

September 24, 2019

# QUICK RESPONSE FREIGHT METHODS (QRFM III) UPDATE

*Learn more about the latest QRFM update and  
leveraging its methods in development of State Freight Plans.*



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

# AGENDA



## **1. QRFM III Overview and Webinar Purpose**

*Birat Pandey, FHWA*

## **2. Leveraging Freight Analysis for State Freight Plans**

*Tiffany Julien, FHWA*

## **3. QRFM III Contents and Organization**

*Dan Beagan and Dan Tempesta, Cambridge Systematics*

## **4. Q&A / Discussion**

# PRESENTER INTRODUCTIONS



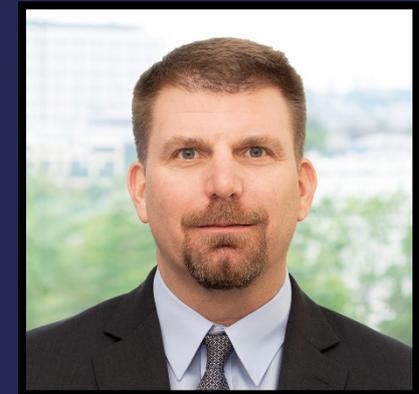
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# OVERVIEW



Webinar series on the latest freight analysis resources and research.

1. **Quick Response Freight Methods (QRFM III) Update**
2. Update to Freight Analysis Framework (FAF) Tool for Estimating Truck Flows
3. Exploratory Research and New Tools in Freight Data and Analysis

# LEARNING OBJECTIVES

This webinar aims to:

Increase your understanding of QRFM III content coverage

Enhance knowledge on available resources to help make decisions on uses of freight data and methods for more effective freight transportation planning and analysis.

# EVOLUTION OF QRFM III



- QRFM I – 1996:
  - Make freight information background available
  - Locate freight related data
  - Provide simple techniques and transferable parameters for four-step models and site planning
  
- QRFM II – 2007:
  - Update 1996 Manual
  - Provide freight methods appropriate for different geographic and temporal scales
  - Provide alternative analysis methods, data sources, and data collection methods to improve the accuracy of freight forecasts

# EVOLUTION OF QRFM III



- QRFM III – 2019:
  - Quick Response Freight Manual is now Quick Response Freight Methods.
  - Informational and descriptive resource, not prescriptive.
  - Background information on the freight transportation system and factors.
  - Provides options that use various data sources and analysis methods to prepare freight demand and forecasts.
  - Simple techniques and elements used to develop freight forecasts.

# STATE FREIGHT PLAN



49 U.S.C. 70202 lists ten required elements that all State Freight Plans must address for each of the transportation modes.

# STATE FREIGHT PLAN



## Fast Act Requirements

- **Requirement # 1:** Identification of significant freight system trends, needs, and issues. Key issues confronting the freight system (present and future).
- **Requirement # 2:** Description of freight policies, strategies, and performance measures guiding transportation investment decisions.
- **Requirement # 3:** When applicable, a listing of...
  - Multimodal critical rural freight facilities and corridors designated within the State under Section 70103 of Title 49; and
  - Critical rural and urban freight corridors designated within the State under Section 167 of Title 23.

# STATE FREIGHT PLAN



## Fast Act Requirements

- **Requirement # 4:** How the plan will improve the ability of the State to meet the goals of the National Multimodal Freight Policy and the National Highway Freight Program?
- **Requirement # 5:** Innovative technologies and operational strategies that improve the safety and efficiency of freight movement.
- **Requirement # 6:** Description of improvements that may be required to reduce or impede the deterioration due to heavy vehicles.
- **Requirement # 7:** An inventory of facilities with freight mobility issues, such as bottlenecks, and mitigation strategies.

# STATE FREIGHT PLAN

## Fast Act Requirements

- **Requirement # 8:** Consideration of any significant congestion or delay caused by freight movements and mitigation strategies.
- **Requirement # 9:** A freight investment plan that includes a list of priority projects and describes how funds would be invested and matched.
- **Requirement # 10:** Consultation with the State Freight Advisory Committee, if applicable.

