Socio/economic data
- Jurisdictional boundaries
- Key freight generators

Freight Connector Definition

Step 2
Identify Key Truck Routes
- Business Surveys
- Truck Tailing
- Commercial Truck Counts
- Roadway Networks

Step 3
Technical Evaluation
- Point Features
- Continuous Features
- Interpretive Features
  (User identified problems)
- Problem Truck Points
- Problem Truck Miles

Freight Connector Performance Assessment

Issues defined by users

Issues defined by data

Step 4
Adequacy Measure / Score
- Connector Miles Performance Score
- Connector Point Performance Score
- User Rating Score

The remainder of this report describes in more detail the suggested tasks in each step of the Freight Connector Adequacy Road Map. The report is structured as a "how to guide" for transportation planners and engineers who wish to examine freight connector adequacy.

Recommendations are provided at the end of each section for improving the effectiveness and/or efficiency of the process, or compensating for data limitations. The report concludes with broader recommendations for how Mn/DOT might consider moving forward with a more comprehensive freight connector program.

1. FREIGHT CLUSTER DEFINITION

Applying Land Use and Socio-Economic Data to Cluster Identification

The TCMA Freight Connector Study was initiated with an extensive literature review that is presented in **Appendix A**. Much of the existing literature about freight connectors has been generated by recognition of intermodal freight connectors in the Transportation Equity Act for the 21st Century (TEA-21), passed by Congress in 1998. The language of TEA-21 called upon the Federal Highway Administration (FHWA) to conduct an analysis of roadways connecting major

Step 1
Freight Cluster Definition
- Land use data
- Socio/economic data
- Jurisdictional boundaries
- Key freight generators

freight hubs to the National Highway System (NHS). The resulting report to Congress documented significant investment needs for "last mile" routes in and out of major intermodal freight hubs.[3] Given the intermodal context of the national dialogue, much of the previous literature and research focused on highway connections to major airports, water ports, and railroad intermodal terminals.

At a regional level, the issue of freight connectors has, at times, been examined in the context of land use and/or economic development planning. Several studies, including a previous study conducted by Mn/DOT, have examined clusters of freight activity without regard to intermodal connections. The TCMA Freight Connector Study focused on freight stakeholder needs and the ability of the highway network to serve those needs, regardless of whether more than one mode was involved.

The process for identifying freight clusters in the Twin Cities Metro Area began with overlaying land uses with the locations of facilities in Mn/DOT's Freight Facilities Database. A clustering of freight land uses and facilities was observed in many areas. These areas were then delineated by using Census Bureau Traffic Analysis Zones (TAZs). A TAZ usually consists of census blocks, block groups, or census tracts, and is the unit of analysis used by Met Council for traffic modeling. Clusters were therefore identified for the metro region using this TAZ method. This study began with these TAZ-based clusters and focused on three clusters for further research and refinement, as described in the next section.

Initiating the Cluster Identification Process: The process for identifying the freight clusters to be studied was based on previous research conducted by the Center for Neighborhood

Technology (CNT) in urban Chicago. CNT developed a freight-planning tool referred to as the "Cargo-Oriented Development Optimizer" (COD-Optimizer).

"COD is a form of development that concentrates manufacturing and distribution businesses at a location where they benefit from efficient access to multiple modes of freight transportation, the presence of complementary businesses, and an available industrial workforce."[4]

The COD-Optimizer tool was developed to help identify areas in urban Chicago suited for freight related urban redevelopment. The Optimizer uses a statistical function to mathematically score the potential of an area or site for freight related economic development activities based upon eight data variables. For the TCMA Freight Connector Study, ten socio-economic and land use variables were obtained as GIS data sets and thematically mapped. The wall maps, available upon request, were then presented to the TAC as aids to selecting candidate freight clusters to be examined by the study. The eight thematic maps displayed the following data:

- o Existing Cluster Definitions for the Twin Cities Area
- o Metropolitan Council Transportation Analysis Zones
- o Major Intermodal Terminal Locations
- o Major Retail and Manufacturing Establishments
- o Industry Sector Employment
- o Land Use
- o Annual Average Daily Traffic (AADT)
- o Truck Crash Locations
- o Average Income
- o Education Level

(Small-scale versions of these maps were included as an Appendix to Tech Memo 1).

TAC members were provided a ballot and asked to rank their top choice within three freight land-use categories. A discussion of the land-use categories can be found in Technical Memorandum 1. Based upon the TAC votes, the following three clusters were selected:

1. Mature Intermodal Development – Shoreham / NE Minneapolis Area
2. Non-Intermodal Industrial Cluster – Eagan
3. Emerging Freight Cluster – Rosemount

Once the candidate freight clusters were identified, a major effort was undertaken to acquire relevant data identified by the client that might be used in an adequacy assessment. As a first step, the consultant team redefined the boundaries of each freight cluster to correspond with the TAZs found in the current version of the Metropolitan Council's Regional Travel Demand Model. There should be a note of caution when defining clusters using TAZ boundaries because
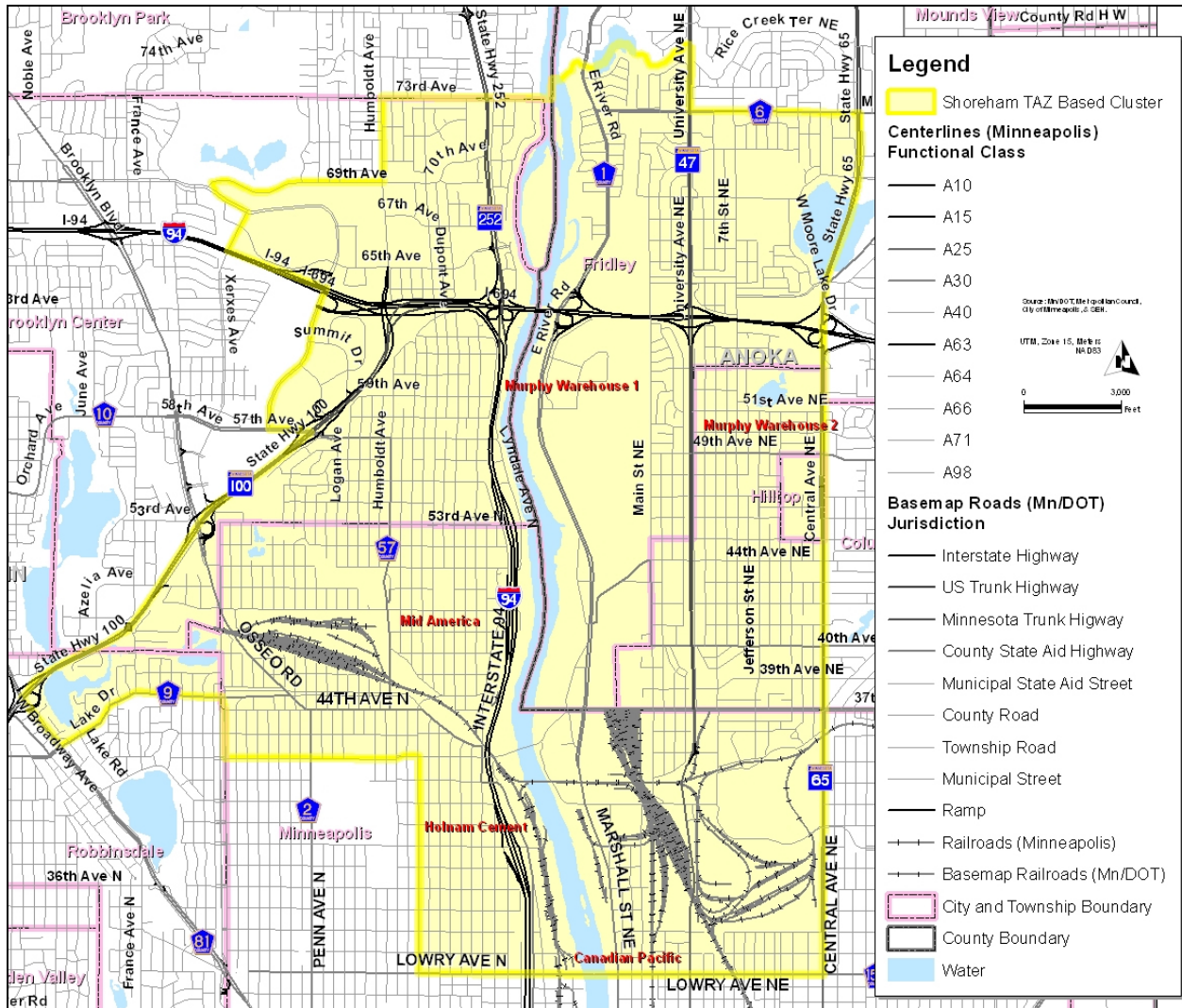
the resulting clusters often cross city jurisdictional boundaries creating challenges for obtaining standardized data sets.

- The Shoreham / NE Minneapolis freight cluster area was defined by 24 TAZs totaling approximately 10,500 acres as shown in **Figure 2.** This area is approximately 3 miles from the east to the west, and 4 miles from the north to the south. The Shoreham / NE Minneapolis cluster is framed by Central Avenue (US Highway 65) on the east; Lowry Avenue, 42nd Avenue and County Road 9 on the south; Fremont Avenue, County Highway 81 and Minnesota Highway 100 on the west; and 72nd Avenue and County Road 6 on the north.
- The Eagan freight cluster, defined by 20 Metropolitan Council TAZ boundaries is shown in **Figure 3**. This area is approximately 4.5 miles from the east to the west, and 5 miles from the north to the south. The Eagan cluster included approximately 13,100 acres, and is framed by County Road 63 on the east; I-494 and Trunk Highway (TH) 110 on the north; the Minnesota River and TH 77 to the west; and County Road 30, and Westcott Road to the south.
- The Rosemount freight cluster, as defined by 6 Metropolitan Council TAZ boundaries, is shown in **Figure 4**. This area is approximately 8.5 miles from the east to the west, and 8 miles from the north to the south. The Rosemount cluster includes 6 TAZs and approximately 17,200 acres, and is framed by the Mississippi River and Furlong Trail to the east; Barnes Avenue, County Road 42 and TH 52 on the north; Country Road 71 and Robert Trail on the west; and 160th Street to the south.

