

# USING ARCHIVED TRUCK GPS DATA FOR FREIGHT PERFORMANCE ANALYSIS ON INTERSTATE I-94/I-90 FROM THE TWIN CITIES TO CHICAGO

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U.S. Department of Transportation  
**Federal Highway Administration**





# Objectives

- Use available truck AVL data from ATRI to analyze freight activity along I-94/I-90
- Compare variations of truck speed and travel time to identify potential freight bottleneck and forecast future freight demand
- Identify the needs of local highway infrastructure improvement to sustain growing freight demand

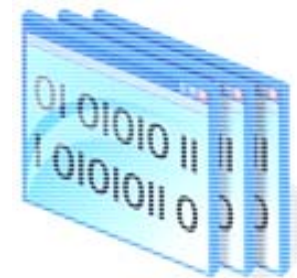




# Data Summary

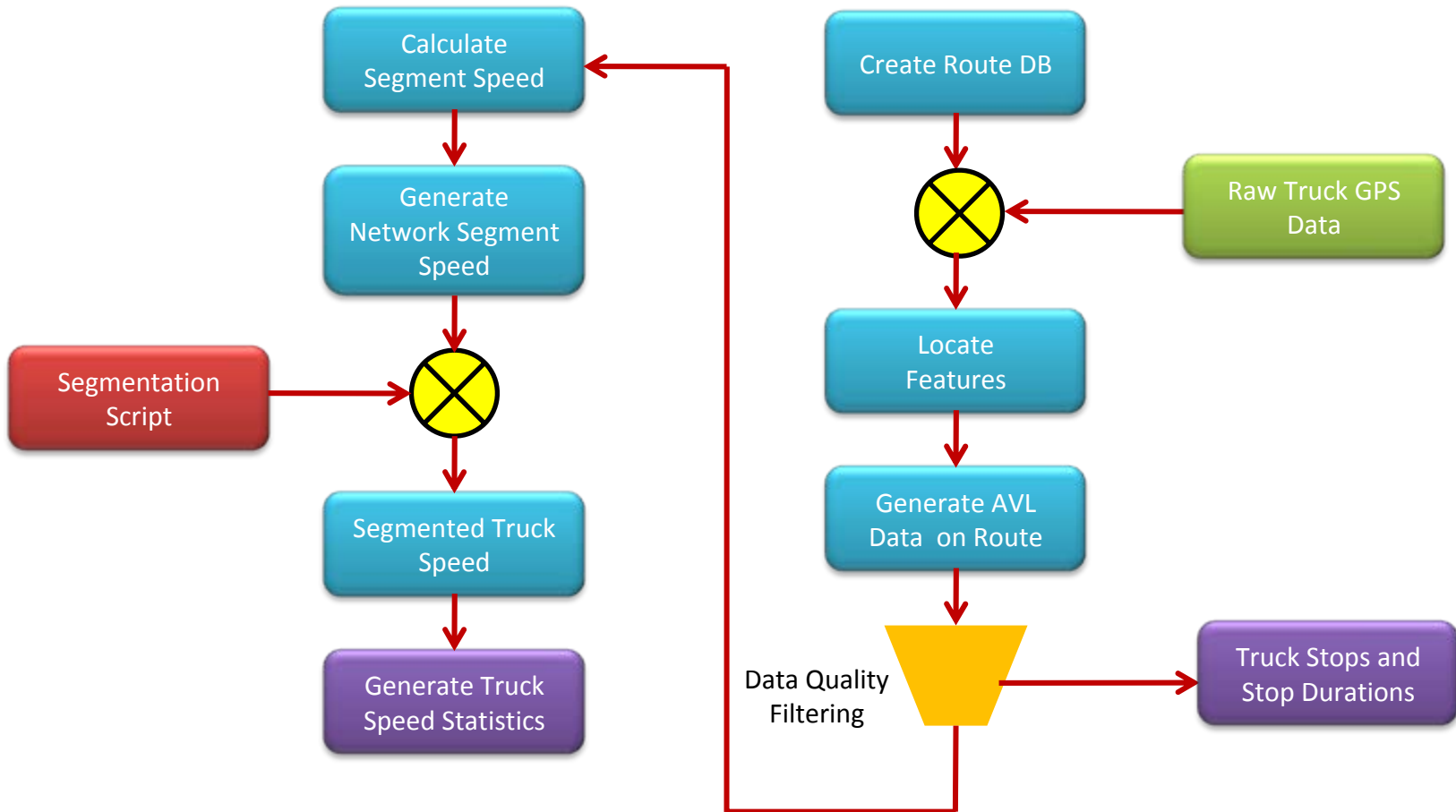
- FAF2 Data from FHWA
- 12 months (May 08 ~ Apr. 09) of Truck AVL/GPS Data from ATRI
- Highway Speed Data from MNDOT , Wisconsin DOT and IL State Toll Highway Authority

Month	# of Trips
May 08	26365
Jun 08	54511
Jul 08	55657
Aug 08	53279
Sep 08	51920
Oct 08	54456
Nov 08	46529
Dec 08	47126
Jan 09	44708
Feb 09	42631
Mar 09	44158
Apr 09	57165





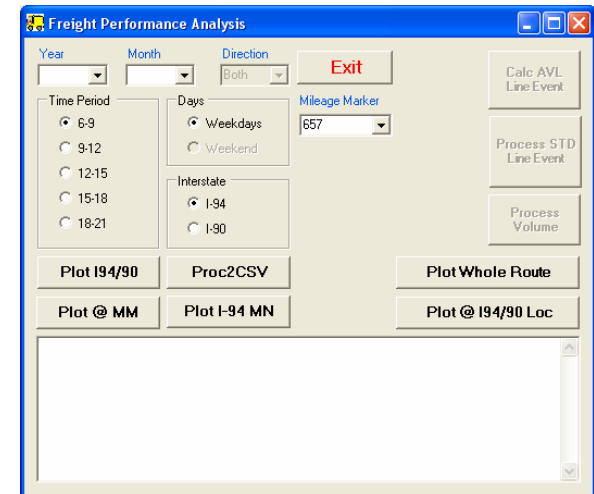
# Data Processing Flow Chart





# Data Analysis

- Speed By Location
- Speed By Hour Of Day
- Speed and Volume at Location
- Performance Index
- Trip Destinations
- Truck vs. General Traffic
- Truck Stops & Durations





## Average Truck Speed By Location

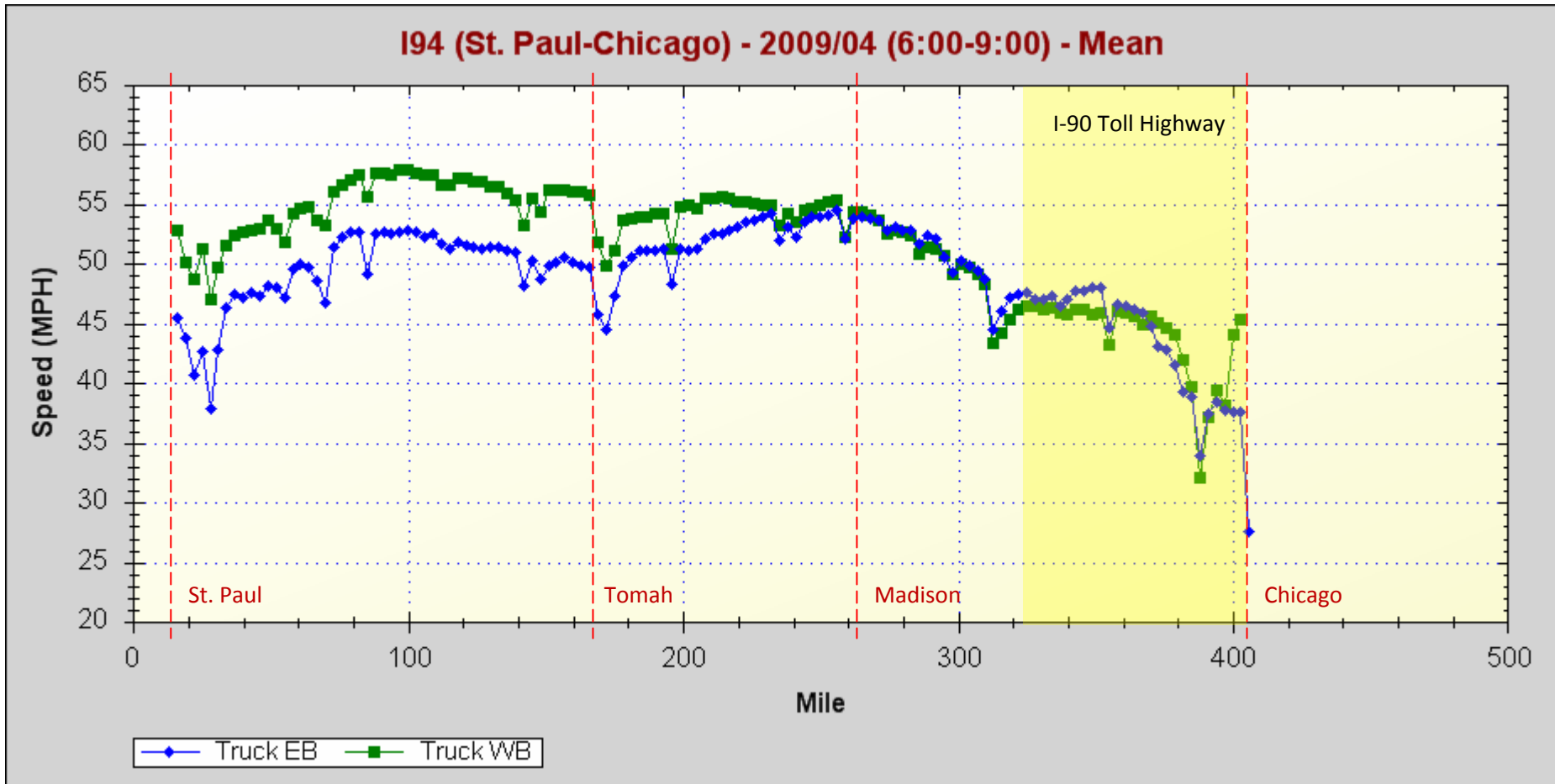
# I-94/90 (TWIN CITIES – CHICAGO)