# IMAGE SOURCE

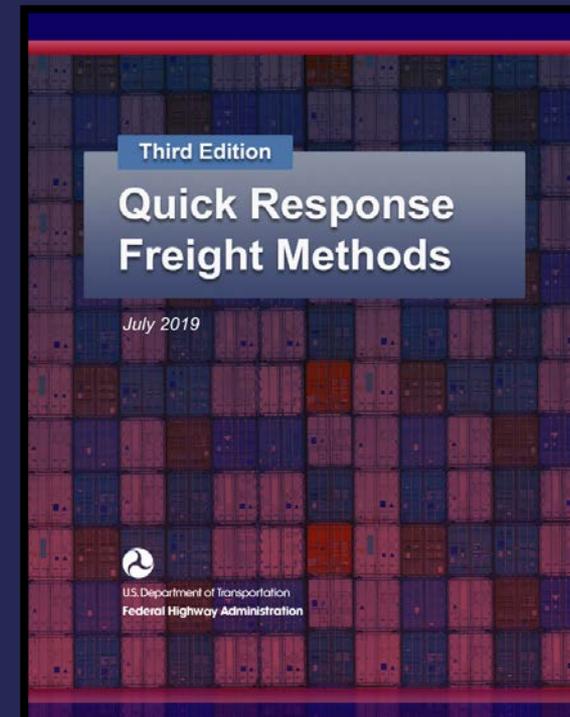


All image sources are FHWA, unless otherwise indicated.

# QUICK RESPONSE FREIGHT METHODS

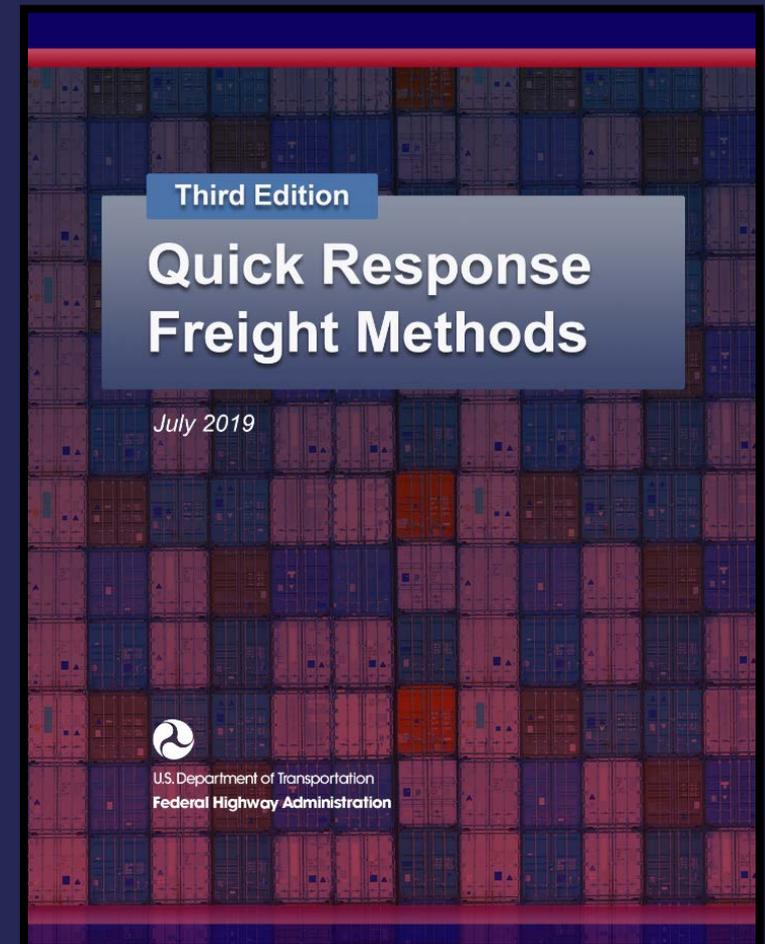
2019 Update of the QRFM III available online at:  
<https://ops.fhwa.dot.gov/freight/resources/bookshelf/index.cfm>