Figure 2: Shoreham / NE Mpls Area Freight Cluster

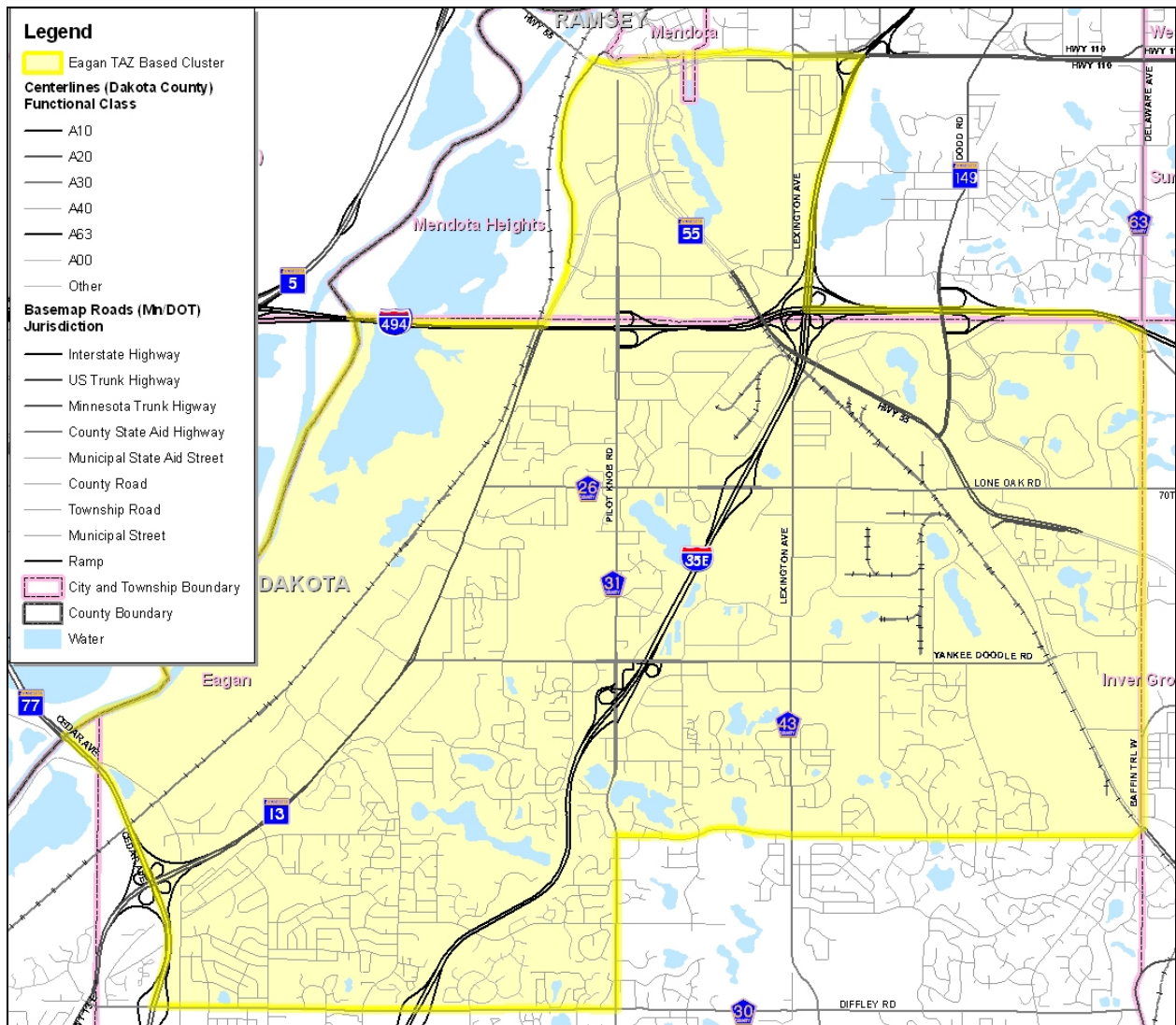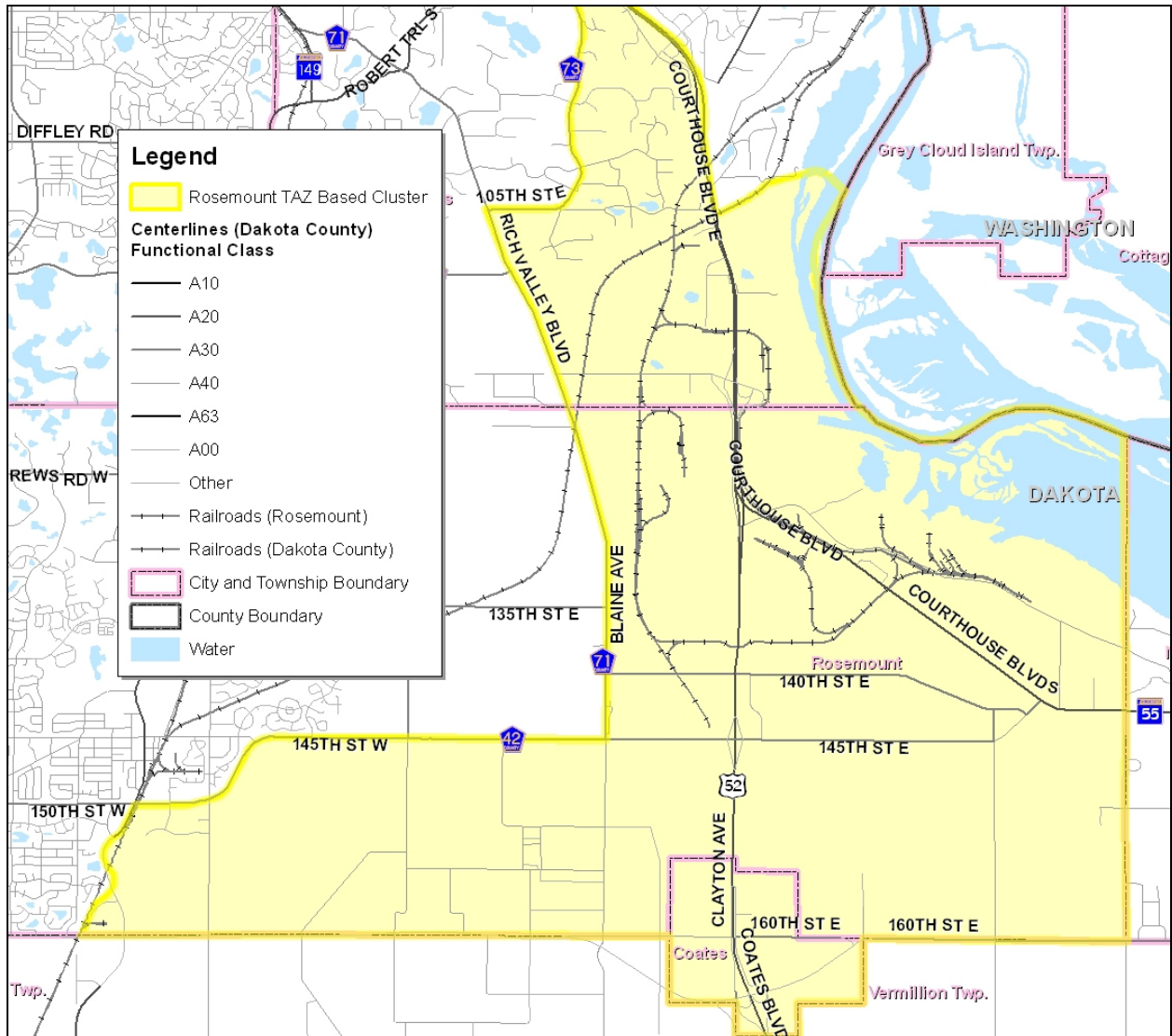**Figure 3: Eagan Freight Cluster**

Figure 4: Rosemount Freight Cluster

Data Acquisition and Analysis

At the outset of the TCMA Freight Connector Study, an objective of the investigation was to develop a "data driven" process for determining connector adequacy. An effort was made to identify an automated means of screening select variables to determine connector adequacy, using existing Mn/DOT and local government GIS data sets. **Table 1** on the next page provides a summary of the GIS data acquired and organized for use in assessing connector adequacy.

The regionally based data sources were very beneficial and efficient in terms of the metro-wide screening process. Yet along with some of the state agency GIS databases, they also showed clear gaps in the data needed for the local-scale element of this study. Likewise, it became apparent that more specific datasets would need to be researched and gleaned from County and Municipal sources. Following contact with corresponding County and Municipal GIS personal, the existence, as well as variations in standards and format (GIS/CAD/Tabular) of the data (e.g. pavement rating systems, roadway weight designations, turning radii, lane width), became apparent.

Ultimately, the methodology for automating the screening of numerous alternative truck routes based on a GIS analysis using the "routed" base map system was not feasible. It was originally intended to utilize the existing state base map to develop and intersect GIS based "route event tables" which enables the efficient automation of the quantification efforts. Difficulties arose as a result of the given availability and standardization of some key GIS datasets. While some of the GIS-ready files proved effective in automating the locational mapping of key assessment criteria, a fully automated quantification method was not possible given the various "positional/locational" formats of the data. The required conversions of these data that would have enabled further development of the method were beyond the time and budget for this project. It is important to note that all of the key adequacy criteria in current GIS locational format could ultimately be converted and applied to the state base map route system. In turn, this could lead to more effective automation of mapping and quantification routines in the future.

Table 1: TCMA Freight Connector Data & Key Adequacy Criteria (Highlighted)

Additional Mapping Information Collected to Determine Adequacy (D-Dakota; H-Hennepin; A-Anoka; DOT-Mn/DOT; MC-Metropolitan Council, E-Eagan; R-Rosemount; M-Mpls; F-Fridley)
2005 Markhurd Orthophotos
2003-04 Minneapolis Orthophotos
Barging Facilities (D)
Bridges (DOT, D)
Deficient Intersections (D, E)
Railroad Centerlines (DOT, D, E, M, R)
Signals/Signalized Intersections (D, E, M)
Stop Signs (M)
Roadway Weight Capacity - 10 Ton (A, D, H, DOT)
Roadway Weight Capacity - 10 Ton (A, D, H, DOT)
Trucking Terminals (D)
Road Centerlines (D, H, M)
Freight Forwarders (D)
Functional Classification Roads (D, E, MC, M)
Intersection Improvements (E)
Existing Land Use (E, F, M)
Proposed Land Use (E, F, R)
Pavement Condition (E, H-table, SEH & WSA)
Underutilized Land (E)
Lane Width (H-table, SEH & WSA)
Freight Model Runs 2005, 2020, & 2030 (MC)
Metro Model 2000 TAZ Boundaries (MC)
TAZ Based Cluster Boundaries (WSA & SEH)
Bike Trails/Trails (M)
Traffic Flow Volumes (M)
Bridge Condition & Capacity (DOT)
Freight Facilities Database (DOT)
Metro Projects List (DOT)
Pavement Width (DOT)
Railroad Crossings (DOT)
Municipal Traffic Volumes for Heavy Commercial Vehicles - Tube Counts (DOT)
Zoning (R)
Turning Radii (SEH & WSA)
Route Event Tables (SEH & WSA)
Manufacturing & Warehousing with 20+ EmployeesTonnage Mapping Analysis (SEH & WSA)

Identifying Key Freight Generators

Commercially Available Business Location Databases

In 2004, Mn/DOT acquired TRANSEARCH Database of commodity flows for Minnesota from Global Insight (formerly Reebie Associates). The Freight Locator Database is a derivative of the commercially available InfoUSA business establishment database. The Freight Locator database distributed by Global Insights has been enhanced to include several additional fields not available directly from InfoUSA, such as estimated commodity tonnages by facility. An analysis of the Freight Locator database produced the following statistics for the three freight clusters examined in TCMA Study:

- The Shoreham / NE Minneapolis freight cluster contained 86 warehouse and manufacturing facilities that produced approximately 635,000 tons of freight in 2002. These 86 firms were responsible for over 10,000 jobs in the cluster. The top commodities by tonnage in the cluster were Petroleum and Coal Products, and Clay, Concrete, Glass, and Stone.
- The Eagan freight cluster contained 83 manufacturing and warehouse facilities that produced in excess of 1.5 million tons of freight in 2002. The Clay, Concrete, Glass, or Stone commodity group lead the cluster in tonnage production accounting for nearly one-third of the estimated tonnage. Businesses producing Printed Matter account for nearly half of the manufacturing and warehouse jobs in the cluster, while producing just 3 percent of the cluster's tonnage.
- The Rosemount freight cluster contained nine manufacturing and warehouse facilities that produced in excess of 750,000 tons of freight in 2003. The Chemicals commodity group dominates the cluster in tonnage production accounting for nearly one-third of the estimated tonnage.

Table 2 illustrates the top commodity producing companies by cluster. Because the InfoUSA data is geo-coded, the top commodity producing companies were also mapped, showing the relationship between these freight generators and the road network. Maps of facility location and relative commodity production are shown in **Figures 5, 6,** and **7.**

Table 2. Top Commodity producing Companies by Cluster

Freight Cluster	Company Name	Est. Tons
Shoreham/ NE Mpls	MARSHALL CONCRETE PROD	139,600
Shoreham/ NE Mpls	GAF BUILDING MATERIALS	118,512
Shoreham/ NE Mpls	OWENS-CORNING FIBERGLAS	89,980
Shoreham/ NE Mpls	WALLBOARD INC	35,127
Eagan	COCA-COLA BOTTLING CO	653,015
Eagan	AGGREGATES INDUSTRIES	226,730
Eagan	CEMSTONE PRODUCTS CO	163,146
Eagan	UNIVERSAL CO-OP	77,238
Rosemount	ENDRES PROCESSING LTD	59,697
Rosemount	CENEX FEED PLANT	23,517
Rosemount	PRAXAIR INC	186,093
Rosemount	CONTINENTAL NITROGEN	47,826
Rosemount	CONTINENTAL NITROGEN	47,826