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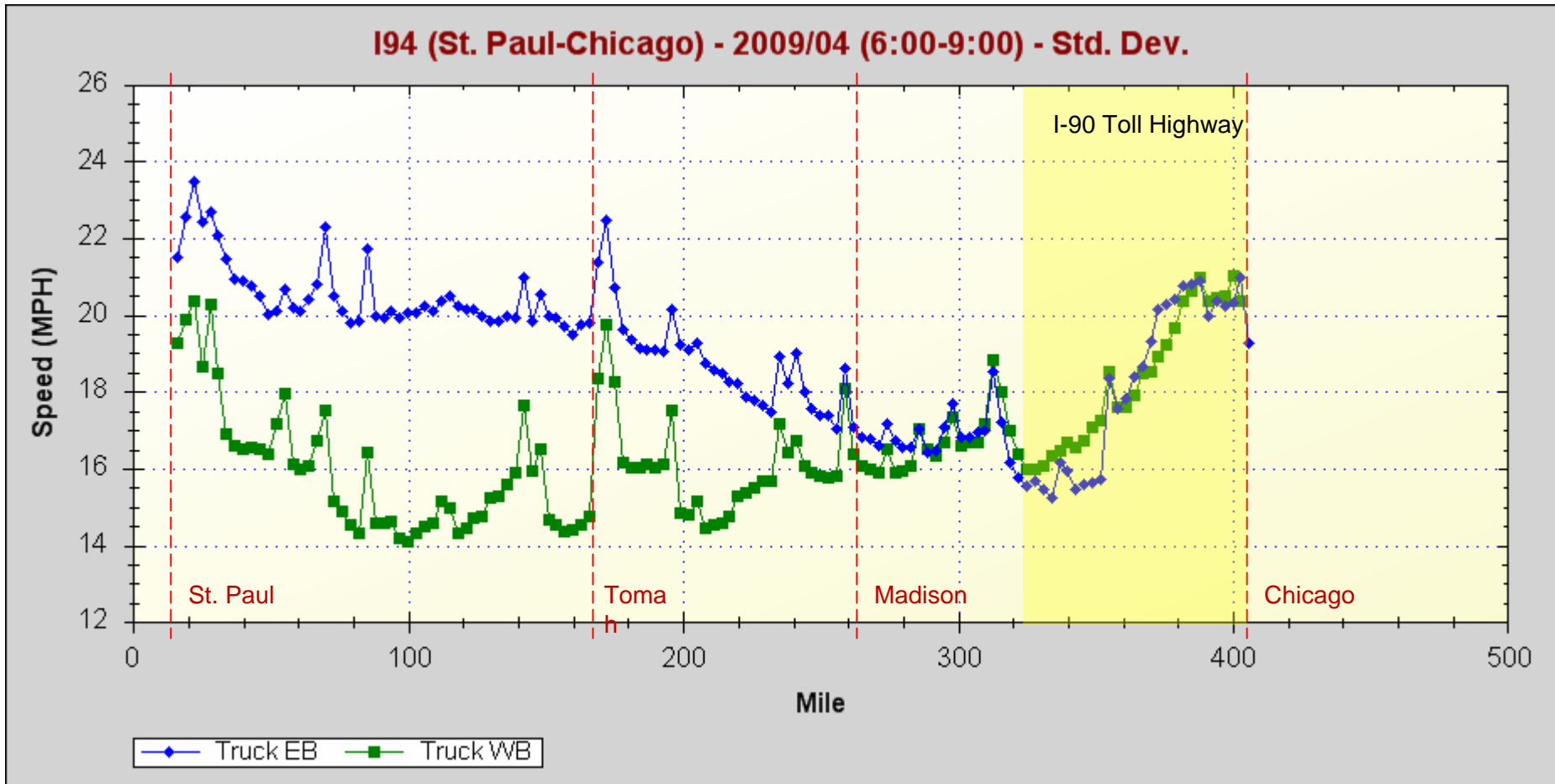


# Average Truck Speed of April 2009





# Average Truck Speed STDEV of April 2009

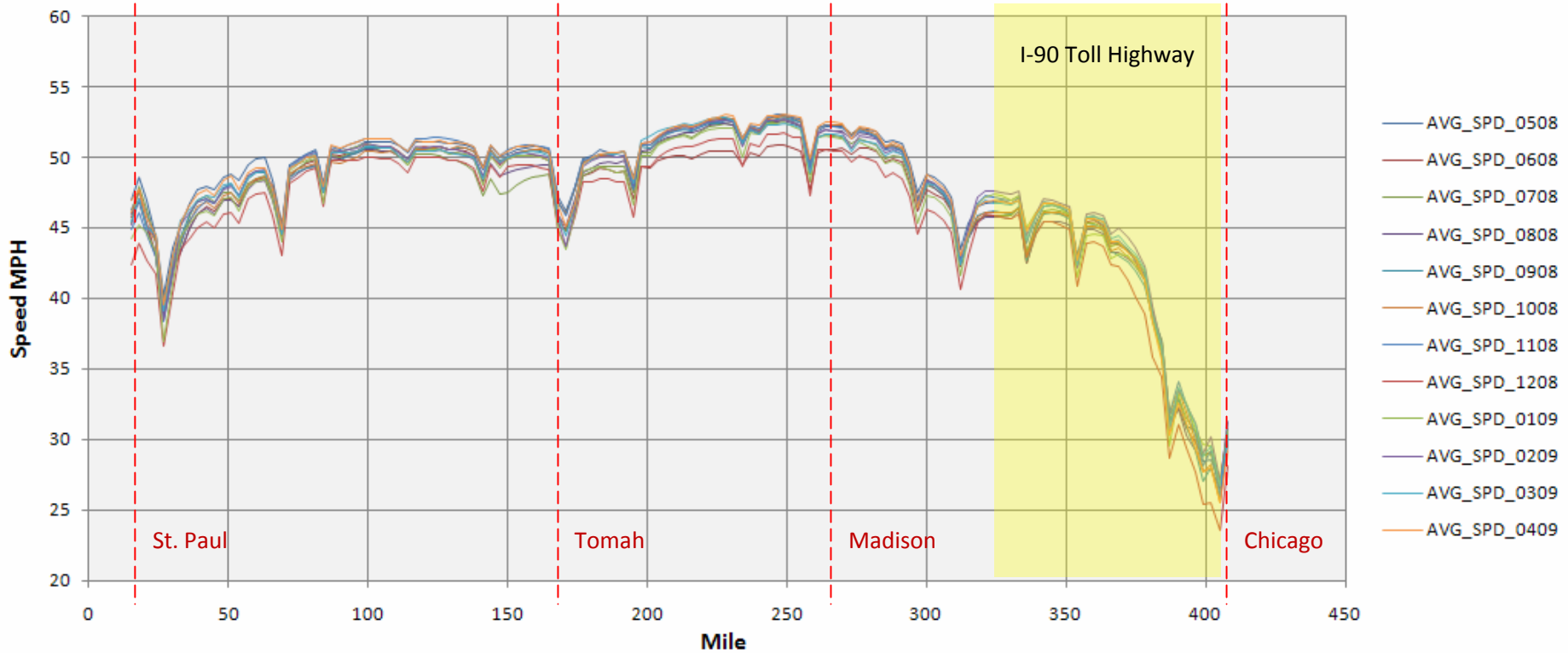






# Average Speed (EB)

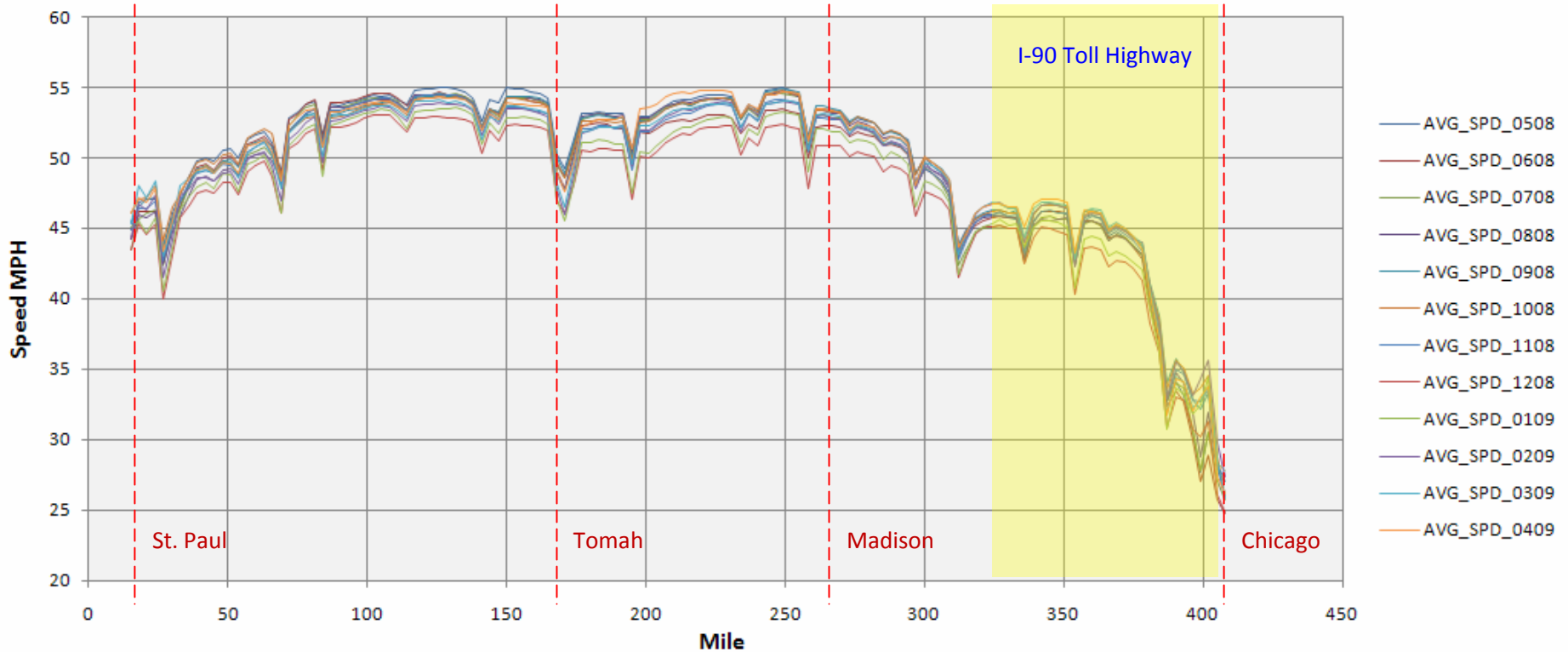
## Average Speed Eastbound





# Average Speed (WB)

## Average Speed Westbound





Truck Speed and Volume Variation By Time of Day

# I-94/90 (Twin Cities – Chicago)

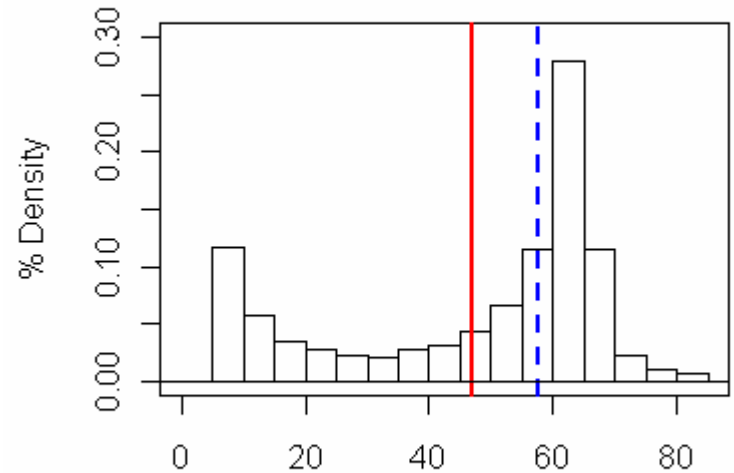
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# St. Paul, MN