The screenshot displays the website for the Quick Response Freight Methods (QRFM) Third Edition. The page is titled "Quick Response Freight Methods Third Edition" and features a "Table of Contents" sidebar on the right. The main content area is titled "Inside the QRFM" and is divided into four parts: Part A. Introduction, Part B. Data, Part C. Methods, and Part D. Applications. Each part includes a brief description of its content. The "Table of Contents" sidebar lists the following sections: Documentation, Part A. Introduction (with sub-sections: Chapter 1. Introduction, Chapter 2. Freight Forecasting: History and Definitions, Chapter 3. Freight Demand and Performance—Controlling Factors), Part B. Data, Part C. Methods, Part D. Applications, and Acknowledgements. The footer of the page includes the FHWA logo, navigation links, and the date "Last modified: May 2019".



# QRFM III CONTENTS

- Part A – Introduction
- Part B – Data
- Part C – Methods
- Part D - Applications



# PROGRESSION OF TRUCK MODELING

Factor  
Auto Trips

Truck  
Generation  
Rates (QRFM I)

O-D Matrix  
Estimation  
(ODME)

Commodity  
Flows

Truck  
Touring  
Models

Supply  
Chain  
Models

- Factor Auto Trips – factor auto table to obtain truck tables
- Truck Generation Rates – QRFM I: light, medium, heavy rates
- ODME – Build a truck table from count data
- Commodity Flows – Convert goods flows to truck flows
- Truck Touring – Intra-city truck movements
- Supply-Chain – Freight logistics modeling

# FACTORS THAT AFFECT FREIGHT

## Economic Structure

- Who moves freight?

## Supply Chains and Logistics

- Where does freight move?

## Cost and Service by Mode

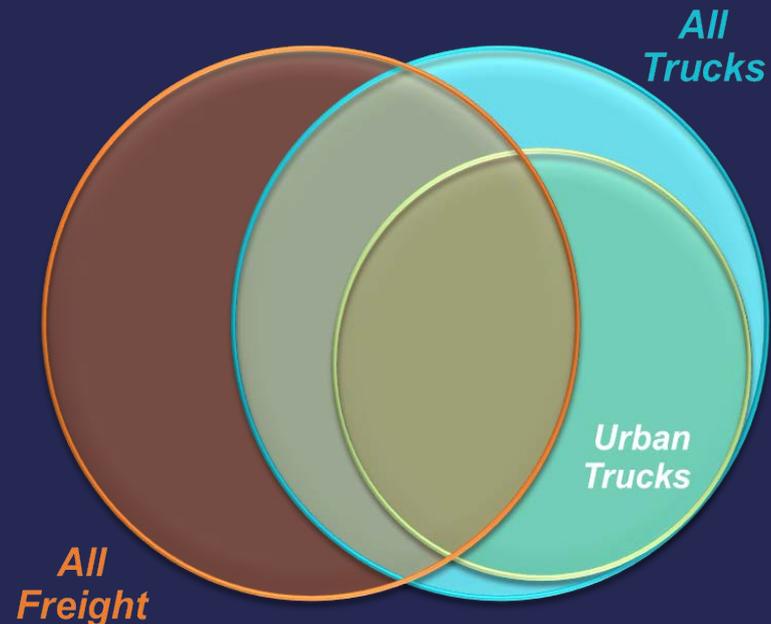
- How does freight move?

## Freight Flows

- What and how much freight is moved?

## Organization and Public Policy

- Why does freight move the way it does?