Figure 5: Top Manufacturing Facilities in the Shoreham Cluster by Tonnage

Figure 6: Top Manufacturing Facilities in the Eagan Cluster by Tonnage

Figure 7: Top Manufacturing Facilities in the Rosemount Cluster by Tonnage

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During the survey/interview process, an effort was made to compare the employment and tonnage estimates found in the Freight Locator database with estimates provided by the contact person at each facility. To make it easier for facility representatives to respond to questions about levels of employment and tonnage production, they were asked to provide a response within a r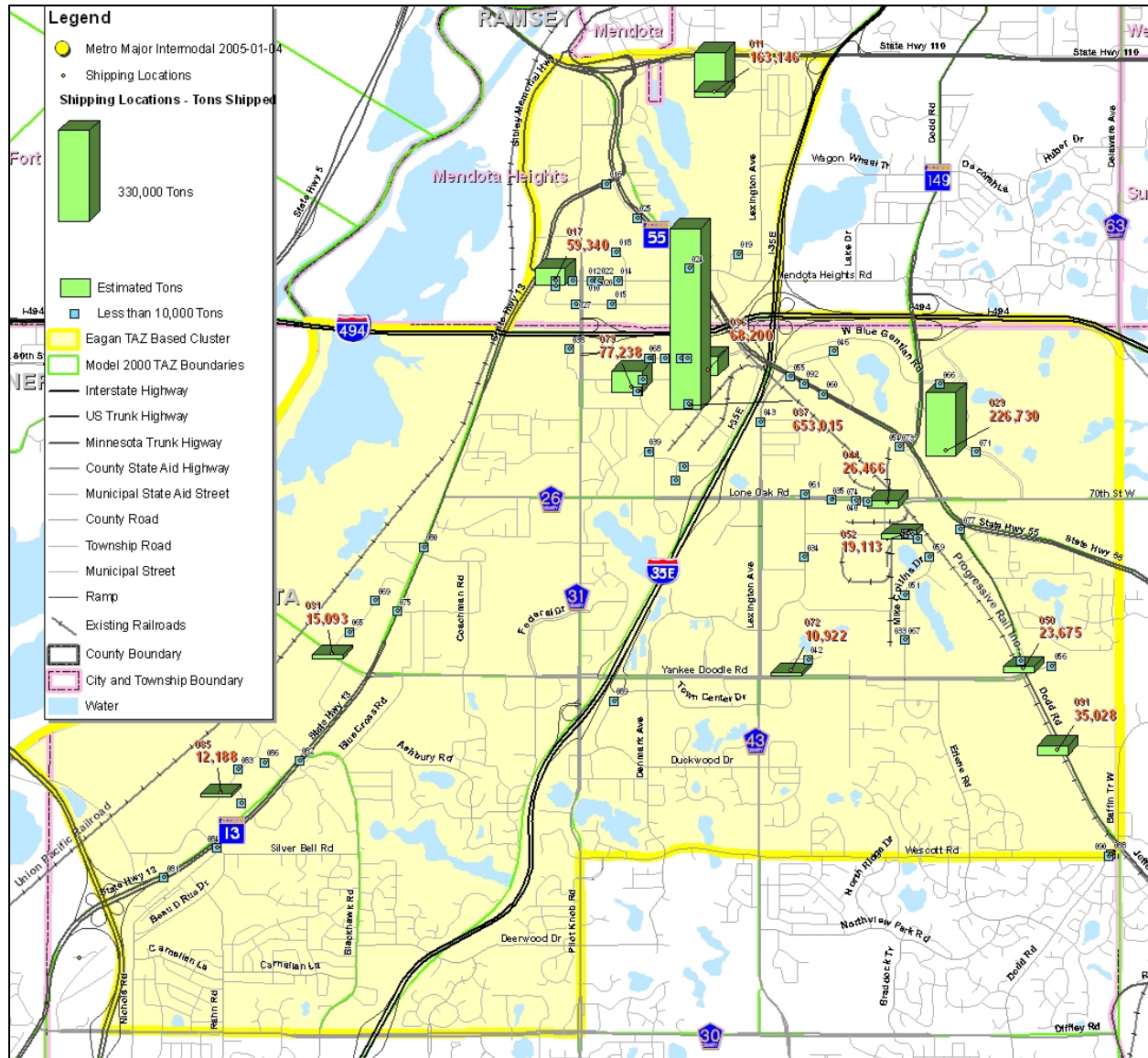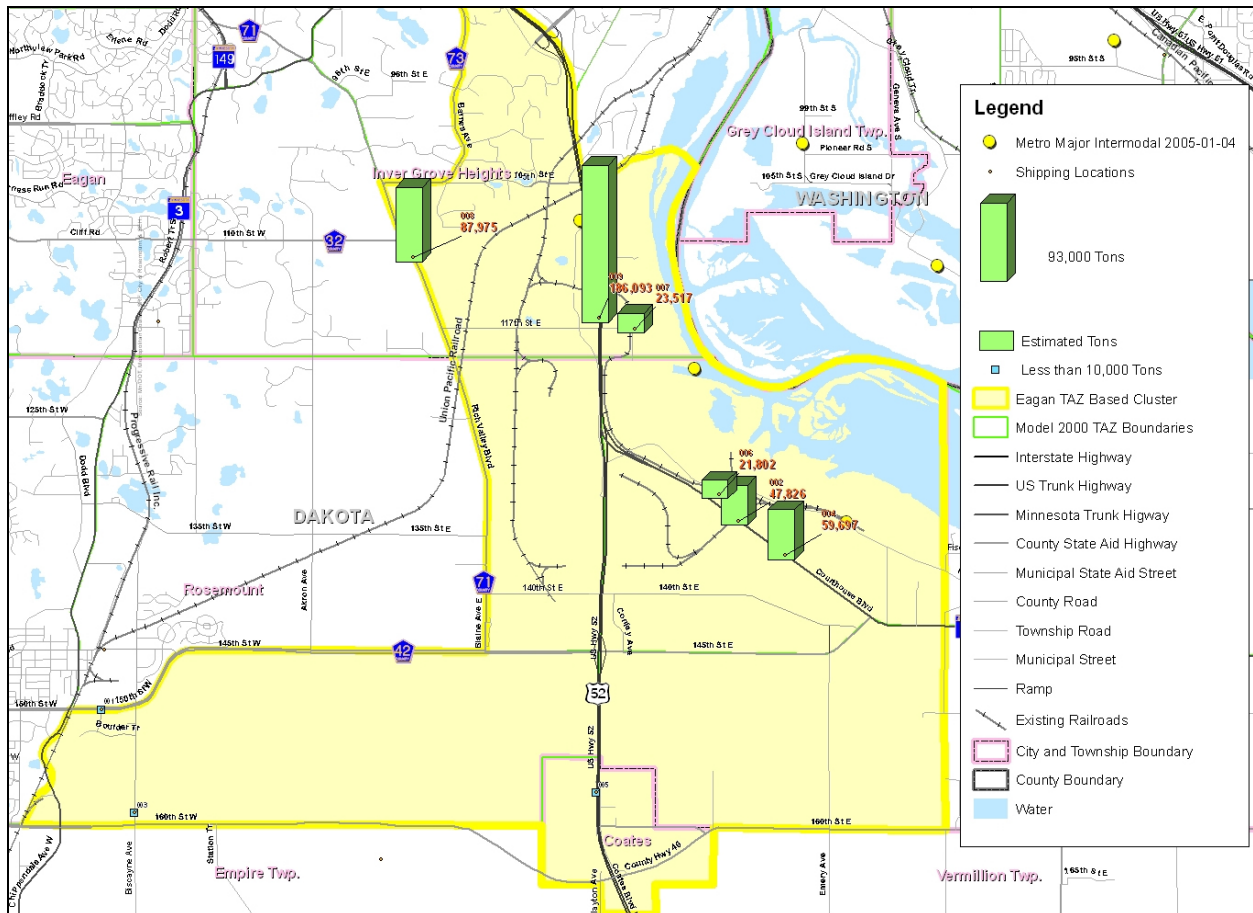ange of values. **Table 3** shows a sample of companies from each cluster, and compares how the survey responses compare with the information provided in the Freight Locator database. While employment estimates provide in Freight Locator tended to fall within the range of values received from the survey/interview process, in some cases the tonnage estimates fell considerably short of the survey responses.

Table 3: Comparison of Freight Locator Database Estimates and Survey Responses

Company Name	Database Employment Estimates	Survey Employment Response	Database Tons	Survey Tons
SGI	375	100-250	3,369	1,000-25,000
LCS	45	25-50	1,674	1,000-25,000
Marshall Concrete Prods	80	50-100	139,600	170,000
Owens-Corning	77	50-100	89,980	450,000
Endres Processing	60	25-50	59,697	Over 100,000
Cenex	23	25-50	23,517	Over 100,000
Cannon Equipment	150	100-250	5,178	500-1,000

The Mn/DOT Freight Facilities Database

The Mn/DOT Freight Facilities database was also examined as a source for identifying large freight generators. The Mn/DOT Freight Facilities database identified 153 facilities in the Shoreham Freight Cluster, including retail facilities and gasoline service stations. For this study retail stores and service facilities were excluded from the cluster population. Most of the remaining manufacturing and distribution facilities were also identified in the Freight Locator database. There were, however, seven key facilities identified in the Mn/DOT Freight Facilities database, that did not appear in the Freight Locator database: 1) Murphy Warehouse, 2) Mid-America Distribution Center, 3) Holcim Minneapolis Cement Terminal, 4) River Services Bulk Loading Dock North, 5) CP Shoreham Intermodal Railroad Yard, 6) CP Shoreham Transfer and

Reload Railroad Yard, and 7) Distribution Centers of Minnesota. These facilities were added to the Shoreham Cluster facility population for the stakeholder outreach efforts.

The Mn/DOT Freight Facilities database listed 154 establishments in the Eagan cluster, and 21 in the Rosemount cluster. When retail and service establishments were removed from the database 110 establishments remained in the Eagan population, and 14 in the Rosemount cluster. No additional major facilities were identified in the Eagan cluster using the Mn/DOT database. In Rosemount, the Mn/DOT database identified several trucking companies, river terminals, and a pipeline terminal that were not identified in the Freight Locator dataset.

Recommendations for Improving Freight Cluster Definition

- **Market the connector program data needs to local governments:** During the course of the study, one of the major challenges that faced the consultant team was the existence, availability, and standardization of GIS datasets from municipal, county, regional, and state governments. The governmental units intersecting the candidate freight clusters varied widely in terms of the quantity of available digital GIS mapping relevant to this study. Some governmental units are just beginning GIS database development initiatives, while others have higher levels of GIS integration and mapping products. The project team would encourage Mn/DOT to communicate with local government GIS user groups about the growing importance of freight transportation, and the impact of freight on the local economy, and in turn how key GIS data sets can be used to support freight mobility.

- **Update and refine the Mn/DOT Freight Facilities Database:** The Freight Facilities database created and maintained by Mn/DOT can be a valuable resource for moving forward with a more comprehensive freight connector program; however, many of the entries in the database are outdated. In addition, some of the fields and many of the records have questionable relevance to major freight facilities. In comparing several commercially available databases such as the InfoUSA or Harris Database, it appears that many of the most important facilities and fields can be purchased and updated annually at a very reasonable cost (i.e. under $1,000 for manufacturing and warehouse facilities of 50 employees or more). The project team would recommend that Mn/DOT approach several of the major database vendors with a request for the specific data fields they deem most important and request comparison price quotes. The base data could also be supplemented through the development of a brief on-line survey marketed directly to key facility operators in Minnesota.

2. IDENTIFYING KEY TRUCK ROUTES

The major decision point faced by the project team during the conduct of the study was whether adequacy criteria should be applied to connector corridors or connector routes. Under a corridor approach - the adequacy criteria would be applied to individual roadway facilities or sections of facilities. While a corridor approach has merit, the actual routes to and from a major freight generator is likely to involve a combination of roadway facilities that entail

> **Step 2**
> Identify Key Truck Routes
> - Business Surveys
> - Truck Tailing
> - Commercial Truck Counts
> - Roadway Networks

intersection geometry and other network links. Another hurdle with a corridor approach is that to cover all road links heavily used by trucks would possibly entail the task of conducting adequacy evaluations across a broad network of facilities. The literature review identified previous research on access-related impediments relevant to large commercial vehicles that overcame the deficiencies of a corridor approach by focusing on actual truck routes.[5]

After consulting with the TAC, the project team decided to identify a sample of representative freight connector routes from each of the three freight study clusters. Specific truck routes enabled a more detailed and meaningful analysis of adequacy criteria. Representative freight connector routes were defined as the actual path that a commercial vehicle takes between a freight-generating facility and the regional highway system. Representative freight connector routes were selected based on: 1) feedback from industry stakeholder interviews/surveys; 2) on-site observations of areas with high levels of truck traffic; 3) field observations from following trucks to and from key freight generators; and, 4) recommendations from city representatives on the TAC.
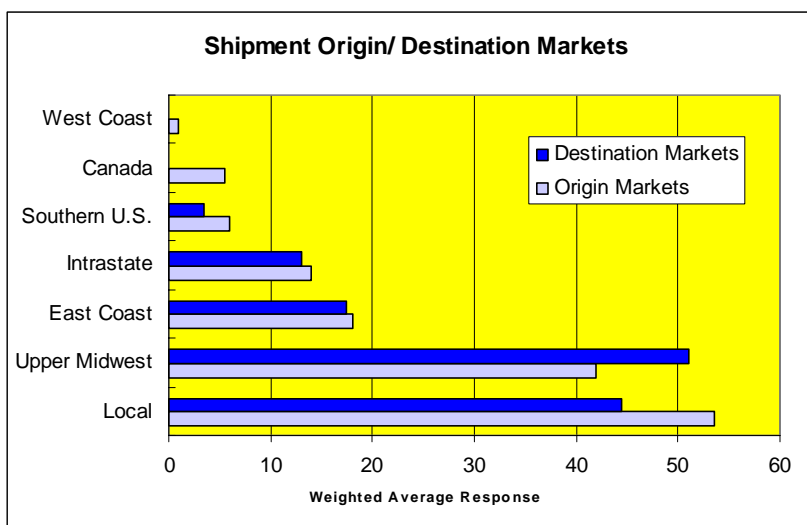
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Market Areas for Study Clusters

The InfoUSA business directory and Mn/DOT Freight Facilities database were also used as a resource in contacting manufacturing and transportation firms located in the cluster areas to complete a survey or interview about their transportation operations and preferred truck routes to and from their facilities.

Figure 8: O/D Markets for Study Cluster Facilities

Figure 8 provides a summary of responses regarding origin/destination (O/D) markets for all companies surveyed in the three freight clusters studied. The most popular origins for all companies interviewed were locations in the Twin Cities area. The most popular destinations for outbound shipments were other states in the Upper Midwest (defined as Wisconsin, Illinois, Iowa, and the Dakotas).

Facility managers were also asked to indicate the number of inbound and outbound truck trips generated by their facility.

- In Shoreham, the greatest number of truck trips was generated by the CP Shoreham intermodal facility that reported generating about 400 truck trips each day. Temp Distribution and Marshall Concrete each reported generating on average 200 truck trips per day, evenly split between in and out bound. Murphy Warehouse and Owens Corning each generate about 100 trips per day. Combined, the responding entities produce up to 1000 truck trips in and out of the Shoreham cluster on a daily basis.

- For companies in the Eagan cluster, Freight Masters terminal facility was the largest trip generator of facilities surveyed, with approximately 700 trips per day, evenly divided between in and outbound trucks. The second largest was the United States Postal Service (USPS) Distribution Depot. The USPS produces 100 inbound and 100 outbound trips per day.   Aggregate Industries reported generating only 5 inbound truck trips while producing up to 100 outbound truck trips daily. Most of the inbound commodity traffic at this facility arrives by barge. The survey indicated that Aggregate Industries receives approximately 80 barges per month over an 8-month period.