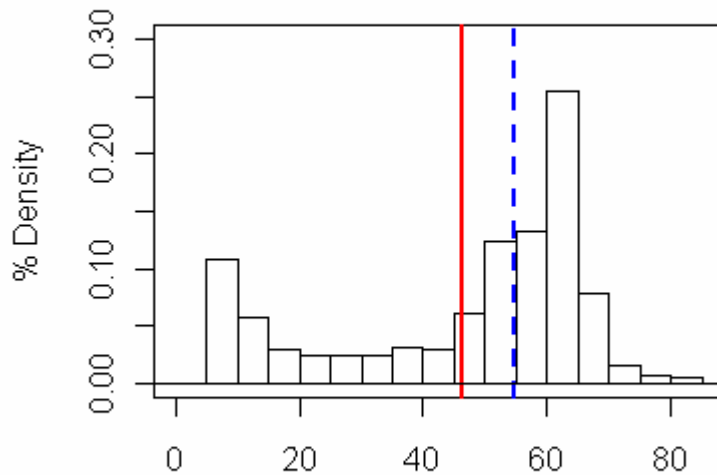


### Speed Distribution at US52, EB



Speed (MPH)  
EB Mean=46.9, Median=57.7, N=33,610

### Speed Distribution at US52, WB



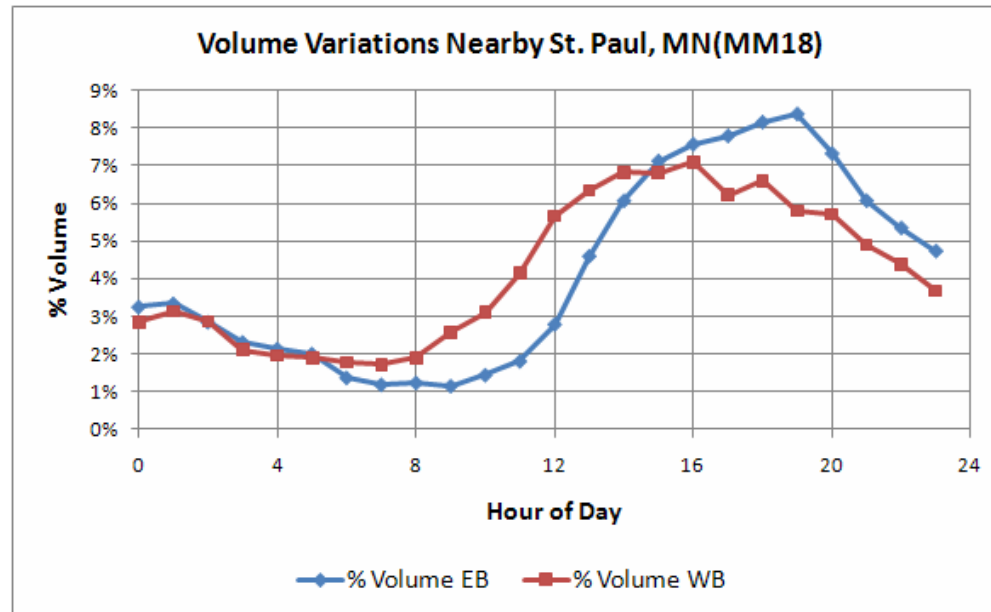
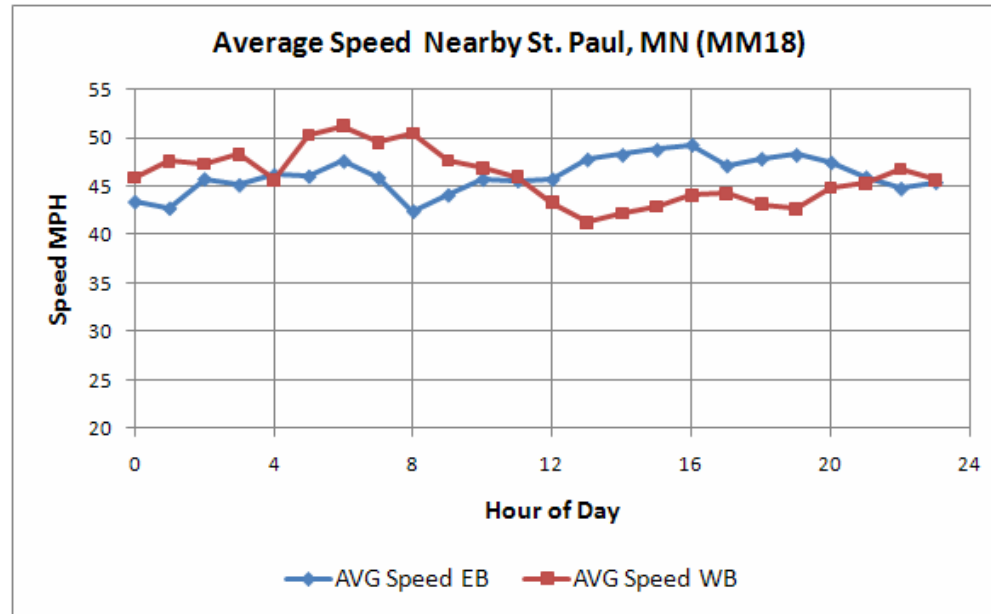
— Mean  
- - - Median

WB Mean=46.4, Median=54.6, N=33,788

# St. Paul, MN



## I94 & US52



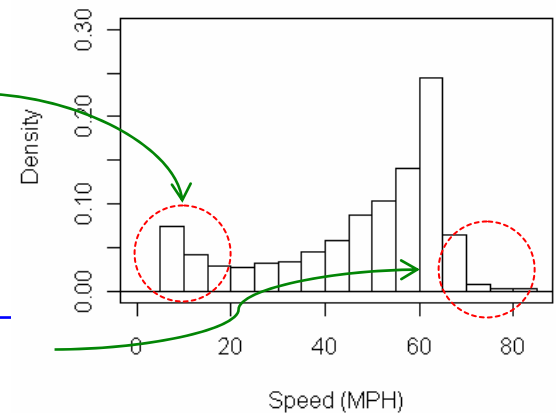


# Performance Index

## Reliability Measure

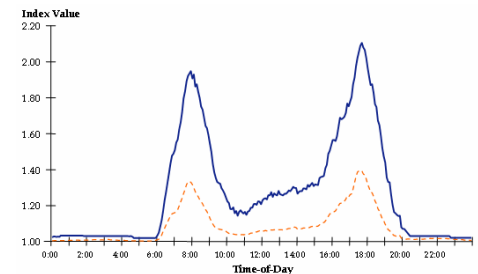
$$\text{Buffer Time Index (BTI)} = \frac{95\% \text{ TT} - \text{Avg. TT}}{\text{Avg. TT}}$$

$$\text{Buffer Speed Index (BSI)} = \frac{95\% \text{ Speed} - \text{Avg. Speed}}{\text{Avg. Speed}}$$



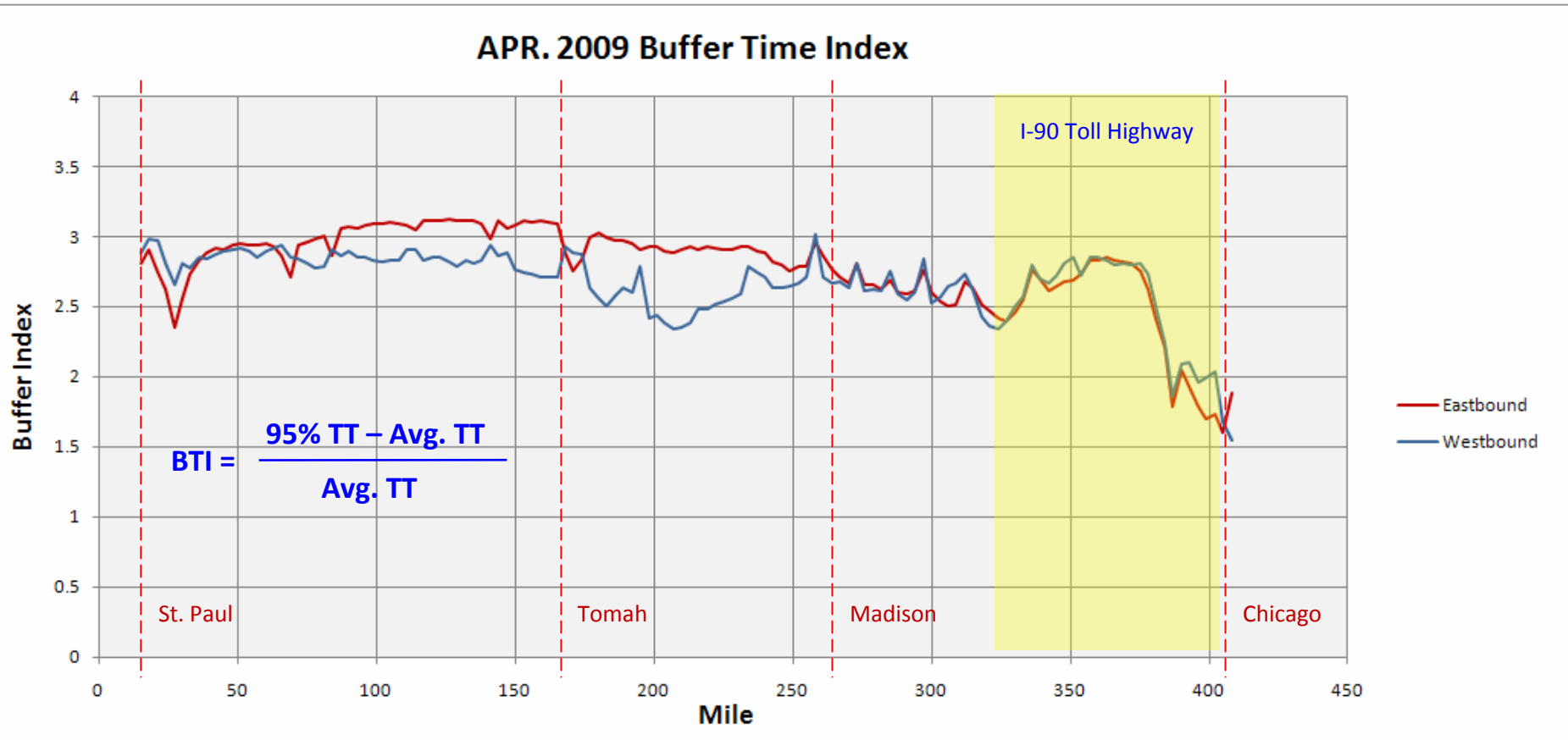
## Congestion Measure

$$\text{Travel Time Index (TTI)} = \frac{\text{Peak Travel Time}}{\text{Free Flow Travel Time}}$$