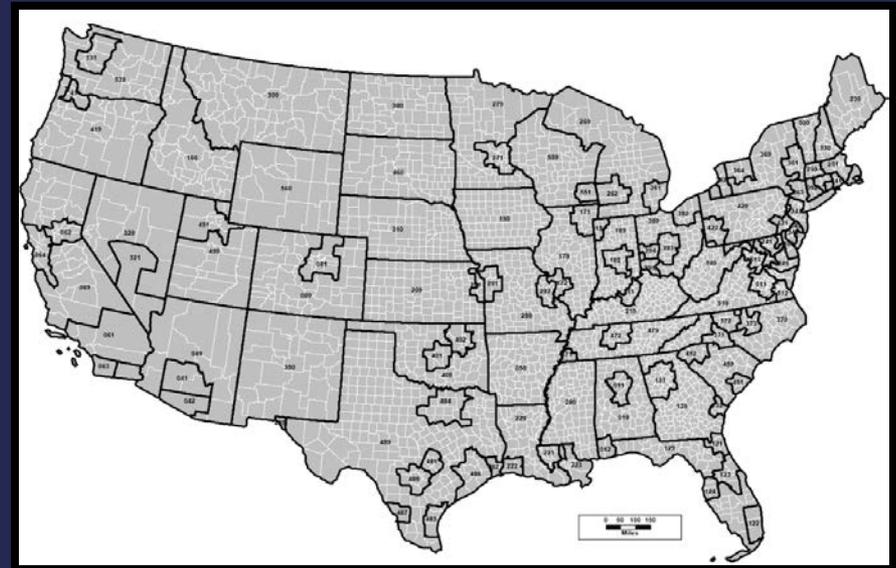
# PART B: DATA

- Existing Data
- Data Collection

# EXISTING DATA: ORIGIN-DESTINATION (O-D) FLOWS

## Multimodal Commodity Origin-Destination Tables

- FAF
- Commodity Flow Survey
- IHS Markit's  
TRANSEARCH Data  
TRANSEARCH



# EXISTING DATA: SYSTEM USAGE



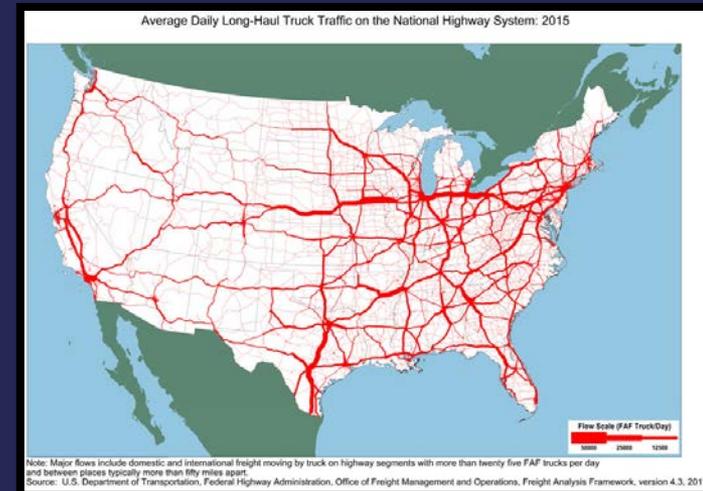
## Mode-Specific Data

- Vehicle Inventory and Use Survey (VIUS)
- Carload Waybill Sample
- Waterborne Commerce Statistical Database
- Travel Monitoring Analysis System (formally VTRIS)

# EXISTING DATA: NETWORK

## Freight Network and Infrastructure

- Multimodal Freight Network
- National Transportation Atlas Database
- National Transportation Research Center
- Mode-specific sources:
  - Federal Highway Administration
  - Federal Railroad Administration
  - U.S. Army Corps of Eng. Marine Freight
  - Federal Aviation Administration



# EXISTING DATA: EMPLOYMENT

## Employment/Industry Data

- U.S. Bureau of Labor Statistics
- State Department of Labor
- Current Employment Statistics
- U.S. Bureau of Economic Analysis
- Local Area Unemployment Statistics
- Occupational Employment Statistics
- U.S. Census Bureau's County Business Patterns
- U.S. Economic Census Industry Data

**REGIONAL HOMEPAGES**

BLS offers many types of data for regions, states and local areas. To browse for available information, visit the regional pages to the right or use the economic news release finder below.