- In the Rosemount cluster, Endres Processing reported generating between 50 and 100 truck trips per day, while Olson Carriers, Flint Hills Resource, and Cenex/Land O' Lakes each report generating between 50 and 75 inbound truck trips per day, and 25-50 outbound truck trips per day. Combined, the responding entities produce in excess of 500 truck trips in and out of the Rosemount cluster on a daily basis.

Carriers and Shippers interviewed were also asked about the routes used by commercial vehicles accessing their facilities. The actual interview/survey question appears below followed by a sample route response for the Shoreham / NE Minneapolis cluster in **Table 4**:

> *"What are the primary origins for commodities being brought into the (**named facility**)? In serving this location, what are the primary highways and local routes that truck drivers use to access the facility? (i.e., primary routes include Interstate, US or MN highways; local routes include city streets, and state and county highways)."*

Table 4: Sample Route Description for Shoreham Intermodal Facility Access

Origins and Highway Routes Used to Access Facility		
Origin a.	Midwest Cities East to Canadian Pacific Shoreham Intermodal Yard	45% of total shipments
Primary Route	I-694 to University Avenue South to 30th Street NE	
Secondary Route	I-94 to Washington Avenue, to Lowry street to University Ave.	

Carriers were the best source of information regarding the actual routes used to access facilities. Many shippers were aware of popular corridor used, but were unsure of the exact route used by carriers. Some facility managers also referred members of the project team to trucking companies that served their facilities.

Field Observation / Truck Tailing

In addition to the survey and research conducted for the three respective clusters, several hours of field study were conducted to identify some of the most used connector routes. Time was spent following freight trucks from the highest truck traffic generating facilities in each of the clusters. Additional study was conducted to identify a number of the most used freight connector routes in each cluster. To begin the field research, it was important to first identify the major truck trip generating facilities within the identified study areas. Then, time can

be most efficiently spent following trucks originating and terminating at these specific locations. Once the major facilities had been distinguished, multiple trucks were followed from each major cluster facility location to generate a basic idea of the most well-used and preferred truck routes. Most often, trucks used different routes depending on the distance and direction of their freight movement.
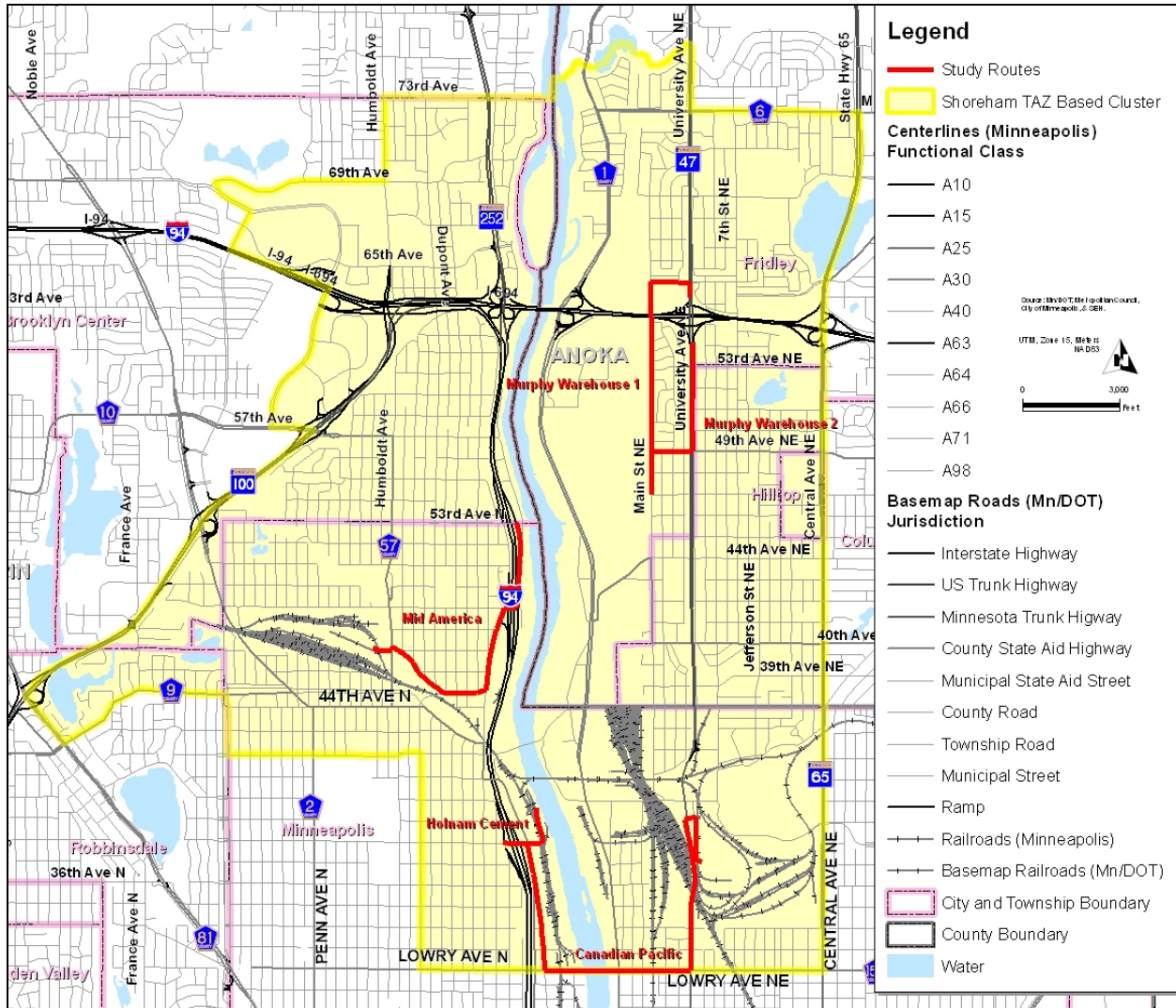
Sample Route Descriptions

- USPS Bulk Mail Facility Routes - Eagan: The USPS facility is located on Lexington Avenue in Eagan. The first truck followed onto Lexington Avenue traveled south to Yankee Doodle Road, then east to southbound Highway 149. The second trip "tailed" out of the facility also traveled south on Lexington Avenue to westbound Yankee Doodle Road, and then to southbound I-35E; the trip taking approximately five minutes. The third truck traveled north on Lexington Avenue. The driver then turned west onto Lone Oak Road and onto northbound I-35E.

- Coca-Cola Distribution - Eagan: The first truck followed traveled south on Eagandale Boulevard, a facility well designed for truck traffic. After traveling southbound through the business park, the truck traveled east on Lone Oak Road to northbound I-35E. The second truck that was followed began north on Eagandale Blvd., and turned west on Highway 55. The third truck followed drove on to eastbound Highway 55 via Eagandale Blvd. After crossing over I-35E, the driver exited onto southbound Lexington Avenue, turning onto Lone Oak Road. Finally the truck reached its destination by traveling south onto Neil Armstrong Boulevard into another business park.

- The Shoreham Intermodal Yard - NE Minneapolis: Trucks leaving the Shoreham facility access University Avenue via a frontage road that runs parallel to University to an access point at St. Anthony Boulevard. (Some delays were observed due to an at-grade crossing at the entrance into the yard due to train traffic and many trucks were slowed by the bumps on either side of the crossing). All trucks leaving the Shoreham Intermodal Yard use the frontage road (32nd Street) to gain access to University Avenue. The first two trucks tailed followed University Avenue north to I-694. The third truck followed University Avenue south into Minneapolis. Where the roadway narrows at the intersection of University and Broadway, the driver was observed straddling two lanes through the intersection.

Using the combination of information provided through the survey/interview process, field work, and TAC representative input, seven routes within the three clusters were identified for further study: five routes in the Shoreham / NE Minneapolis cluster, and one each in Eagan and Rosemount. These seven routes appear in the maps in **Figures 9, 10** and **11.**

Figure 9: Key Freight Connector Routes in the Shoreham/NE Mpls Cluster

Figure 10: Key Freight Connector Routes in the Eagan Cluster

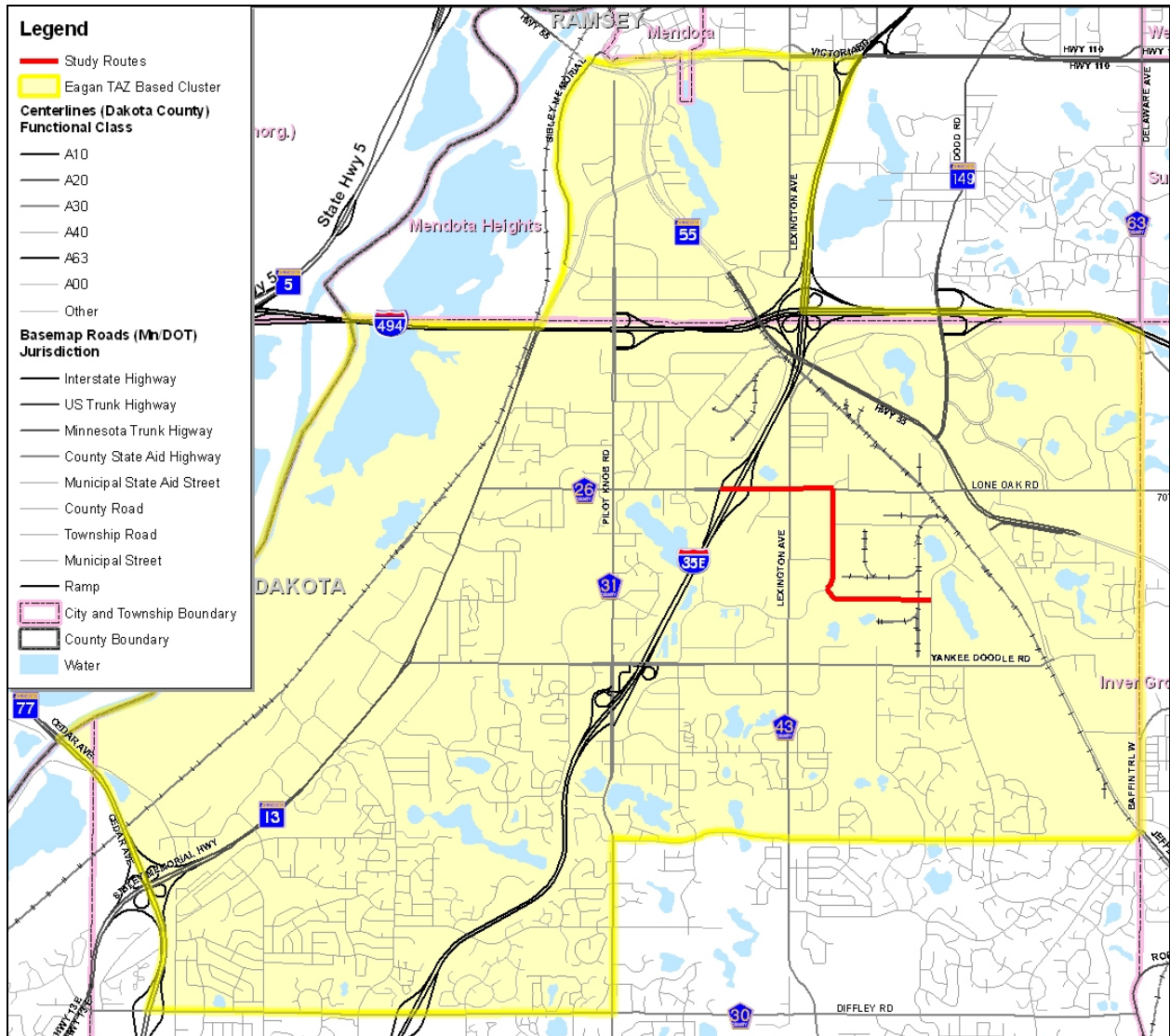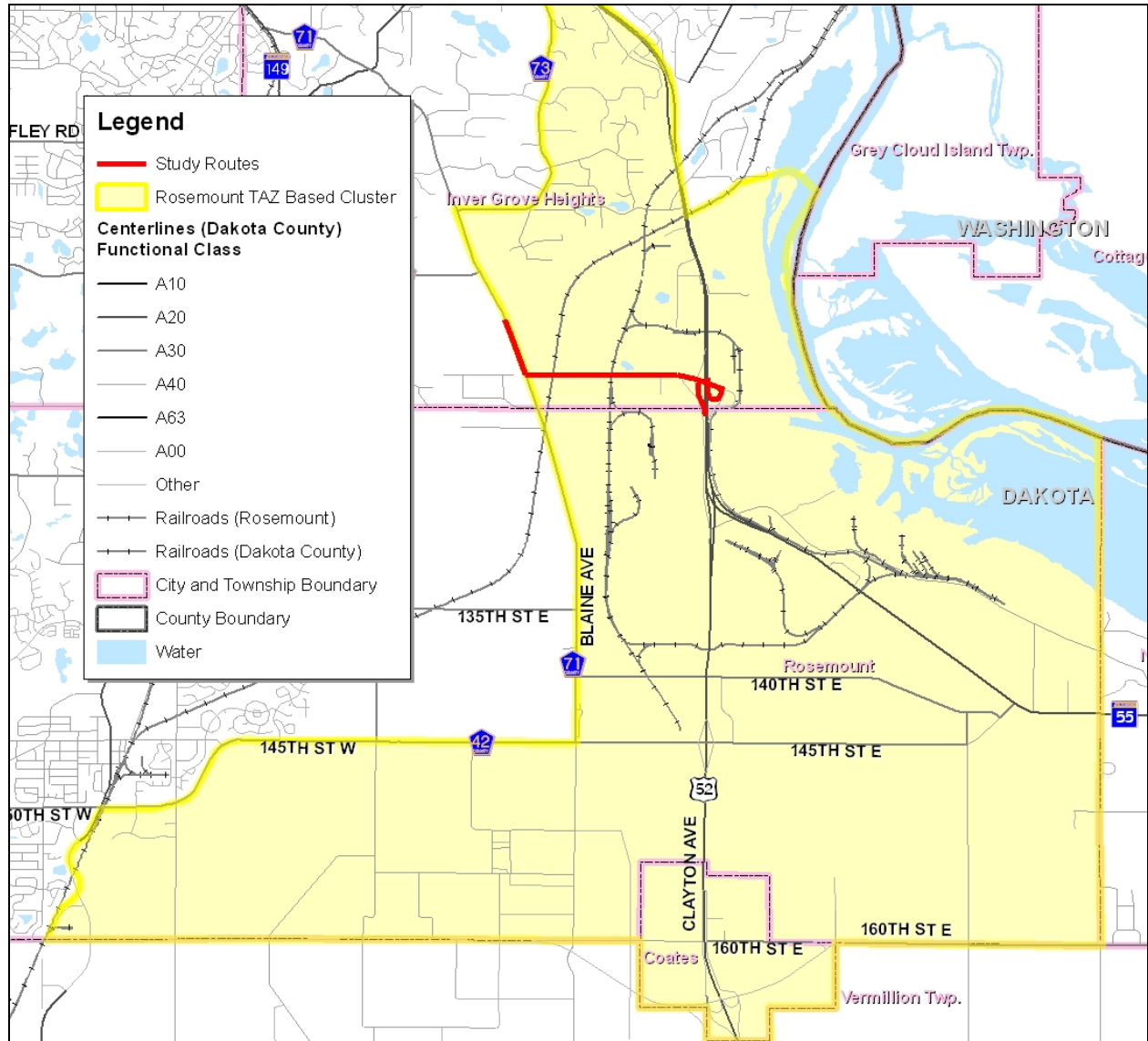**Figure 11: Key Freight Connector Routes in the Rosemount Cluster**