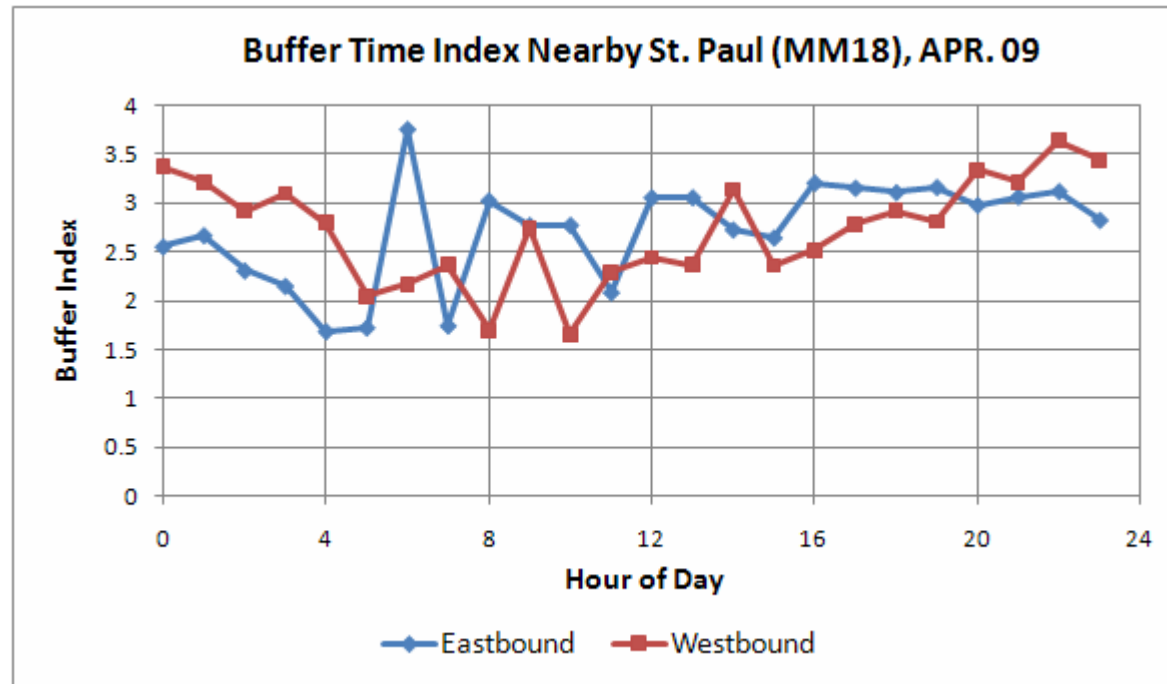


# Buffer Time Index (BTI) of Apr. 2009





# BTI by Hour of Day at US52 (MM18)



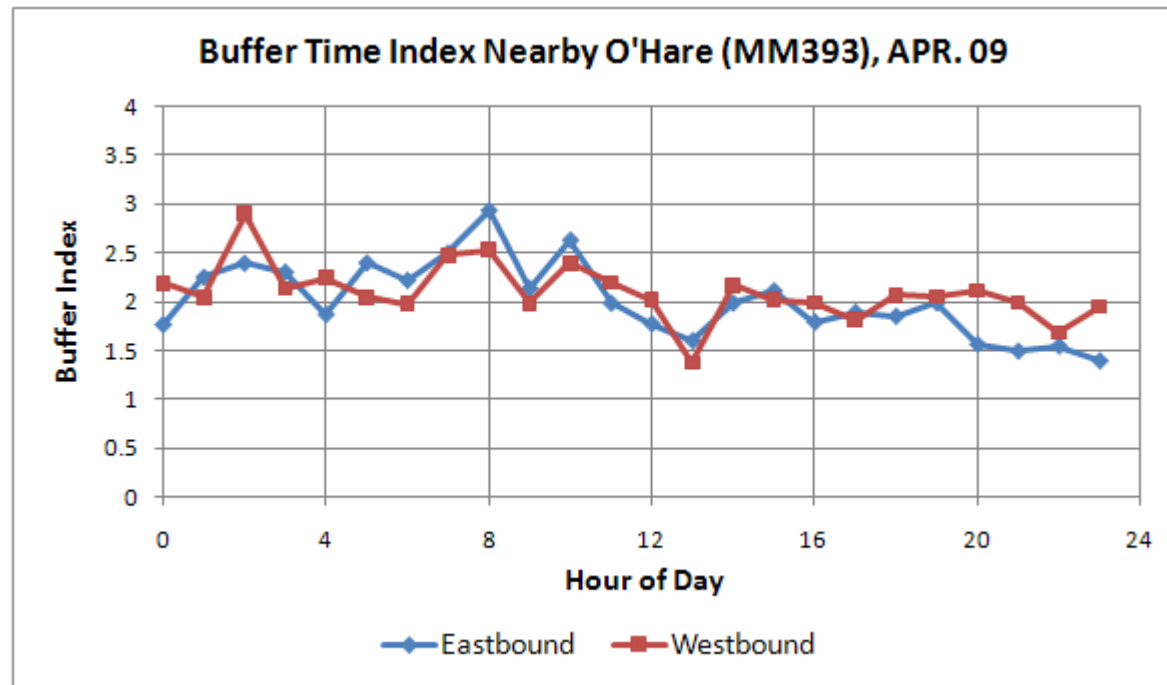
$$BTI = \frac{95\% TT - Avg. TT}{Avg. TT}$$







# BTI by Hour of Day at MM393

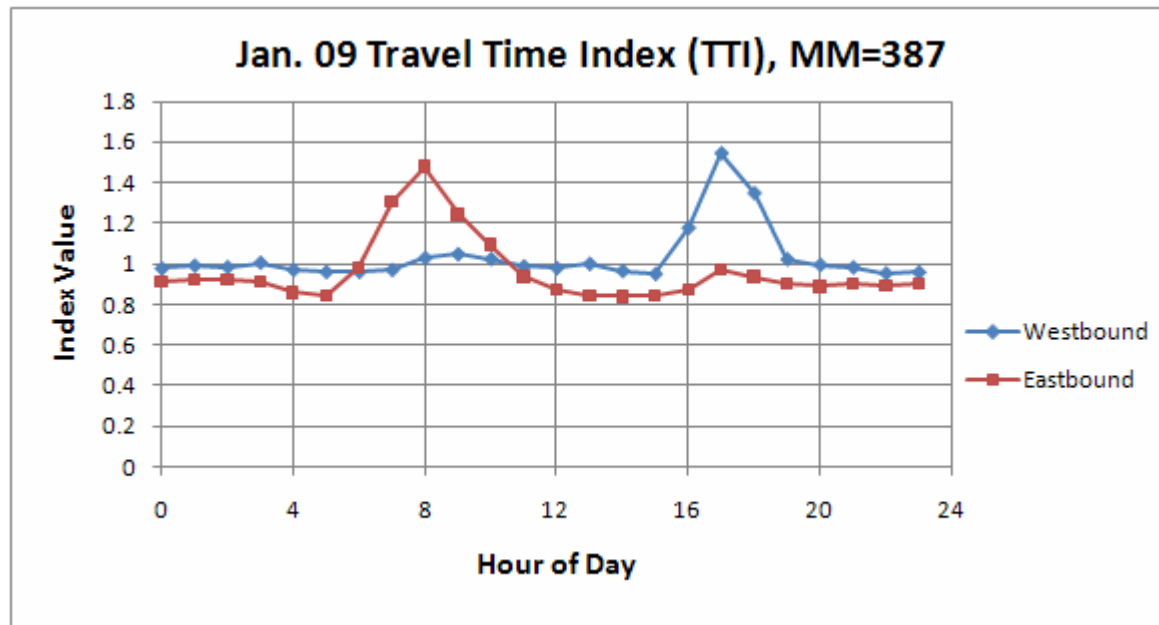


$$BTI = \frac{95\% TT - Avg. TT}{Avg. TT}$$





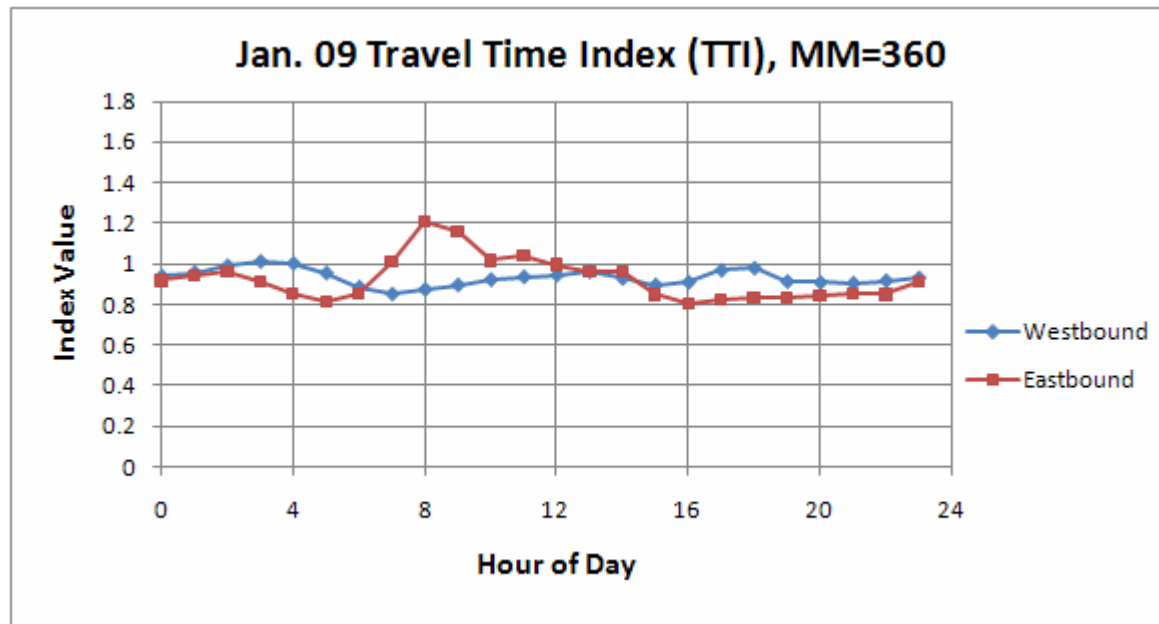
# Travel Time Index (TTI) of Jan. 2009



$$\text{Travel Time Index (TTI)} = \frac{\text{Peak Travel Time}}{\text{Free Flow Travel Time}}$$



# Travel Time Index (TTI) of Jan. 2009



$$\text{Travel Time Index (TTI)} = \frac{\text{Peak Travel Time}}{\text{Free Flow Travel Time}}$$



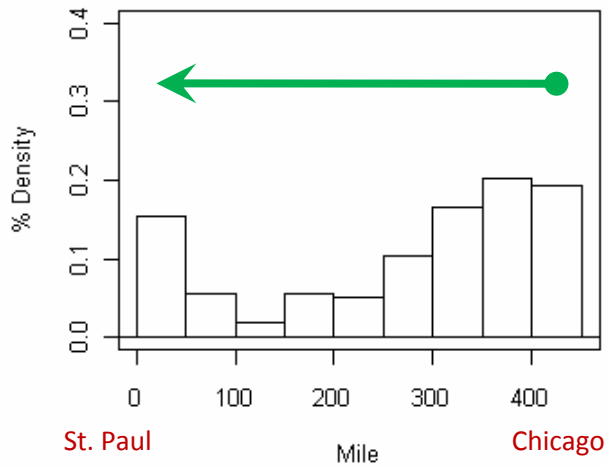
## Trip Destinations Analysis

# I-94/90 (TWIN CITIES – CHICAGO)

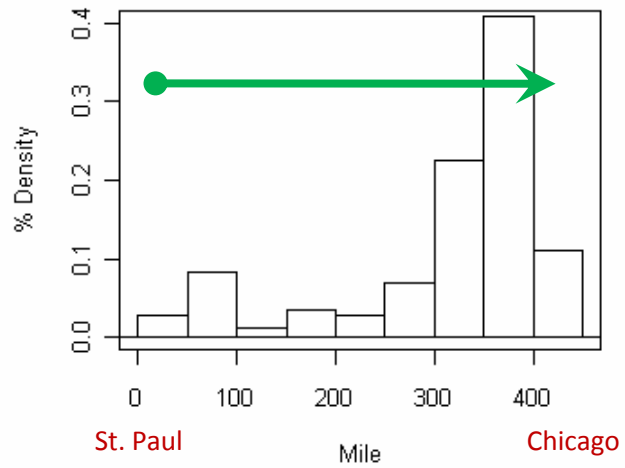
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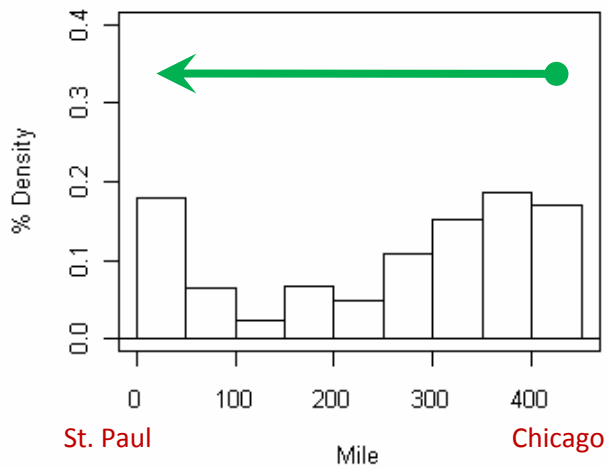
Mar. 09 WB, N= 3919