**Economic news release finder**

Choose a State  **GO**

Choose a Subject  **GO**

NEW ENGLAND  
NEW YORK - NEW JERSEY  
MID - ATLANTIC  
SOUTHEAST  
MIDWEST  
SOUTHWEST  
MOUNTAIN - PLAINS  
WEST

<https://www.bls.gov/>

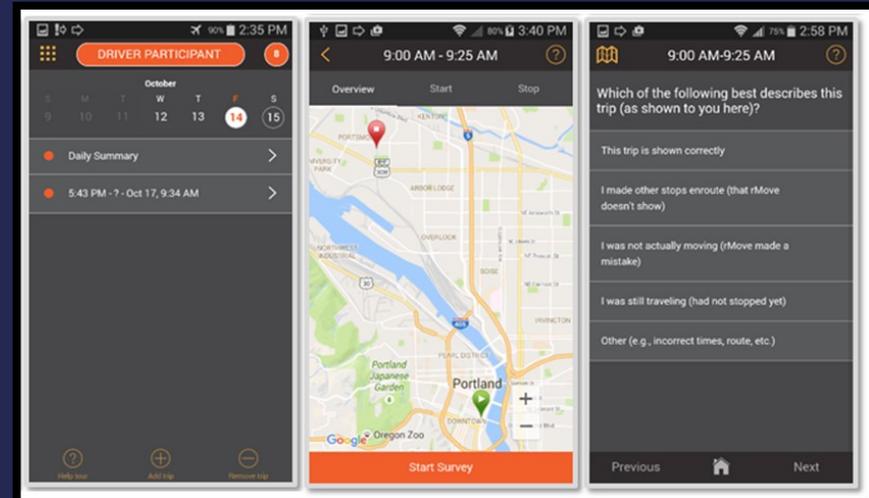
# LOCAL DATA COLLECTION

## Local Freight Data Collection Methods

- Establishment Surveys
- Travel Diary Surveys
- Roadside Intercept Surveys
- Vehicle Classification Counts

## New Survey Methods

- Public/Private Data Sharing
- Integration of Different Approaches



Example of a survey smartphone application.  
(Source: Portland Metro.)

# QRFM III PART C: METHODS



- Existing Forecasts: Use an existing forecasts
- Growth Factors: Edit an existing forecast
- Direct Acquisition of Commodity Flows: Use existing O-D flows
- Trip Based Forecasting: Combine commodity flow data with local data to develop rates
- Freight Supply Chain and Non-Freight Truck Touring: Advanced Activity/Tour-based approach

# EXISTING FORECASTS

Existing Forecast: Use an existing study/report to support your project

## Pros:

- Readily available
- Prepared/vetted by others
- Few special resources required

## Cons:

- Forecast may not be consistent with local data/plans
- Demand stratification may not match areas of local interest
- Indirect impacts may not be considered

# GROWTH FACTORS

Growth Factor Forecast: Factor an existing forecast O-D tables or assignments for your study

## Pros:

- Can focus on specific facilities
- Limited resources required
- Uses readily available data

## Cons:

- Cannot change usage and performance of background flows
- New facilities may not have been considered in forecast preparation

# DIRECT ACQUISITION

Direct Acquisition Forecast: Acquire existing forecast O-D tables and assign them for your study

## Pros:

- Local network usage and performance can be forecast
- Consistency with national forecasts
- Required resources can be modest

## Cons:

- Uses trip tables, as is
- Indirect impacts not captured
- Data may be inconsistent with local data

# TRIP-BASED

Trip-Based Forecasting: Development of O-D tables using estimated processes and assigning them for your study

## Pros:

- Inclusion of local economic data and forecasts
- Predicts O-D table flow and routing changes
- Usage and performance for specific commodities and/or truck types