Commercial Truck Counts

The scarcity of truck volume data within the three freight clusters was a significant concern for the project team. Previous research on the subject used commercial truck volumes to normalize/aggregate various point and continuous features; which facilitated the ability to make comparisons among multiple freight connector routes.

After consulting with Mn/DOT's Office of Transportation Data Analysis (TDA), a limited number of counts were conducted on key route links using tube count equipment. The project team identified the following target locations (**Table 5**) based upon existing count data, the key routes identified for further study, and input from local jurisdictions.

Table 5.Target Traffic Count Locations.

Shoreham Cluster
2nd St. North. South of 34th Avenue
2nd St. North. South of Lowry Avenue NE
Lowry Ave. NE. West of 2nd St. NE
49th Ave. NE. East of Main Street
53rd Ave. NE. East of Main Street
Main Street NE. North of 44th Avenue NE
Eagan Cluster
Lone Oak Road. Between Lexington and 35E
Lexington Avenue. South of Lone Oak Road
Neil Armstrong Blvd. East of Lexington
Neil Armstrong Blvd. South of Lone Oak Road
Rosemount Cluster
117th Street E. West of Highway 52
117th Street E. East of Highway 52

Because the identified routes sometimes involved short segments and/or obstacles such as rail crossings or curbs that made the use of tube counters difficult, short duration manual traffic counts were also conducted.

Manual counts were conducted by observing commercial vehicle classification counts in one hour increments across three time periods: morning (between 6 am and 9 am), mid-day (between 11:00 am and 1:00 pm) and afternoon (between 3:00 pm and 6:00 pm). The three one-hour manual counts were then factored by finding the vehicle class percentage by hour. These percentage class counts by hour were then compared to the vehicle class types per hour taken from for 2002-2004 Statewide Vehicle Class Counts, described as follows:

- Manual vehicle classification counts were conducted for one hour within each of three time periods:
    - o morning (between 6 am and 9 am),
    - o mid-day (between 11:00 am and 1:00 pm) and
    - o afternoon (between 3:00 pm and 6:00 pm).
- For each of the count periods, an hourly percentage of the daily total by vehicle type was calculated using 24 vehicle classification data from 2002-2004 (the hourly percentages were summed and the total divided 100 to get a factor to bring the three hourly volumes to daily totals).
- On average, the 3 hourly counts made up about 20% of the daily totals per vehicle type. So it was assumed that the three-hour manual counts recorded 20% of all truck vehicles for that day. After estimating the number of trucks, Mn/DOT's TDA office subtracted the total truck number estimates from total AADT for the facility to get the number of estimated cars.

Below is an example of the procedure for manual counts taken on Lowry Avenue in N. E. Minneapolis:

Lowry Avenue Manual Truck Count Factoring Methodology

Time	3 Axle Semi Count	% of hr/day
6:30 AM - 7:30 AM	3	5.2%
11:00 AM - 12:00 PM	4	8.2%
4:00 PM - 5:00 PM	1	6.7%
Calculation:		
5.2 + 8.2 + 6.7 = 20.1 100 / 20.1 = 5 5 X 8 = 40		

Thus, this Lowry Avenue location was estimated to experience 40 three-axle tractor, semi-trailer combinations daily.

Recommendations for Identifying Key Truck Routes

▪ **Seek cooperation from the Metropolitan Council:** Very early in the development of the study process, the Met Council was represented on the TAC. Due to a change in personnel, the Council did not have a representative on the TAC as the study moved forward. The freight clusters defined for the study were based upon Travel Analysis Zones (TAZs) defined in the Met Council's regional traffic model. The use of TAZ boundaries was pursued so that estimates of truck traffic from the regional model might be integrated into the study approach. The Met Council did produce estimates of current and future year truck traffic upon request, but the resources were not available to make meaningful comparisons of the modeled output to the information gathered through the study. Involvement of the Met Council in future connector program activities would likely benefit the data collection and estimation of traffic counts for both Mn/DOT and the Council.

▪ **Encourage truck counts by local jurisdictions:** The scarcity of truck volume data within the three freight clusters was a significant concern for the project team. Future freight connector evaluations would be significantly assisted if a greater number of local jurisdictions actively pursued vehicle classification counts on roadways that generate high levels of freight traffic. During the study, it was determined that Mn/DOT has traffic count equipment that can be requested for use by local planning agencies. Mn/DOT should promote this program to encourage municipalities to borrow equipment to perform vehicle classification counts.

▪ **Develop survey questions to identify routes not taken:** The focus of the study effort was on developing performance metrics for connector routes used to access major freight generating facilities. During the interview process, members heard suggestions for new infrastructure that would have improved access and efficiency (e.g. an entrance ramp from a popular connector route directly on to a Interstate freeway facility, and a new roadway along the edge of a major railway yard). Routes that are not used because they currently have some form of truck restriction (i.e., low or posted bridge; pavement weight posting), or routes that do not currently exist can be identified with an improved survey. The survey instrument used

to identify key truck routes should have additional questions added that asks about routes not currently used, for instance:

- o **"**Do drivers currently take the most direct route between your facility and major arterial roadway facilities? If not, why not?"
- o Are there alternate routes that trucks would use, that are currently not used due to some type of restriction or bottleneck? If so, what is the route, and what is the restriction?

3. FREIGHT CONNECTOR TECHNICAL EVALUATION

After assembling the relevant data for each cluster, conducting interviews with cluster businesses, and conducting field reconnaissance to identify key truck routes, the relevant data is ready to be assembled into connector profiles. The recommend procedures developed for this study are intended to be easily replicated by Mn/DOT and local planning organizations for assessment of other routes into the future.

Step 3
Technical Evaluation
- Point Features
- Continuous Features
- Interpretive Features
  (User identified problems)
- Problem Truck Points
- Problem Truck Miles

The technical analysis framework involves three distinct steps, intended to arrive at quantifiable measures for each truck route evaluated: 1) problem truck points, 2) problem truck miles, and 3) interpretive features.

The selection of criteria for determining connector adequacy was done in coordination with the TAC for the study. At the third TAC meeting, the consultant team presented TAC members with information pertaining to 18 criteria for measuring connector adequacy:

- Bridge Condition
- Railway Crossings
- Turning Radii
- Underpass Clearance
- Lane Width
- Roadway Weight Capacity
- Maximum Safe Speed
- Curve Offtracking
- Shoulder Width
- Posted Speed
- Clear Zone
- Bridge Load Limit (alternative measure to Bridge Condition)

- Stopping Sight Distance
- Traffic Operations
- Grade
- Crash History
- Pavement Condition
- Continuity/Connectivity/Accessibility

Using a ballot process, the TAC selected eight geometric, infrastructure, and operational roadway features that were identified as important and readily quantifiable for determining the adequacy of freight connector routes. A number of additional features were also raised by members of the TAC and were considered in the final ballot. Ultimately, several features were dismissed from further consideration because of the inability to secure the necessary data, or the ability to secure the data in common formats. (See Technical Memorandum 2 for additional details on connector adequacy criteria and the selection process).

There were also several features that were determined by the TAC to be very important in determining connector adequacy, even though uniform or complete data were not readily available to assess these features using a "data driven" approach. These features (pavement condition, crash history and traffic operations) were included as interpretive features. All of the adequacy criteria were then classified into one of the three types of evaluation features:

a)   **Point Features**: Point features are located at specific locations on a route, and include bridge condition, railroad crossings, turning radii, and vertical clearance.

b)   **Continuous Features:** Continuous features occur along the length of the route, and include lane width and roadway weight capacity.

c)   **Interpretive Features**:   Interpretive features are much more difficult to objectively quantify and uniformly convert into individual adequacy rankings; these features are discussed for informative purposes only, and recommendations for addressing these features through stakeholder surveys or field observations will be further discussed in the final recommendations.

Roadway Features Analysis Procedure

A brief description of each point, continuous, and interpretive feature selected as an adequacy evaluation criteria is provided below. The point and continuous features include a discussion of how each is assigned either a "preferred," "adequate," or "less than adequate" ranking. It should be noted that where possible, the evaluation of point and continuous features incorporated existing Mn/DOT performance measures.

Point Feature: Bridge Condition

This feature assesses the physical and structural condition of a bridge to determine whether commercial vehicle traffic may be safety accommodated.   The sufficiency rating formula evaluates highway bridge data by calculating four separate factors to obtain a metric indicative of the overall bridge condition.   The resulting score from 1 to 100 suggests that a score of 100 represents an entirely sufficient bridge and 0 represents an entirely deficient bridge.

The adequacy rankings were categorized based on the Highway Bridge Replacement and Rehabilitation Program.   A sufficiency rating less than 80 qualifies a bridge for rehabilitation. A sufficiency rating lower than 50 qualifies a bridge for replacement. The adequacy ranking is also influence by the presence or absence of a bridge posting for load carrying capacity.   The National Bridge Inspections Standards require the posting of load limits only if the maximum legal load configurations in the State exceed the load permitted under the operating rating. A "less than adequate" bridge has a lower operating rating than the legal maximum gross vehicle weight (GVW) of operating trucks. Under these circumstances (legal truck GVW exceeds bridge operating rating) the bridge would be posted.

Criteria:

- Preferred = Sufficiency Rating of 80-100 (Unless Bridge is Posted).

- Adequate = Sufficiency Rating of 50-79 (Unless Bridge is Posted).

- Less Than Adequate = Sufficiency Rating 0-49 (*Note: All Posted Bridges are Considered Less Than Adequate).

Mn/DOT Bridge Structure Inventory Reports were used as source data in the study freight connector adequacy assessments. The adequacy criteria initially proposed by the project team involved using the National Bridge Inventory (NBI) ratings system. The NBI contains ratings on the conditions of three major bridge components: the deck, superstructure, and substructure. However, each bridge has multiple NBI ratings, making it difficult for the project team to assign a single adequacy score.

The Bridge Sufficiency Rating, (a number from zero to 100) indicating the sufficiency of a bridge to remain in service, is recommended as an alternate metric since it encompassed all of the individual NBI ratings. Based on TAC input, the bridge adequacy metric should also be influenced by whether a bridge is posted for load carrying capacity.   The resulting hybrid measure provides a good indication of the bridge's overall condition, especially as it relates to its ability to accommodate commercial vehicles. The Mn/DOT Bridge Structure Inventory Reports provide an excellent data source for identifying bridge sufficiency ratings and posting restrictions.

Point Feature: Railway Crossings

On steep approaches, trucks require longer distances to accelerate and cross railroad tracks following a complete stop. The increased time needed by some trucks to clear certain at-grade

rail crossings, may also require longer sight distances at unsignalized crossings to ensure that trucks clear safely. At-grade rail crossings with steep approach grades or "humped crossings" can also cause trucks with a long wheelbase to "bottom out" and become stuck on the tracks.