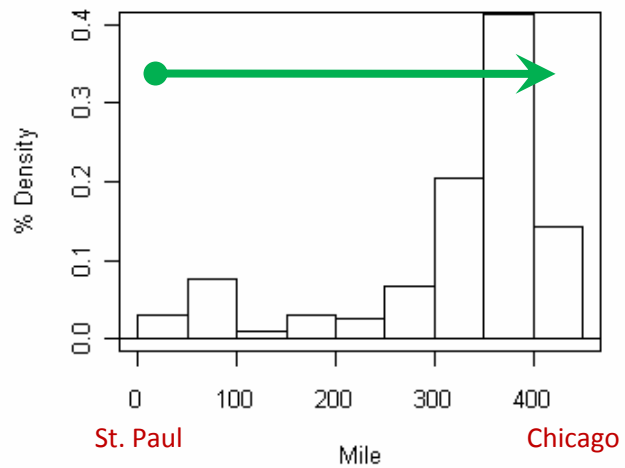
Mar. 09 EB, N= 4554



Apr. 09 WB, N= 5960



Apr. 09 EB, N= 6299



### Distribution of Trip Destinations



Truck vs. General Traffic

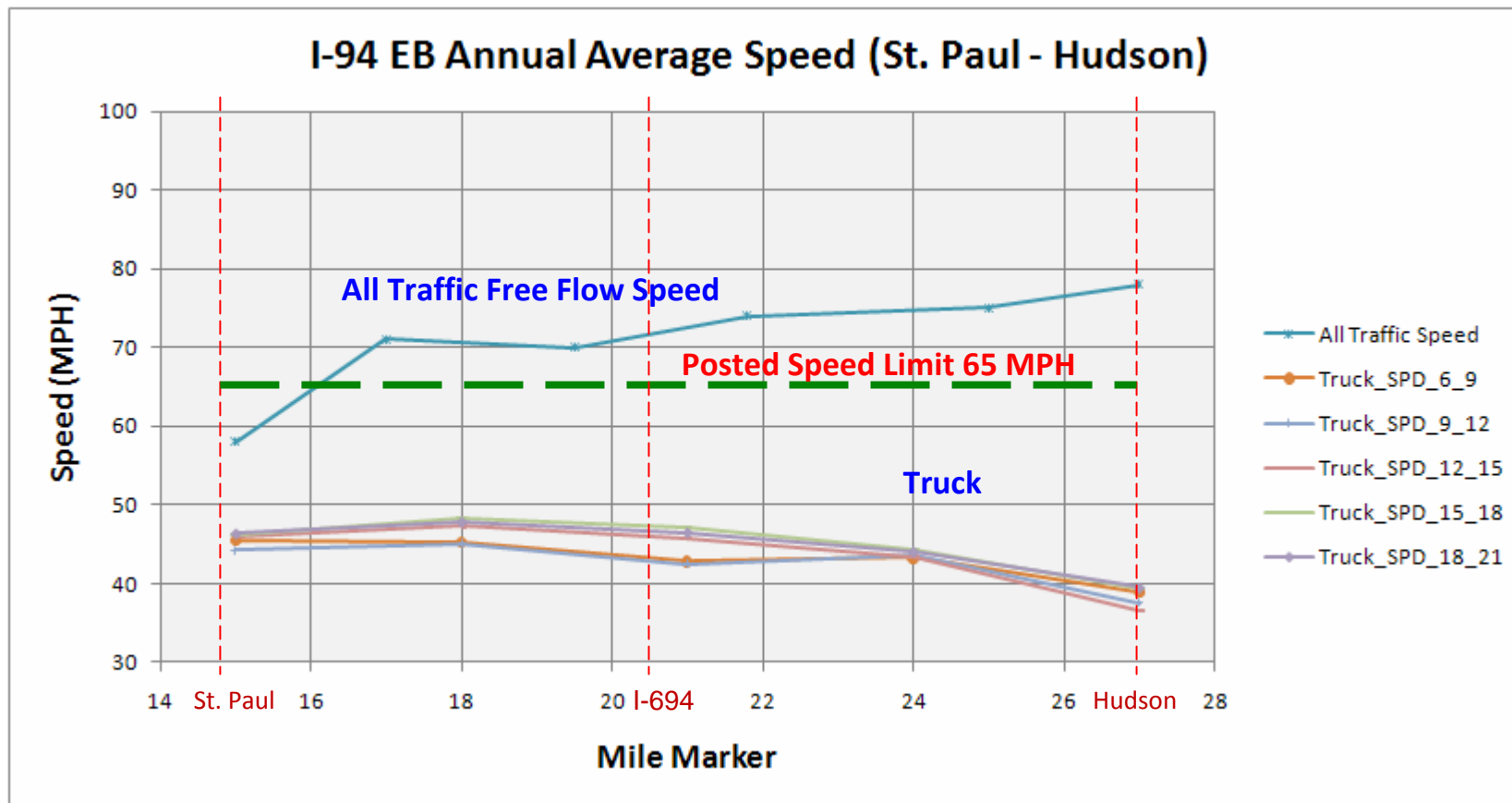
# I-94 (TWIN CITIES-HUDSON, WI)

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# I-94 Annual Average Speed (EB)

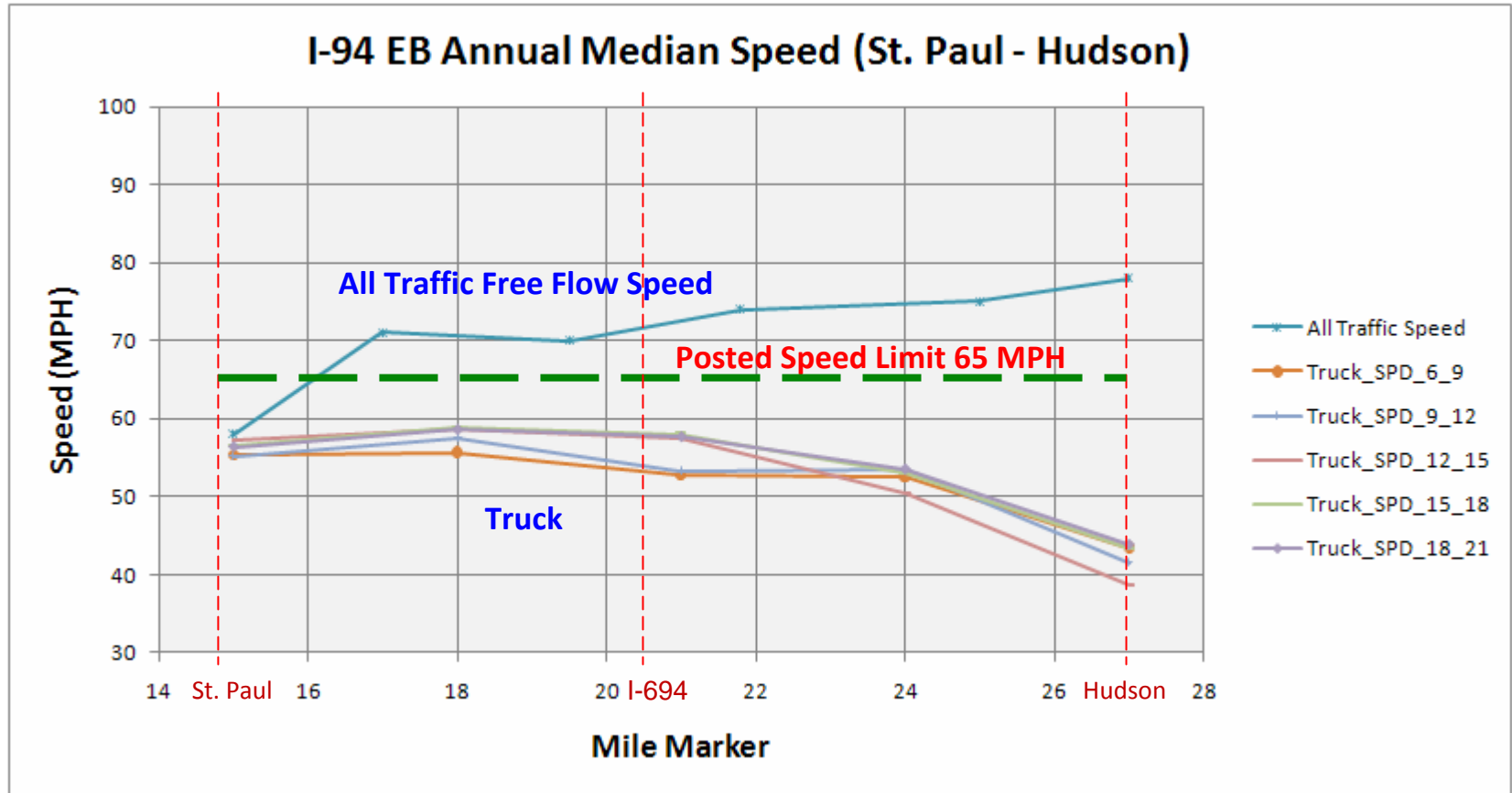


Average Free Flow Speed Obtained from Mn/DOT





# I-94 Annual Median Speed (EB)



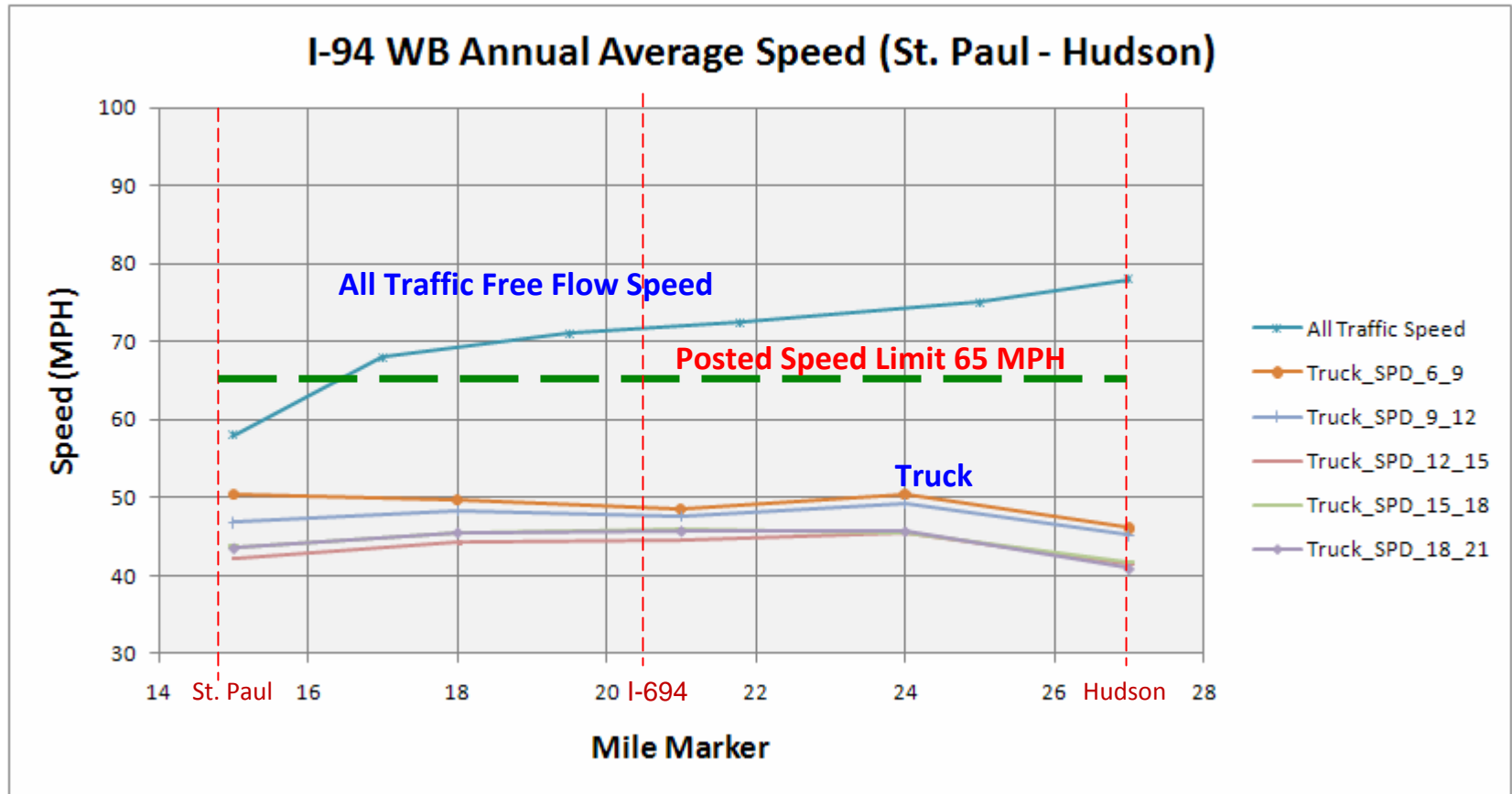
Average Free Flow Speed Obtained from Mn/DOT