## Cons:

- Substantial data resources required
- Special treatment of intermediate stops

# TRIP-BASED FORECASTING: MAJOR COMPONENTS



## Trip Generation

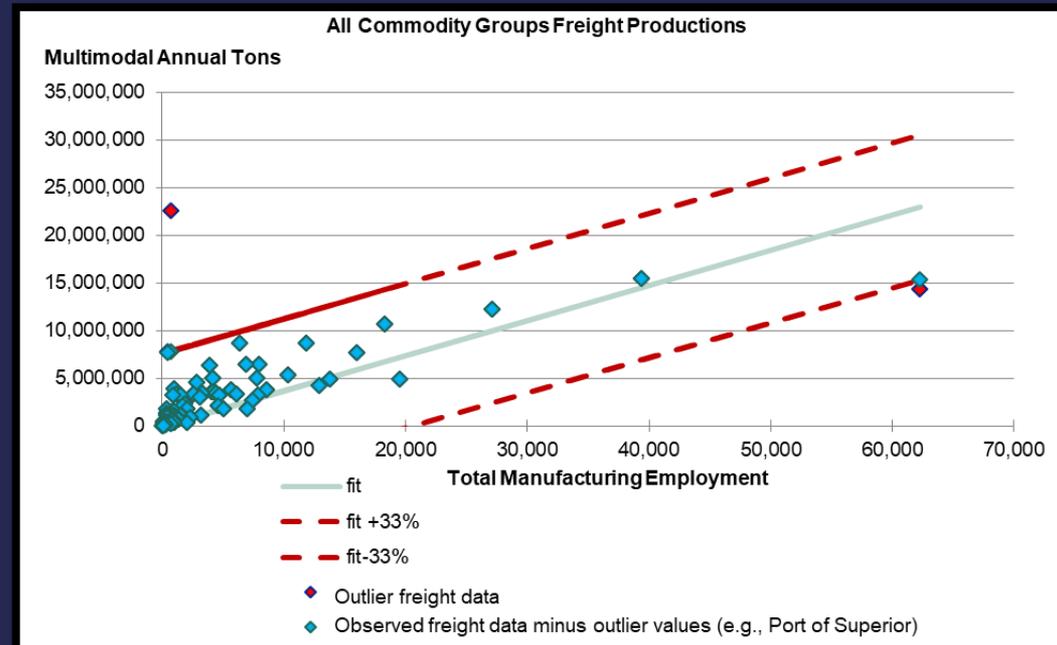
- Outliers
- Tons exceed employment
- Employment exceed tons

## Trip Distribution

## Mode Shares or Mode Choice

## Payload Factors

## Assignment



# TRANSFERABILITY OF PARAMETERS



## Trip Generation

- Region needs to have similar economy
- Must use same commodities or groups

## Trip Distribution

- Region needs to have similar economy AND trading partners

## Mode Shares

- Region needs to have similar economy AND trading partners AND mode availability

## Payload Factors

- Region needs to have similar commodity groups

# SUPPLY-CHAIN AND TOURING MODELS



## Freight Supply-Chain Modeling

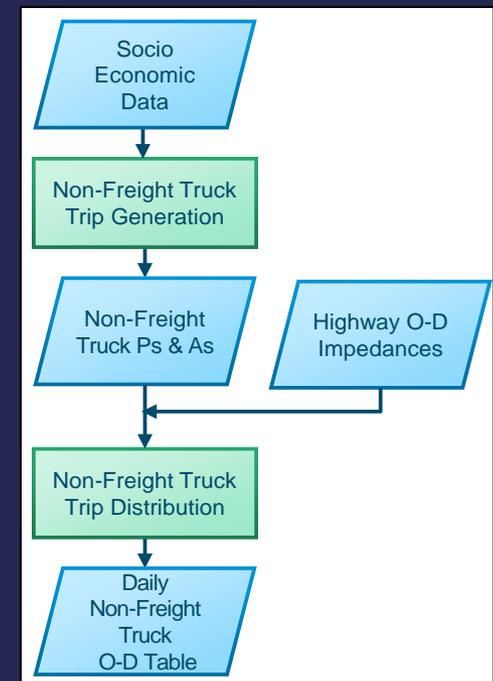
- Firm Synthesis
- Determined by the utility of each modal link or trip in the supply chain
- Considers level of service at the transfer points between trips along the supply chain (transport logistics nodes)
- Cargo is maintained throughout the entirety of the supply chain – Multimodal

## Touring Models - Non-Freight

- Vehicle and tour pattern choice
- Number of tours and stops
- Stop sequence and duration
- Delivery time of day