The project team defined at-grade railroad crossing adequacy based upon a crossing's accident prediction rate (as defined by the USDOT Accident Prediction Formula). The at-grade rail crossing adequacy criteria, using factors from the Accident Prediction Formula, is predicated on the following five factors:

1) The at-grade crossing intersection should be close to 90 degrees,

2) The crossing should have sufficient sight distance (if there is insufficient sight distance, warning gates and/or signals should be present),

3) Crossings should have smooth pavement/surface quality,

4) Crossing should have nearly level approach grades, and

5) Have an accident prediction rate of less than .05 (less than one accident every 20 years).

At-grade Railroad Crossing Freight Connector Criteria:

- Preferred = Exhibits four or more of the characteristics listed above

- Adequate = Exhibits only three of the five characteristics listed

- Less Than Adequate = Exhibits two or less of the characteristics listed

Field evaluations along with Mn/DOT's At-Grade Crossing Safety Database were used as data sources in the freight connector route adequacy assessment. The project team defined adequacy by considering the appropriateness of at-grade crossings for truck traffic rather than possible delay that could be experienced. As indicated in previous research, any approach to normalize for train volume or speed would be subjective.

Field observations were conducted to confirm the presence/absence of the four key geometric characteristics. Based on TAC feedback, the at-grade crossing's accident prediction rate was also incorporated into this measure. The USDOT Accident Prediction rate values were obtained from Mn/DOT's At-Grade Crossing Safety Database. The hybrid measure provides a good indication of the appropriateness of at-grade crossings for commercial vehicle traffic. The adequacy criteria developed for the railway crossings feature is rather straightforward and can easily be replicated.

Point Feature: Turning Radii

A large truck making a right turn through an inadequate intersection can cause property damage, injury, and/or create traffic conflicts with other motorists. When the rear wheels of a large truck

track outside the lane edge or shoulder of an intersection, the truck may strike objects or persons on the street edge (fire hydrants, signs or pedestrians) near the intersection. Alternatively, to avoid tracking across curbs in an intersection with insufficient turning radii, trucks often must encroach on opposing traffic lanes.

The minimum turning radius for truck is defined as the path of the outer front wheel, following a circular arc at a very low speed, and is limited by the vehicle's steering mechanism. Based upon input from the TAC it is recommended that this feature be limited to a "pass/fail" metric based upon whether or not the selected intersection was able to accommodate tractor semi-trailer combinations with a 67 foot wheelbase or longer.

Criteria:
- Preferred = Intersections designed to accommodate tractor semi-trailer combinations with a 67 foot wheelbase or longer.

- Less than Adequate = Intersections that are not designed to accommodate tractor semi-trailer combinations with a 67 foot wheelbase.

The procedure for determining intersection turning radii used high-resolution aerial photography and AutoTURN Software to develop a WB-67 design vehicle turning movement template. The WB-67 design vehicle turning template was manually laid over an aerial photograph depicting the freight connector route intersection. (The aerial photos were copied to the same scale as the template). While this process was time intensive, it was less resource intensive than going into the field to take site measurements.

Point Feature: Vertical Clearance

This feature is defined as the vertical clearance height at bridges along the route required to accommodate truck traffic.

Criteria:
- Preferred = 16 feet or greater.

- Adequate = 14.5 to 16 feet.

- Less Than Adequate = Less than 14.5 feet.

The AASHTO Green Book (highway design manual) recommends a vertical clearance of 14 feet on local roads and collectors, and 16 feet on arterials and freeways. Most trucks do not exceed 13.5 feet in height.

Continuous Feature: Lane Width

Lane width can have significant implications on truck driver safety and comfort. Trucks are significantly wider than passenger cars, and as a result the problems resulting from inadequate lane widths are greater for trucks. The AASHTO Green Book encourages wide lanes when designing roads to accommodate trucks.

Criteria:

- Preferred = 12 feet or greater.

- Adequate = 11 feet.

- Less Than Adequate = Less than 11 feet.

Data on lane width was collected in the field using a measuring wheel to determine lane widths for the seven representative freight connector routes. (Note: A Mn/DOT database field exists for Pavement Width, but it does not include "lane width" information. It was suggested by that lane width could be derived by dividing the number of lanes into the pavement width, however because the pavement width includes the roadway shoulder, it was decided that field measurements would be taken that could be compared with the existing roadway inventory data.).

Continuous Feature: Roadway Weight Capacity

Transportation agencies design highway infrastructure based on predicted truck traffic volumes and axle weights. The majority of pavement wear (also referred to as pavement consumption) is attributed to heavy truck traffic. While Interstate, U.S. and State Highways allow axle weights of 10 tons and gross weights of 80,000 pounds, many city and county highways are rated at limits less than 10 tons.

Criteria:

- Preferred = Rated for axle weights 10 tons or greater.

- Less Than Adequate = Axle weight rating less than 10 tons.

Based upon input from the TAC, it is recommended that this feature should be limited to a "pass/fail" option based on whether the roadway is rated for axle weights of 10 tons or greater.

Roadway weight capacity data was collected from a compilation of Mn/DOT, county and city data sources. The Mn/DOT database maintained for this feature extended only to the TH system. Counties report this information to Mn/DOT, but on an inconsistent basis. The data on weight capacity maintained by county and city jurisdictions differed significantly in form and format.

For instance, Dakota County had a GIS file based on the Lawrence Group Centerline GIS file - which is not effective for an automated analysis using Mn/DOT GIS base data (i.e. different centerline coordinates). Hennepin County could only send a hardcopy map of their designated truck routes - which was then used to create a route event table to map the information on Mn/DOT's base map.

Interpretive Feature: Pavement Condition

Pavement condition can affect truck operations in several ways. Poor pavement with severe potholes or large bumps can damage sensitive shipments, affect truck braking distance, and the ability of the driver to maintain control of the vehicle.

The project team conducted site observations and made general assessments about overall pavement quality on each of the selected connector routes. It was recommended that pavement condition be considered as an interpretive feature, because the existing datasets for the three freight clusters were incomplete; on-site evaluations were needed to supplement available data. Several jurisdictions within the three study freight clusters had developed their own pavement condition ratings, such as City of Eagan Pavement Condition Index (100-point scale), Hennepin County Pavement Surface Rating (PSR), and Anoka County pavement management classification system.

Due to the lack of standardization in the pavement condition data among local jurisdictions the project team recommends that the Pavement Condition feature be assessed through field observations and stakeholder input. It is suggested that the criteria for measuring the adequacy of pavement condition be based upon the NHS Criteria

For the NHS Connector report that was submitted to Congress, the rating of pavement was broken into five categories and was based primarily on assumptions about the speed at which a commercial truck can comfortably travel. The pavement rating guidance is shown in Table 6.

Table 6: National Highway System Intermodal Connector Criteria for Pavements

Rating	NHS Connector Pavement Rating Description
Very good	Newly built or resurfaced and distress free.
Good	Smooth surface with little to no cracking or rutting.
Fair	Serviceable with shallow rutting and moderate cracks beginning to occur, but does not affect travel speed on the connector.

Poor	Same problems as fair but worse, causing some reduction in speed.
Very poor	Major problems with potholes etc., causing substantial reductions in speed.

These criteria are translated for consistency to the format applied to other features below:

Criteria:

- Preferred = Very Good or Good condition: Newly built or distress free with very little cracking or rutting.

- Adequate = Fair condition: Moderate rutting or cracks with no effect travel speed.

- Less Than Adequate = Poor or Very Poor: Large cracks and potholes exist along the route and the ride quality is poor resulting in reductions in speed.

Interpretive Feature: Crash History

The crash history along the identified freight connector routes was cited by the TAC as a feature of interest, however without accurate vehicle counts along all segments of a route to normalize the associated crash data it becomes difficult to draw strong conclusions about the relative safety of a route. As a result, it was determined that this feature should be viewed as a "general indication" of relative safety. Truck-related crashes were identified using Mn/DOT's Roads and Crash Database. The database contains the years 2002, 2003, and 2004.

Interpretive Feature: Traffic Operations (Signalized Intersections)

Signalized intersections are a point feature along a transportation route that has the possibility to significantly affect the efficiency of freight movements through a specific area. Traffic signal timing is often structured upon normalized passenger traffic volumes at a particular intersection or transportation corridor, which can often be a barrier to efficient truck movements.

Previous research conducted by Mn/DOT determined that slower accelerating trucks may get "caught" in the red/stop cycle repeatedly at successive intersections in a single corridor. However, the prevalence of signal patterns that impede trucks is based on many factors such as distance between intersections, type of truck traffic using the facility, and the type of signal timing applied to the corridor.   Mn/DOT completed a study in 2001 focused on providing trucks priority at specific traffic signals, by investigating three methods for improving truck operations. Mn/DOT concluded that efficiently operating traffic signals to improve truck operation will provide benefits up to 25 times greater than cost and that other traffic using the intersection will incur little or no additional cost while improving overall traffic operation.

Members of the study TAC identified signalized intersections as a high-priority point feature for analysis. However, in practice, the timing sequence differences between the three studied clusters were found to be very difficult to analyze using a "hard data" approach. There also appeared to be no common denominator for signal timing measures that can be applied to all traffic signals within a cluster area, especially when routes cross multiple jurisdictions. As a result, the consultant team recommended that signalized intersections be included as an interpretive feature (as opposed to a point feature) in the connector evaluation process. In addition, information about signal timing as an impediment to trucks is likely best gained during the stakeholder input and field reconnaissance process. A survey question can be designed to allow stakeholders to rank traffic signal timing for each intersection along a route on a scale from 1 to 10. For example in discussing a key freight connector, truck drivers might be asked:

> *"When driving to and from* [insert name of facility], *how would you rate the traffic operations and signal timing for commercial vehicles on Route #1: Between facility x and Interstate 94?*
>
> *1.........2.........3.........4.........5.........6.........7.........8.........9.........10*
>
> Poor   Fair   Good   Very Good   Excellent
> Always stop   Usually   Sometimes   Rarely stop   Never stop
> at multiple traffic stop at one or   stop at one or   at a traffic signal at a traffic signal
> signals   traffic signals   traffic signals

Responses to this or a similar question can be used to help determine a traffic operations adequacy metric:

Criteria:

- Preferred = Average aggregate response score of 7 or higher.

- Adequate = Average aggregate response score of 4 or more, but less than 7.

- Less Than Adequate = Average aggregate response score of less than 4.

Calculating Problem Truck Points and Problem Truck Miles

For each point and continuous feature, the "preferred," "adequate," and "less than adequate" ranking is converted to an urgency rating using weights for truck volume and section length. For the study investigation, truck count data was assembled by conducting tube counts along the selected connector routes, and truck traffic estimates were also obtained from the Met Council's Travel Demand Model.

Canadian Pacific Railroad Crossing at 30th. Ave NE in Minneapolis

Problem Truck Points

For point features, the requisite procedure is called "Problem Truck Points." Point features are normalized by average daily truck volumes. A description of the methodology, extracted from previous research described the details of the suggested methodology:

> *"[The Problem Truck Points procedure] is equal to the number of truck problem points per day summed over the route for each feature individually. If a point on a route has been labeled "preferred", it will not contribute to the cumulative total of problem truck points per day. The other two categories, "adequate" and "less than adequate," will increase the cumulative total. If a point has been labeled "adequate," every truck that travels by that route point will count as one truck problem point per day. It was assumed that a "less than adequate" point counts for twice the weight of an "adequate" point, meaning that each "less than adequate" point along the route contributes two truck problem points per day for every truck that travels past that point."[6]*

The total problem truck points for an individual truck route can be found by summing the problem truck points contributed by each of the four point features (identified earlier in the report as Bridge Condition, Railroad Crossings, Turning Radius, and Vertical Clearance).

Using the point feature "Turning Radii" (measured by off-tracking) as an example, the equation is defined as:

$$\text{offtracking}_{(PTP)} = \text{offtracking}_{(1)} + (2)\,\text{offtracking}_{(2)}$$

where: $\text{offtracking}_{(PTP)}$ = total number of problem truck points contributed by offtracking for a particular truck route

$\text{offtracking}_{(1)}$ = points along route rated "adequate" * trucks/day

$\text{offtracking}_{(2)}$ = points along route rated "less than adequate" * trucks/day

A key assumption associated with the Problem Truck Points equation is that adequacy of a deficient section or point is directly related to the volume of trucks using the section. In other words, for two equally deficient sections, the section carrying more trucks will receive a lower adequacy score.

Problem Truck Miles

For continuous features, the requisite procedure is called "Problem Truck Miles." Continuous features are normalized by average annual daily truck volumes along the length of the route. A description of the methodology is as follows:

> *"The [Problem Truck Miles] measure will be the weighted truck-miles along problem sections. The weight of a "less than adequate" section versus an "adequate" section will count as two points. Travel along "preferred" feature sections will not contribute to the [cumulative] total."[7]*

The total problem truck miles for an individual truck route can be found by summing the problem truck miles contributed by each of the continuous features (identified earlier in the report as Lane Width and Roadway Weight Capacity).

Using the continuous feature "Lane Width" as an example, the Problem Truck Miles equation can be described as:

$$\text{lane width}_{(PTM)} = \text{lane width}_{(1)} + (2)\,\text{lane width}_{(2)}$$

where: $\text{lane width}_{(PTM)}$ = total number of problem truck miles contributed by lane width for a particular truck route

$\text{lane width}_{(1)}$ = miles exhibiting "adequate" lane width * trucks/day

$\text{lane width}_{(2)}$ = miles exhibiting "less than adequate" lane width * trucks/day

Similar to the point equation, the assumption associated with the problem truck miles equation is that if the same number of trucks traveled down two lengths of otherwise identical roadway having (i.e.) insufficient lane width, the longer section will receive a lower adequacy score.