# I-94 Annual Average Speed (WB)

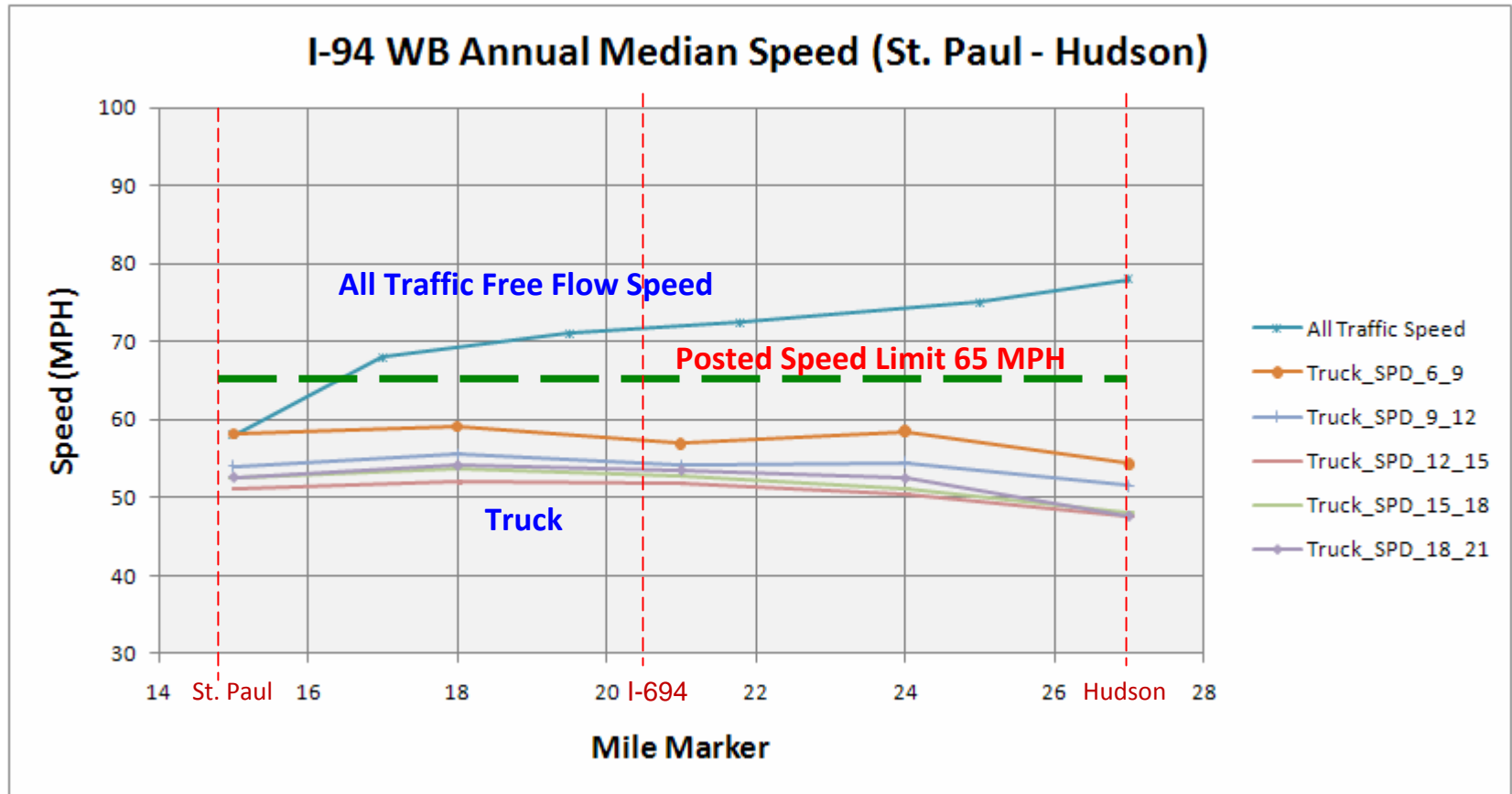


Average Free Flow Speed Obtained from Mn/DOT





# I-94 Annual Median Speed (WB)



Average Free Flow Speed Obtained from Mn/DOT



Truck vs. General Traffic

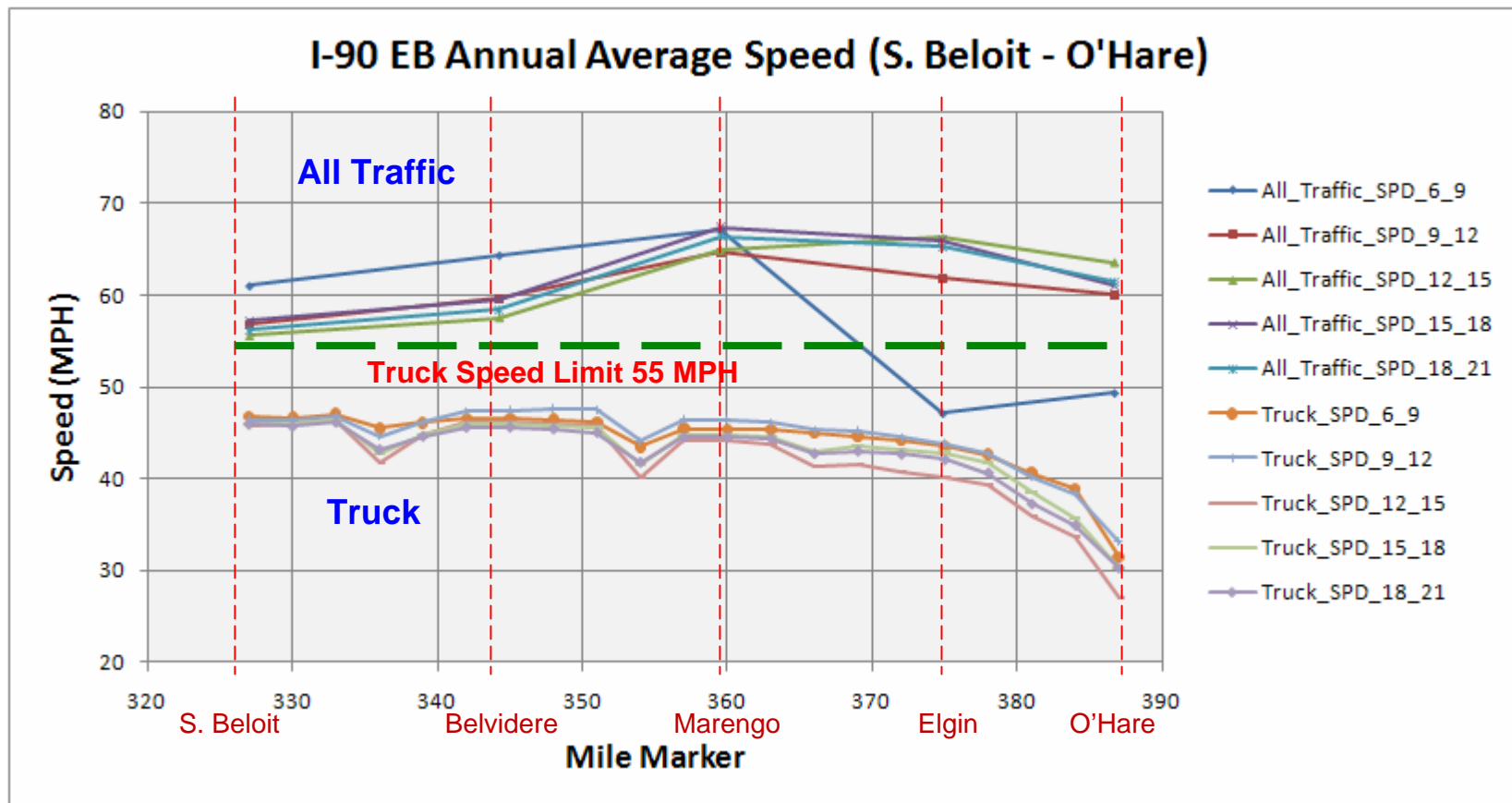
I-90 (S. BELOIT – O'HARE)

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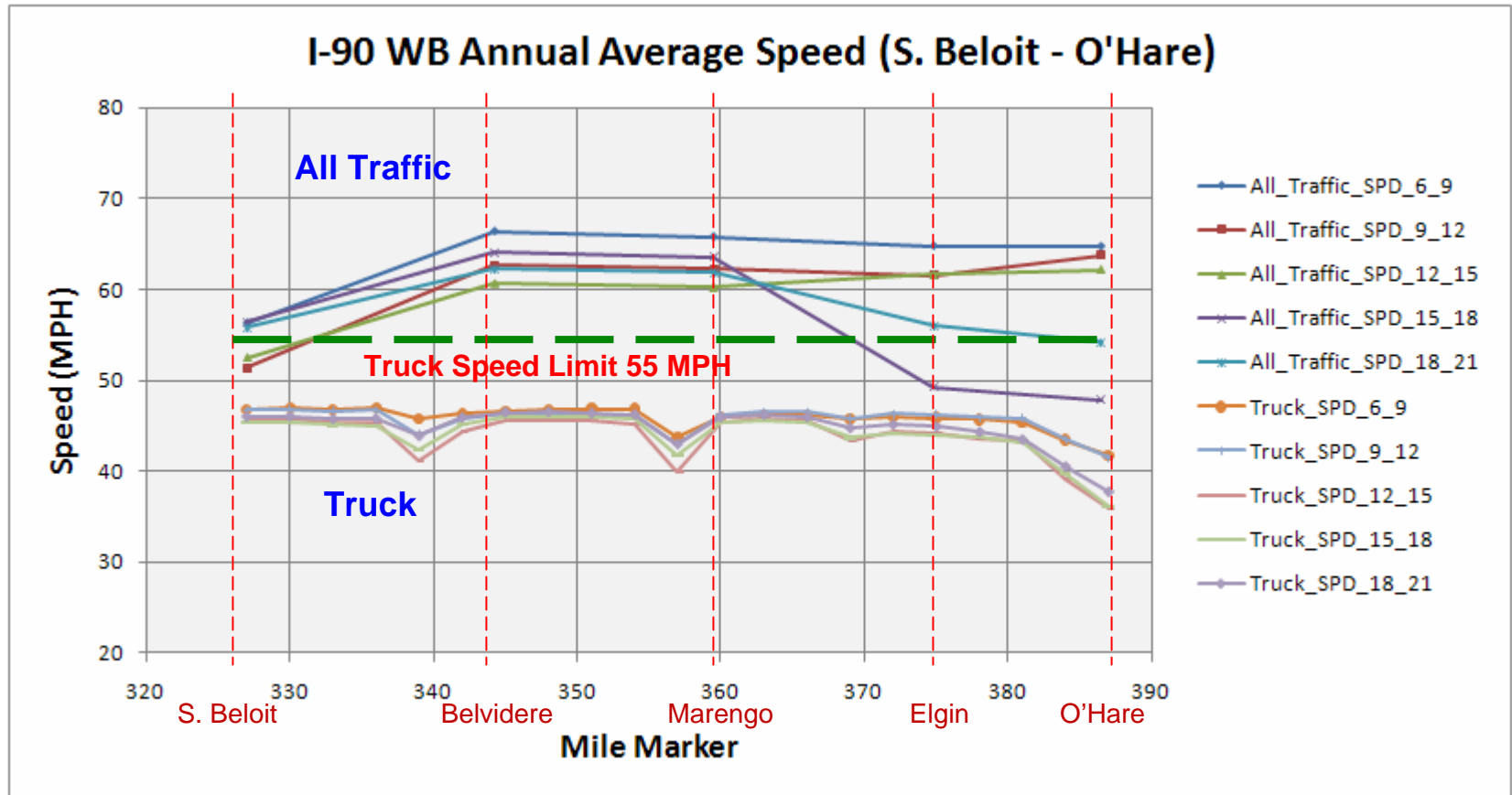
# I-90 Annual Average Speed (EB)