# NON-FREIGHT TRUCKS

- Traditional trip generation and distributions steps
- Light, Medium, and Heavy Trucks
- Generates origins and destinations (same rates for Origins and Destinations)
- Distributed using gravity models
- Combined with freight trucks to get total trucks



# ASSIGNMENT

## Assignment Type

- Preload
- Multiclass or simultaneous

## Time of Day Factors

- Trip based – splitting of trip tables

## Roadway Capacity and Congested Speeds

- Passenger Car Equivalent (PCEs)

## Truck Values of Time

- Commodity sensitively to pricing and tolls

## Truck Prohibitions

# VALIDATION

## Trip Generation

- Market sector
- Geography

## Trip Distribution

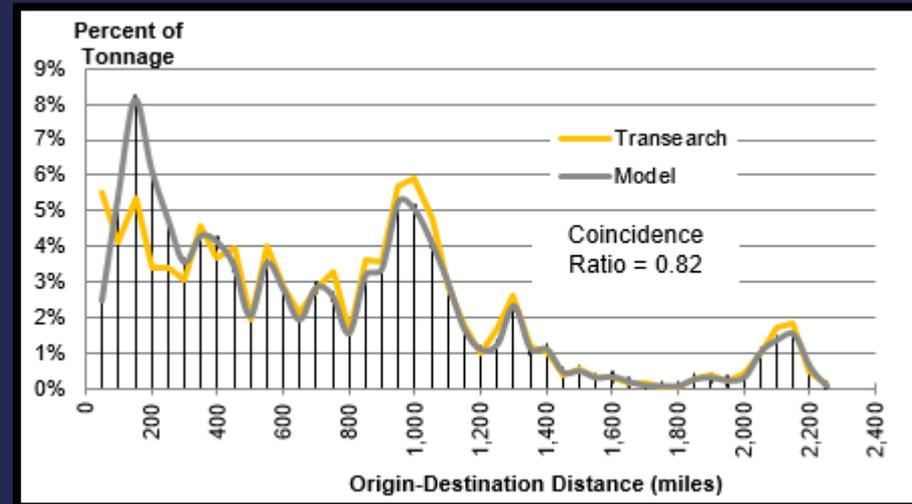
- Average trip length
- Frequency plots

## Mode Split

- Independent validation may not be possible

## Assignment

- Vehicle classification counts
- A truck is a truck, regardless of what it carries



# QRFM III PART D: APPLICATION ISSUES



- Controlling Factors: Shipment size/frequency, reliability, sensitivity to congestion and route resiliency
- Data Collection: Limited resources, transferability of parameters
- Growth Factoring: New facilities or changing markets
- Network And Zone Structure: Regions outside of the study area
- Developing and Assigning a Trip Table: Generation, Distribution, Mode Share/Choice, Flow Conversions, Assignment
- Integration with Passenger Models
- Visualization

# CASE STUDIES



- California Statewide Freight Forecasting Model
- Florida Department of Transportation Model
- Iowa Statewide Traffic Analysis and Iowa Freight Optimization Models
- Maricopa Association of Governments Model
- Memphis Metropolitan Planning Organization Truck Model
- New York Metropolitan Transportation Council Best Practice Model