Recommendations for Improving Connector Technical Evaluation

- **Alternative corridor assessment methodology:** The project team identified a sample of seven representative freight connector routes from the three freight clusters to allow a more detailed and meaningful analysis. In an effort to better streamline the freight connector route adequacy assessments, the project team also developed an alternative approach to the methodology. The alternative approach redefines "freight connectors" as being independent roadway segments that, when taken in full, comprise a network (or grid) of truck routes. The overall methodology remains the same for the alternative approach except for the deletion of the turning radii point feature. This feature is no longer applicable in the alternative approach since turning movements occur at the junction of two independent roadway segments.

  The alternative approach to the adequacy assessment methodology provides greater flexibility for transportation practitioners in conducting freight connector route evaluations by avoiding the data-intensive and more technically demanding exercise of assessing intersection turning radii.

  As an example of how this alternative methodology might be applied, in the Shoreham freight cluster, Lowry Avenue was included as a roadway segment in the CP Shoreham Intermodal Yard Route. Under the suggested alternative adequacy assessment method, the freight connector would be redefined as a segment of Lowry Avenue; which would be individually analyzed and evaluated as a standalone section.

Benefits of this approach include:

- The ability to target and isolate independent roadway segments for detailed analysis;

- The opportunity to link various combinations of independent roadways segments together to analyze actual routes and/or direct routes from specified freight generating facilities;

- The ability to avoid the data-intensive and more technically demanding exercise of assessing intersection turning radii;

- The ability to refrain from normalizing/aggregating disparate truck traffic counts on different roadways; and

- The ability to compare individual roadway segments with others that have similar lengths and truck volumes.

The importance of reliable truck traffic/vehicle classification count data is magnified under the alternative approach; more individual roadway segments will need truck volume data to perform the adequacy evaluation. The project team encourages all jurisdictions to actively pursue vehicle classification counts on roadways that generate high levels of freight traffic.

- **Refine the instrument for evaluating "interpretive features" in the Freight Connector Assessment Process:** The 3-step adequacy evaluation process developed by this study effort for freight connectors is based on engineering design standards and infrastructure conditions described by the "point" and "continuous" roadway features. Bringing the methodology to a logical end, results in a "Performance Score" for route truck miles, and route truck points. However, a number of assessment features considered important by the study TAC, were difficult to evaluated given the condition of existing databases. Given the desire to maintain a "user friendly" approach to the final method, it was recommended that a non-technical approach be used to determine the adequacy of interpretive features. For these features (e.g., Traffic Operations including signalized intersections, and Pavement Condition), it is recommended that a survey instrument or interview guide be developed to elicit information about these features from facility operators and truck drivers that use the connector route being evaluated. Another issue that might be addressed through a survey instrument is the existence of preferred routes not available (due to bridge or other restrictions) or not used.

4. FREIGHT CONNECTOR ADEQUACY PERFORMANCE

Once a practitioner has developed the information regarding problem truck points and problem truck miles from each freight connector route evaluated, the resulting values are summed within each feature category (point and continuous). The total Truck Miles Performance Scores and Truck Point Performance Scores can then be compared and benchmarked against

Step 4
Adequacy Measure / Score
- Connector Miles Performance Score
- Connector Point Performance Score
- User Rating Score

other connector routes to determine the overall performance and adequacy of a route in accommodating truck traffic. Note that caution should be used in combining the values associated with the Truck Miles Performance Scores and Truck Point Performance Scores into a single metric due to the difference in the underlying denominators.

The adequacy assessment method described in this section is a first, and substantial step toward a comprehensive tool for measuring the performance freight connector routes. It is fully anticipated that the method and the data to support it will evolve and improve over time.
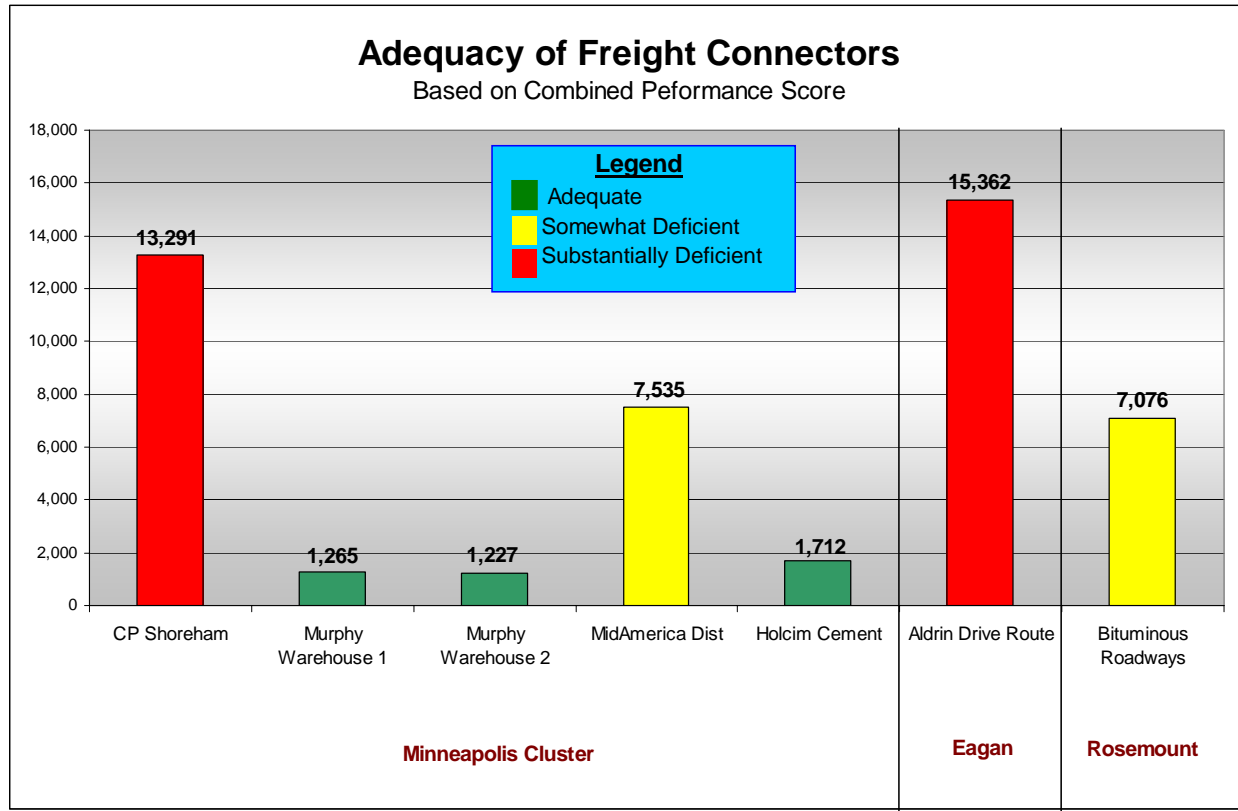
Table 7 provides a summary of the Truck Miles Performance Score and Truck Point Performance Score for the seven freight connector route evaluations completed for this study. The index included in the table should be viewed as an example for illustrative purposes only, as the sample of routes evaluated to date may be misleading. To effectively make benchmark comparisons for a single connector route, a greater number of evaluations need to be completed. **Figure 12** presents similar information in a graphic format. For each connector route examined in column one, the route length, average daily truck volume, and associated Problem Truck Point Score and Problem Truck Mile scores are presented. In column six, the Problem Truck Points and Problem Truck Mile scores have been combined to produce an overall connector route metric. Based upon the range of scores calculated for the seven routes analyzed, each has been given a relative adequacy rating found in the last column.

Table 7: Freight Connector Route Summary Table

ROUTE	Length (Mi)*	Avg. Daily Truck Volume	Truck Pt Score	Truck Mi Score	Combined Performance Score	Adequacy
CP Shoreham	5.8	845	8,458	4833	13291	Low
Murphy Whse #1	3.12	132	396	869	1265	High
Murphy Whse #2	2.26	144	576	651	1227	High
Mid-America Dist	3.76	613	4,298	3,237	7535	Medium
Holcim Cement	0.88	319	1,278	434	1712	High
Aldrin Drive Rte	3.7	1,959	5,880	9482	15362	Low
Bituminous Rdwys	5.1	648	648	6428	7076	Medium

*Route length is bi-directional

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Figure 12: Comparative Route Performance Graphic

As shown in the graphic in **Figure 12,** of the seven freight connector routes evaluated using the point and continuous features criteria, two routes received substantially deficient ratings, two received somewhat deficient ratings, and three received adequate ratings. Deficiency is directly related to the combined performance score; routes with high problem truck point scores, problem truck mile scores, and interpretive feature scores (high combined performance scores) received high deficiency scores, and therefore received low adequacy scores. The two routes that received the lowest connector performance ratings for adequacy were: the CP Shoreham Intermodal Yard Route in NE Minneapolis, and the Aldrin Drive Route in Eagan. Routes considered somewhat deficient included: the Mid-America Distribution Center Route in NE Minneapolis, and the Bituminous Roadways Route in Rosemount. A brief discussion of the rating process for these four routes follows. For a more detailed discussion of the rating process see Technical Memorandum #2.

The CP Shoreham Route consists of segments of the following roadways:

- 30th Avenue NE from Yard to 4th Street NE
- 4th Street NE from 30th Avenue NE to 32nd Avenue NE
- 32nd Avenue NE from 4th Street NE to TH 47, University Avenue

- TH 47, University Avenue from 32nd Avenue NE to Lowry Avenue NE

- Lowry Avenue NE from TH 47, University Avenue to 2nd Street North

- 2nd Street North from Lowry Avenue NE to North Dowling Avenue

- North Dowling Avenue from 2nd Street North to I-94 on-ramp

The total length of the CP Shoreham Intermodal Yard Route is approximately 5.8 miles (2.9 miles in each direction). The truck volume for this route is approximately 845 trucks per day. Truck volume was derived by averaging the data from truck counts conducted along the route.

The route includes six intersections (12 possible turning maneuvers depending on the direction of travel). Eight of the twelve turning movements along the route received less than adequate

4th Street NE and 30th Avenue NE

rankings for the Turning Radii point feature. Of three bridges on the route, the Lowry Avenue NE / Mississippi River Bridge also received an inadequate rating, due to the bridges' 41.6 sufficiency rating. In addition, 2.8 miles of the route scored deficient on the Roadway Weight Capacity continuous feature.

The CP Shoreham intermodal yard was previously identified in the Minnesota Statewide Freight Plan as one of four intermodal freight terminals likely to meet the criteria designated by the FHWA for NHS Intermodal Connector status. As discussed in Technical Memorandum #2 for this study, the current threshold of NHS designation for truck/rail intermodal facilities is:

> *100 trucks per day, in each direction on the principal connecting route, or other units measured that would convert to more than 100 trucks per day in each direction. (Trucks are defined as large single-unit trucks or combination vehicles carrying freight.)*

Based upon information supplied by the Shoreham terminal manager and truck counts conducted near the facility, several key connector routes in the N.E. Minneapolis/Shoreham freight cluster are eligible for NHS Intermodal Connector Status. Many of the maps and data produced for this report, as well as the outreach to local officials should support Mn/DOT's application:

> *"The guidance for principal connectors to major intermodal terminals and for other NHS routes is located in 23 CFR 470A, Federal-aid Highway Systems, and its Appendix D to Subpart A. 'Guidance Criteria for Evaluating Requests for Modifications to the NHS'. Additional criteria for connectors and terminals are in Paragraph 9 of Appendix D. Basically, any routes should be added that meet the criteria, **be coordinated with local officials** [emphasis added]…*

Specifically, in 23 CFR 470.113 (a), 'proposals for system actions on the National Highway System shall include a route description, a statement of justification, and statements of coordination with adjoining States on State-line connections, with responsible local officials, and with officials of areas under Federal jurisdiction...[8]

Aldrin Drive Route in Eagan consists of the following road segments:

- Aldrin Drive from to Neil Armstrong Boulevard
- Neil Armstrong Boulevard to Lone Oak Road
- Lone Oak Road from Neil Armstrong Boulevard to I-35E on-ramps

Aldrin Drive and Neil Armstrong Boulevard Intersection

The total length of the Aldrin Drive Route is approximately 3.7 miles (1.85 miles in each direction), and the truck volume is approximately 1,959 trucks per day. Truck volume was derived by averaging the data from truck counts conducted along the route. The directional (WB only) traffic count taken on Lone Oak Road was doubled to estimate bi-directional traffic. Of the four possible turning maneuvers at two intersections along the route, three received less than adequate ranking scores. In addition, approximately 2.42 miles of the route has roadway weight capacity of less than 10 tons.

Two additional routes rated using the study methodology were assessed with somewhat deficient ratings: 1) Mid-America Distribution Route in NE Minneapolis and, 2) the Bituminous Roadways Route in Rosemount.