General Traffic Speed (Segment Speed) Derived from Illinois Toll Highway Authority Inter-Plaza Travel Time



# I-90 Annual Average Speed (WB)



General Traffic Speed (Segment Speed) Derived from Illinois Toll Highway Authority Inter-Plaza Travel Time





Truck Stops

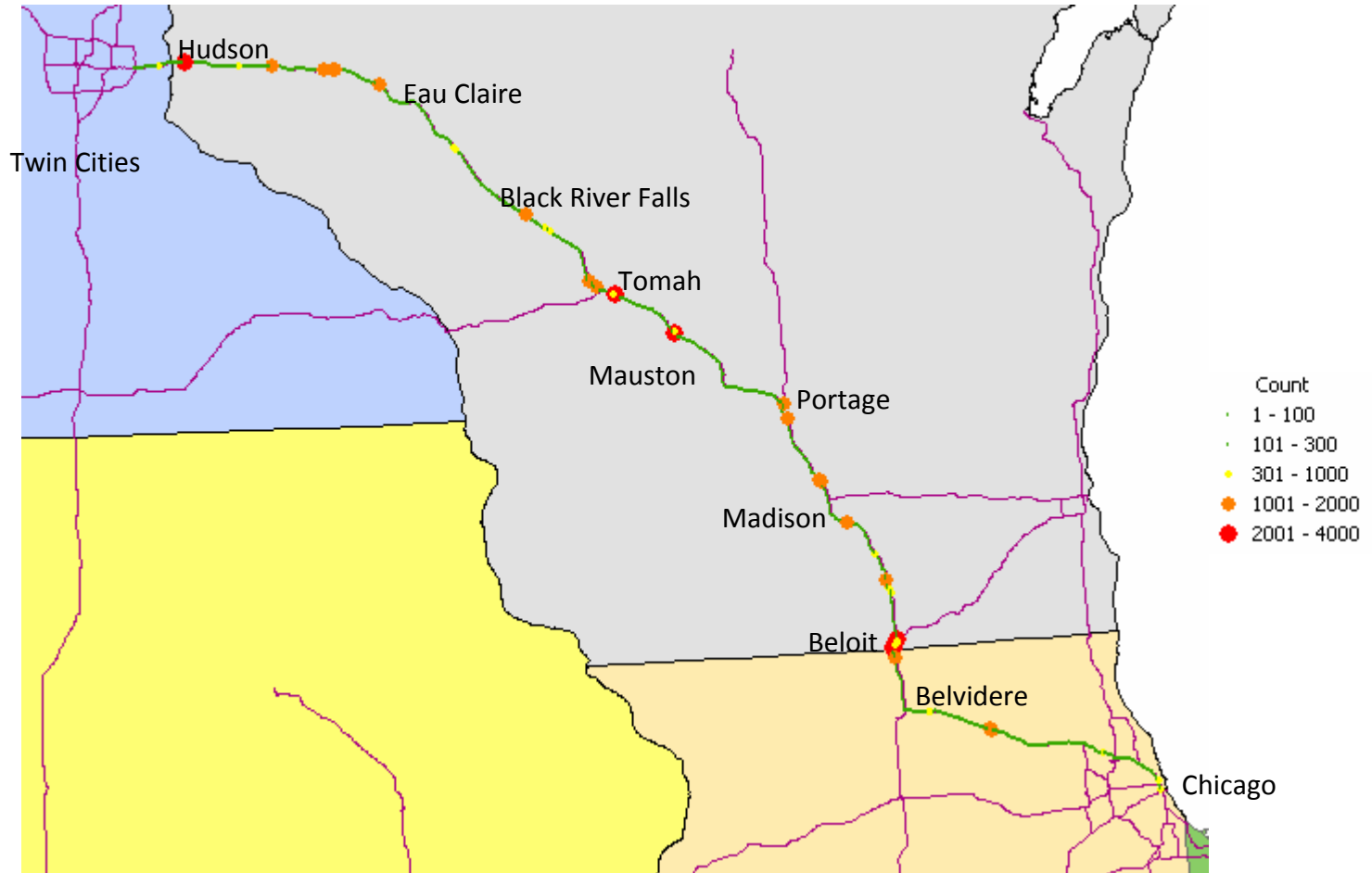
# I-94/90 (TWIN CITIES - CHICAGO)

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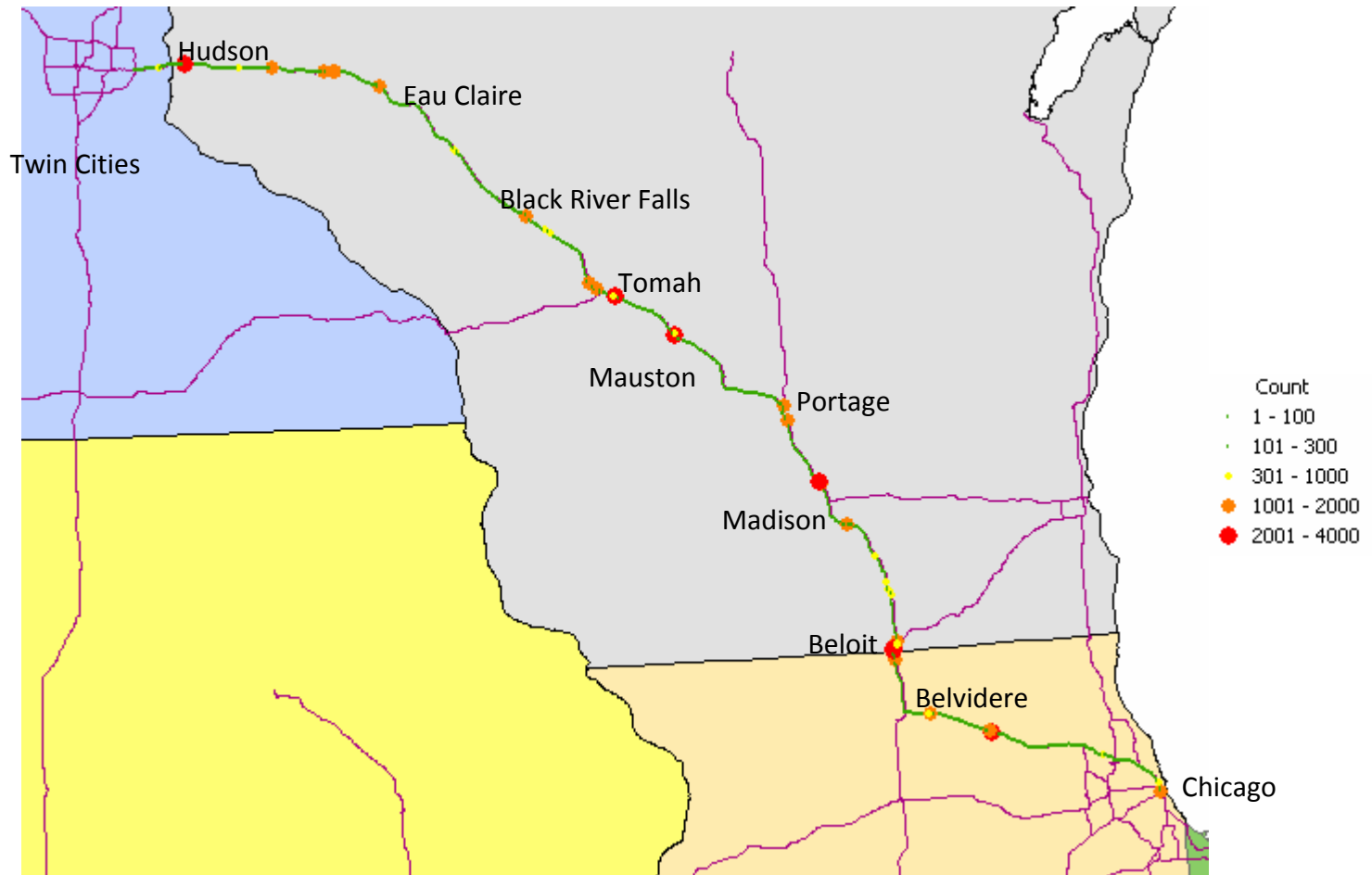
# EB Truck Stops (Apr. 2009)