Mid-America Distribution Center freight connector route in NE Minneapolis by road segments is as follows:

- 47th Avenue North from Yard to Humboldt Avenue
- Humboldt Avenue from 47th Avenue North to Shingle Creek Drive
- Shingle Creek Drive from Humboldt Avenue to 45th Avenue North
- 45th Avenue North from Shingle Creek Drive to W. Lyndale Avenue North
- W. Lyndale Avenue North from 45th Avenue North to 49th Avenue North

Northbound on Humboldt Avenue

- (or W. Lyndale Avenue North from 45th Avenue North to EB I-94 on-ramp)
- 49th Avenue North from W. Lyndale Avenue to E. Lyndale Avenue North
- E. Lyndale Avenue North from 49th Avenue North to WB I-94 on-ramp

The total length of the Mid American Distribution Centers Route is approximately 3.76 miles (1.88 miles in each direction) and the truck volume is approximately 613 trucks per day. Truck volume was derived by averaging the data from the two truck counts conducted along the route.

Of the twelve possible turning movements at six intersections along the route, six were rated as having less than adequate turning radii. In addition, 2.64 miles of the route included roadway sections with less than adequate roadway weight capacity that were rated for less than 10-tons.

The Bituminous Roadways freight connector route in Rosemount is described as:

▪ County Road 71, Rich Valley Boulevard from Yard to 117th Street East

▪ 117th Street East from County Road 71, Rich Valley Boulevard to US Hwy 52 on-ramps

The total length of the Bituminous Roadways route is approximately 5.1 miles (2.55 miles in each direction), and the truck volume is approximately 648 trucks per day. Truck volume was derived by averaging the data from the two truck counts conducted along the route.

On the Bituminous Roadways route, one turning movement was rated as less than adequate, and 4.96 miles of the route rated as having less than adequate roadway weight capacity.

Adequacy Performance Summary

It should be stressed once again that the relative rankings of the seven routes evaluated should be viewed with caution until a greater number of freight connector routes can be reviewed and ranked. It should also be pointed out that other routes may have fared less well, had a rating method been developed for the Interpretive features element. For instance, during the interview process, managers of the Murphy Warehouse indicated that a route adjacent to the existing railroad bed would offer the most direct and uninterrupted access to major highway facilities in the area, but such a route does not currently exist. In a similar fashion, a truck company in Eagan indicated that an entrance ramp from TH-13 on to I-494 would offer a more direct route on to the Interstate, but currently no ramp exists, so the route was not evaluated.

For the seven routes analyzed by the study, the primary factors leading to less than adequate ratings for four routes were intersection design and weight capacity. The project team reviewed the existing Mn/DOT 2006-2008 State Transportation Improvement Program (STIP) and did not find any of the deficient road segments or intersections included for improvement.

5. CONCLUSIONS AND SUMMARY RECOMMENDATIONS

The efficient movement of freight has become an increasing important consideration in transportation and land-use planning as freight volumes and related growth in truck traffic continue to outpace the growth in passenger traffic. Just as businesses continue to search for efficient improvement in their supply chain management strategies, public planning agencies are seeking ways to improve the efficiency of truck travel on public roadways. In recent years, under studies initiated by Congress, local roads accessing major freight generating facilities have been identified as potential obstacles to the seamless movement of cargo needed to support businesses and economic development.

Mn/DOT has undertaken a number of previous planning efforts that have identified major freight generators in Minnesota, and suggested the need for "adequate" access to these facilities. The TCMA Freight Connector Study was undertaken to address design and capacity issues on local roadways that provide access to major freight generating areas in Minnesota. While the study focused upon three freight specific / freight intensive areas, or "freight clusters" in the Twin Cities Metropolitan Area, the intended purpose of the study was to define an evaluation template to quantitatively measure "adequate" from the standpoint of road design and traffic operations. It is intended that the resulting evaluation template be applicable to freight connector routes anywhere in Minnesota.

The TCMA Freight Connector Study began with an extensive literature review of previous studies and research about intermodal or freight connectors. Most of the previous research about local freight connector routes has been directed at the criteria associated with National Highway System (NHS) - Intermodal Connectors Program.   Little previous research existed regarding the desirable attributes of connectors for accommodating commercial vehicle traffic. However, one previous research effort by the University of Kentucky that examined the adequacy of facilities to and from intermodal facilities provided an initial starting point for the framework adopted by the study team. Due to the lack of previous research in this area, the TCMA Freight Connector Study team also relied heavily upon input from the Study TAC.

While most of the study's goals were met, the study team concluded that the goal of defining freight connector performance solely through the use of existing databases presented a significant challenge. While the study determined that a vast amount of useable data exists at the local government level, much of it is in non-standardized formats. In addition, traffic counts for commercial vehicles - a key input to the evaluation process - is lacking on local road systems.
The 3-step Freight Connector Adequacy Evaluation Process outlined in this report should be viewed as a starting point for a broader assessment of freight connectors in Minnesota. The following actions are recommended as opportunities to build upon the current effort:

▪ **Refine the instrument for evaluating "interpretive features" in the Freight Connector Assessment Process:** The 3-step adequacy evaluation process developed by this study effort for freight connectors is based primarily on the engineering design standards and

infrastructure conditions described by the "point" and "continuous" roadway features. Bringing the methodology to a logical end, results in a "Performance Score" for route truck miles and route truck points.   A number of assessment features considered important by the study TAC were difficult to evaluate given the condition of existing databases. For these features (e.g., Traffic Operations including signalized intersections, and Pavement Condition), it is recommended that a survey instrument or interview guide be developed to elicit information from facility operators and truck drivers using the route being evaluated.

▪ **Integrate the Railway Crossing and Bridges GIS Datasets to the Mn/DOT Base Map System:** Currently the Railway Crossing data is based upon XY coordinates, limiting the ability to analyze the data against other linear and point event data maintained by Mn/DOT. Tying these point features to the Mn/DOT basemap system with reference points in TIS would greatly expand opportunities for further analysis and automation of the connector assessment process. In addition to reference points, up-to-date bridge records (e.g., changes in bridge condition) should be maintained in the TIS to assist in planning efforts.

▪ **Broaden the Minnesota Freight Connector Program:** As discussed several times in this report, the study effort and 3-step process for freight connector adequacy evaluation should be viewed as a significant first step toward a broader evaluation effort. It is recommended that the next activities for evaluating connectors focus on Minnesota's largest individual freight generators. While the study effort started with the identification and definition of freight clusters, the cluster concept holds little relevance to the evaluation process as ultimately defined.   Future evaluations should be directed toward the Minnesota's largest individual freight generators, most of which have already been identified through Mn/DOT activities.   Mn/DOT should also seek the assistance of the Minnesota Freight Advisory Committee in identifying a list of candidate "key" facilities that could become the subject of the next connector efforts. Within this general recommendation for broadening the scope of the freight connector program are a number of specific recommendations, including several contained in previous sections of the report:

  o **Use and expand the Freight Connector web site and other media to market future efforts:** The web site developed for this study is an excellent resource that should be used in future marketing efforts to update information about Minnesota's major freight generators, and identify key freight connector routes. The existing data about Minnesota's largest freight generators should be posted with options for facility managers to update information about tonnage production and economic impacts of these facilities. In addition, an application form should be developed to identify key freight connector routes. The form should be directed at truck and facility operators, and might be modeled after the *Freight Forward Program* conducted by the Delaware Valley Regional Commission. [a] Other opportunities to expand the

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[a] www.dvrpc.org/transportation/multimodal/freight/freightforward.htm

awareness and interest among the private sector in future connector activities might also include articles in chamber of commerce and association newsletters.

o **Market the connector program data needs to local governments:** During the course of the study, one of the major challenges that faced the consultant team was the existence, availability, and standardization of GIS datasets from municipal, county, regional, and state governments. The governmental units intersecting the candidate freight clusters varied widely in terms of the quantity of available digital GIS mapping relevant to this study. Some governmental units are just beginning GIS database development initiatives, while others have higher levels of GIS integration and mapping products. The project team would encourage Mn/DOT to communicate with local government GIS user groups about the growing importance of freight transportation, the impact of freight on the local economy, and in turn how key GIS data sets can be used to support freight mobility. The suggestion of using the existing web site and other media to market the connector program to the private sector also extends to local jurisdictions as well, through outlets such as the Technology Transfer (T[2]) program, and the Local Road Research Board.

o **Update and refine the Freight Facilities database:** The Freight Facilities database created and maintained by Mn/DOT can be a valuable resource for moving forward with a more comprehensive freight connector program; however, many of the entries in the database are outdated. In addition, some of the fields and many of the records have questionable relevance to major freight facilities. In comparing several commercially available databases such as the InfoUSA or Harris Database, it appears that many of the most important facilities and fields can be purchased and updated annually at a very reasonable cost (i.e. under $1,000 for manufacturing and warehouse facilities of 50 employees or more). The project team would recommend that Mn/DOT approach several of the major database vendors with a request for the specific data fields they deem most important and request comparison price quotes. The base data could also be supplemented through the development of a brief on-line survey marketed directly to key facility operators in Minnesota.

o **Place emphasis on Minnesota's largest freight generating facilities:** The TCMA Freight Connector Study started with the identification of "freight clusters" in part based on previous work sponsored by the department. While clusters of freight facilities has some merit, most of the problematic issues identified by the route analysis tended to focus on intersection design, and specific segments of a route - often very near a significant freight generating facility. While the proposed methodology can be adapted for corridor based assessments that would better support the cluster approach, it is recommend to first analyze specific truck routes to and from the states largest individual facilities.

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- **Seek cooperation from the Metropolitan Council:** Very early in the development of the study process, the Met Council was represented on the TAC. Due to a change in personnel, the Council did not have a representative on the TAC as the study moved forward. The freight clusters defined for the study were based upon Travel Analysis Zones (TAZs) defined in the Met Council's regional traffic model. The use of TAZ boundaries was pursued so that estimates of truck traffic from the regional model might be integrated into the study approach. The Met Council did produce estimates of current and future year truck traffic upon request, but the resources were not available to make meaningful comparisons of the modeled output to the information gathered through the study. Involvement of the Met Council in future connector program activities would likely benefit the data collection and estimation of traffic counts for both Mn/DOT and the Council.

- **Encourage truck counts by local jurisdictions:** The scarcity of truck volume data within the three freight clusters was a significant concern for the project team. Future freight connector evaluations would be significantly assisted if a greater number of local jurisdictions actively pursued vehicle classification counts on roadways that generate high levels of freight traffic. During the study, it was determined that Mn/DOT has traffic count equipment that can be requested for use by local planning agencies. Mn/DOT should promote this program to encourage municipalities to borrow equipment to perform vehicle classification counts.

- **Develop model design criteria for local truck routes:** During the study process, it was discovered that several of the city jurisdictions in which freight connectors were examined have designated truck routes. However, during interviews with city officials, it was determined that there were no special design criteria applied to these routes that would facilitate truck mobility. For instance, the study process for evaluating intersection turning radii was based upon whether an intersection could accommodate a tractor semi-trailer with a 67-foot wheelbase or longer. The project team used an overlay of a WB-67 design vehicle turning template on top of an aerial photograph that depicted the freight connector route intersection. The current AASHTO Green Book standard for intersection design is based upon a WB-65 vehicle. A recent review of AASHTO design standards under a project directed through the National Cooperative Highway Research Program (NCHRP) suggests that the WB-65 vehicle no longer represents the "worst case" scenario for design off-tracking and recommends that the WB-67 vehicle be adopted to represent the worst case scenario.[9] Such criteria, along with model criteria for the other point and continuous features included in the evaluation criteria could be called out in proposing model design criteria for truck routes in local jurisdictions.

The TCMA Freight Connectors Study was undertaken with the goal of defining freight connector "adequacy" from a technical, data driven process. In most respects the recommended approach for assessing connectors is driven by existing data. However, differences in data standards among local government jurisdictions, as well as the general lack of existing truck count data

limited the ability to derive a totally data dependent methodology. The study team found that most of the data deficiencies could be overcome using freight stakeholder interviews and surveys. The resulting process for defining freight connector adequacy is a good starting point for building a database of information about local truck routes that can be used to bench mark key local freight routes, and to improve the overall efficiency of Minnesota's freight transportation networks.

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[1] Minnesota Department of Transportation (Mn/Dot), *Minnesota Statewide Freight Plan*, May 2005. pp. 8-1.
[2] Mn/Dot Strategic Plan, accessed through the world wide web at:
http://www.dot.state.mn.us/information/statplan00/index.html
[3] NHS Intermodal Freight Connectors; A Report to Congress. US Department of Transportation, December 2000.
[4] Chandler, et. al., Center for Neighborhood Technology, *Cargo Oriented Development: A Tool for Freight Planning in the Chicago Metro Area.* Paper Submission for the 2005 TRB Annual Meeting, pp. 5
[5] Aultman-Hall, L., Hill, M.L., and Agent, K. *Methodology for Evaluating Large Truck Access to Intermodal and Other Facilities.* Transportation Research Record: Journal of the Transportation Research Board, No. 99-0209, TRB, National Research Council, Washington, D.C. 1999, pp. 61-68.
[6] Ibid, Aultman-Hall, et. al.
[7] Ibid, Aultman-Hall, et. al
[8] Update Procedures for the NHS Mainline and NHS Intermodal Connectors, FHWA, Office of Planning. Guidelines available via the world wide web at: http://www.fhwa.dot.gov/hep10/hns/review/nhsproc.html
[9] NCHRP Report 505: Review of Truck Characteristics as Factors in Roadway Design, Transportation Research Board, 2003.