Truck Speed < 5MPH and Travel Distance < 100 meters, N=72,543



# WB Truck Stops (Apr. 2009)



Truck Speed < 5MPH and Travel Distance < 100 meters, N=74,405





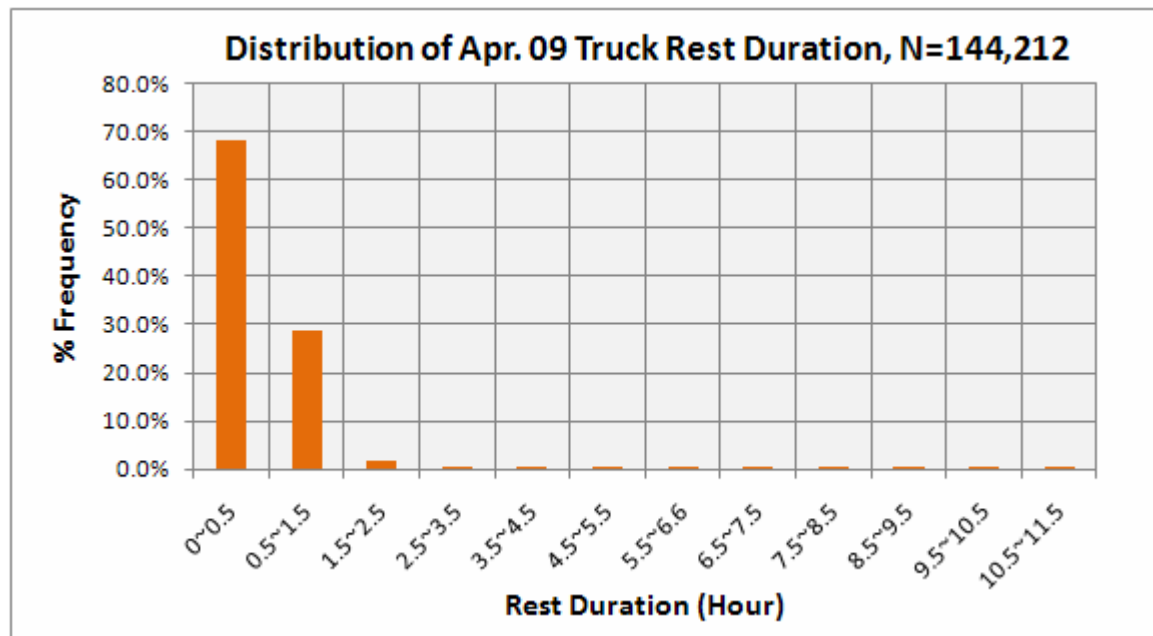
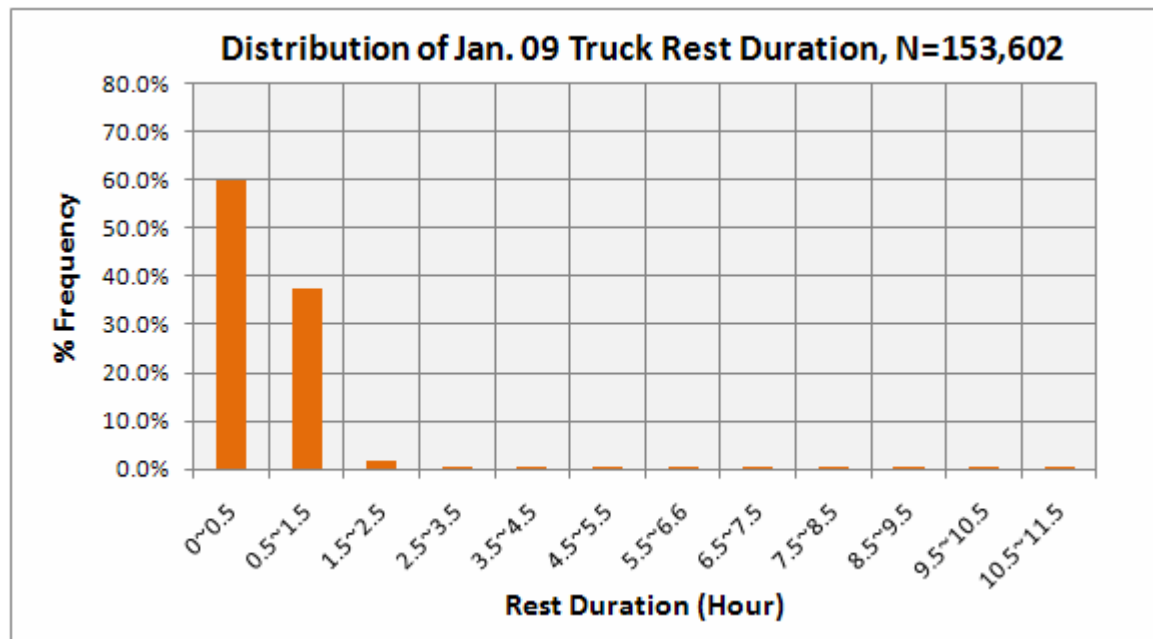


Truck Stop Durations

I-94/90 (TWIN CITIES - CHICAGO)

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Traffic Volume

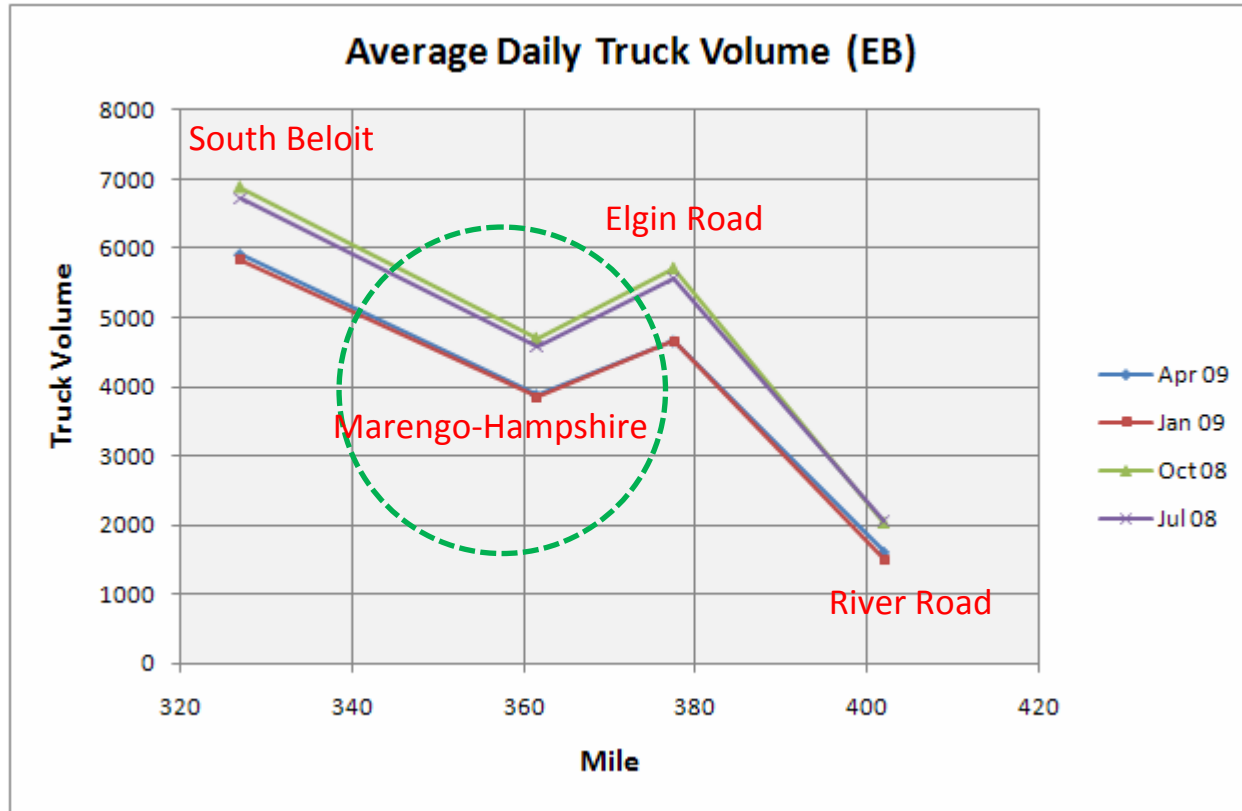
# I-90 (S. BELOIT- CHICAGO)

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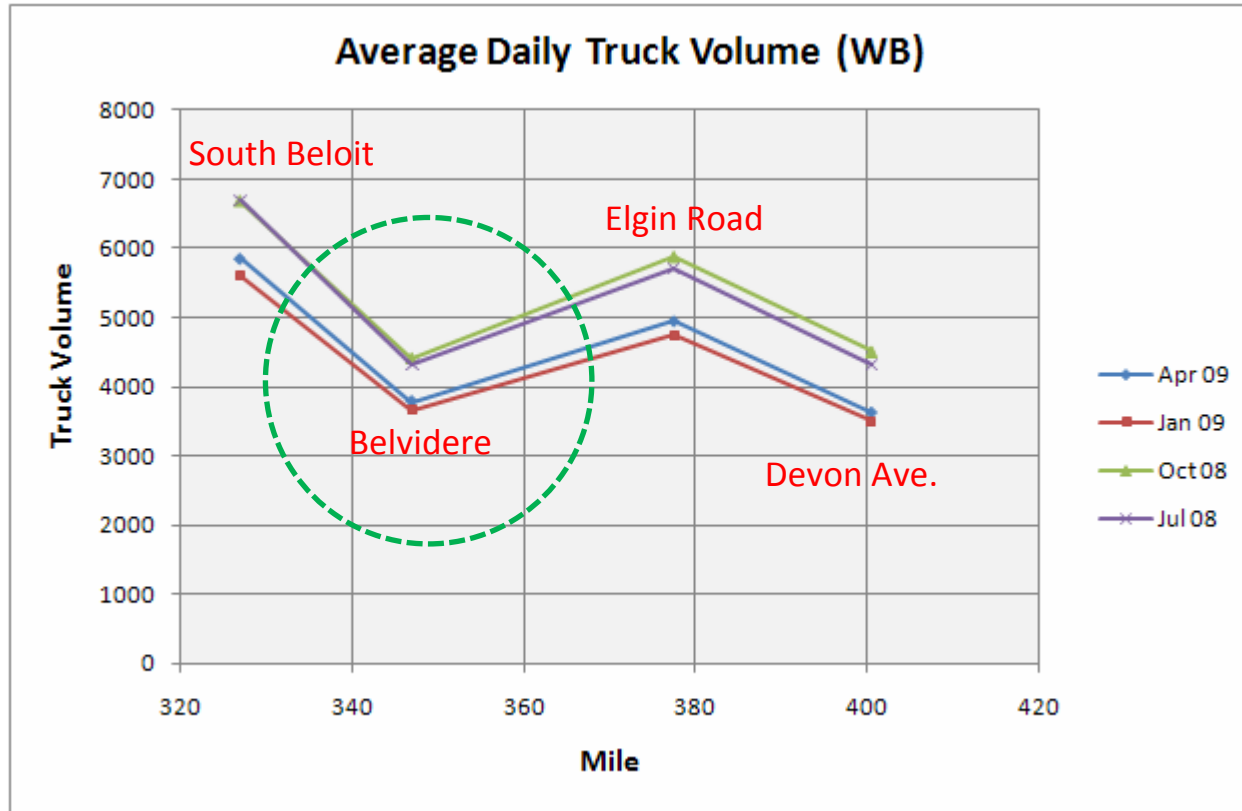


# I-90 EB Truck Volume (Tier 4)





# I-90 WB Truck Volume (Tier 4)





# Summary

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- ❖ FPM data can be used to measure performance over time and by location
- ❖ Truck travel time reliability and level of congestion
- ❖ Truck volume variation and impact
- ❖ Performance Index (BTI, TTI)
- ❖ Truck Destinations
- ❖ Truck Stops and Rest Durations





# Possible Causes of Bottlenecks

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- ❖ Top 30 freight bottlenecks occurred at highway interchange (ATRI Report)
- ❖ Roadway geometry (grade, sight distance)
- ❖ Capacity (number of lanes), Toll booths
- ❖ Required lane of travel for trucks
- ❖ Speed limit and free flow speed
- ❖ Volume ratio of truck vs. general traffic
- ❖ Weather and Others





# Potential Applications

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- ❖ Truck travel time reliability and impact of congestion on cost of freight
- ❖ Identify truck stop facility needs
- ❖ Speed gap between general traffic and truck influenced by traffic volume
- ❖ Need national standard to report freight performance measures regularly
- ❖ Use FPM data for freight study in metro area







# Acknowledgements

❖ USDOT, FHWA



❖ Minnesota DOT and ATRI

❖ Illinois State Toll Highway Authority

❖ CTS, University of Minnesota (UMN)

❖ Minnesota Traffic Observatory (MTO),  
Department of Civil Engineering, UMN



# Using Archived Truck GPS data for Freight Performance Analysis on Interstate I94/I90 From the Twin Cities to Chicago

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*Minnesota Department of*  
**Transportation**



**ITS INSTITUTE**  
Intelligent Transportation Systems

**Department of Civil Engineering (MTO)**  
**University of Minnesota**