# CASE STUDIES

## General Information

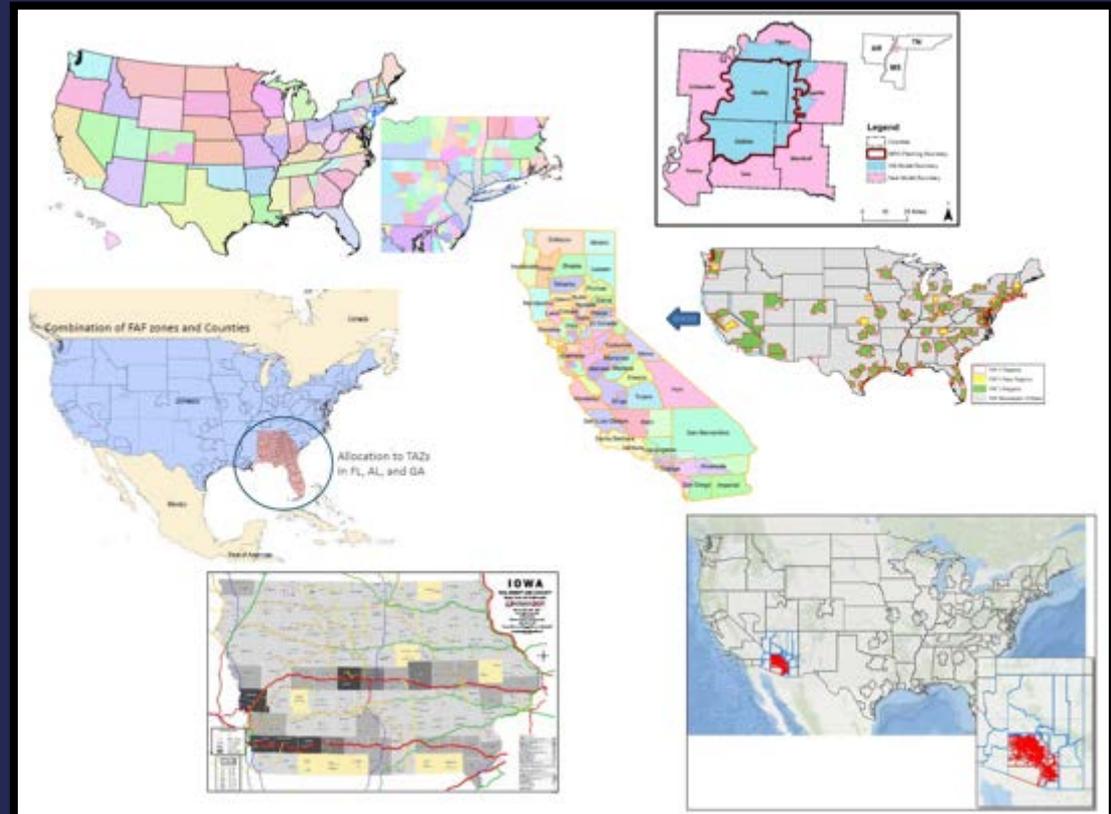
- Usage
- Methodologies

## Coverage

- Geography
- Modes
- Commodities

## Forecast Details

- Freight Table
- Non-Freight Table
- Modal Network Assignment



# CASE STUDY METHODS



## California Statewide Freight Forecasting Model

- FAF-based, four-step commodity-based model capable of capturing high-level interactions between various industries

## Florida Department of Transportation Model

- Uses supply chain and economic methods to explicitly model various aspects of freight decision making behavior

## Iowa Department of Transportation Iowa Statewide Traffic Analysis Model and Iowa Freight Optimization Model

- Integrated commodity flow, long distance, and passenger forecasting model

# CASE STUDY METHODS



## Maricopa Association of Governments Model

- Behavioral-based freight model covering the majority of the freight and truck movement in the State of Arizona

## Memphis Metropolitan Planning Organization Truck Model

- Trip-based model, considering truck freight as an external model and non-freight truck model as the internal model

## New York Metropolitan Transportation Council Best Practices Model

- Activity/tour-based model for regional demand forecasting

# INTERACTIVE WEBSITE

**Quick Response Freight Methods** Third Edition

## Inside the QRFM

### Part A. Introduction

The first three chapters of the Quick Response Freight Methods, Third Edition (QRFM) introduce the framework, methodology, and concepts discussed in this revision. Chapter 1 introduces this edition of the QRFM Chapter 2 discusses the concepts included in this third edition. Chapter 3 discusses the framework of freight forecasting, focusing on which data can be varied in freight forecasting.

### Part B. Data

Both the existing data sources that are described in chapter 4 and the new data sources that are described in chapter 5 can be collected, processed, and analyzed by agencies to support freight forecasting methods.

Both existing data and new data can be used to estimate and support the methods, but they can also be used to validate the forecasts from those methods.

### Part C. Methods

Part C presents the analysis methods in increasing order of complexity. All methods share a common framework; each requires a trip table of geographic freight demand and uses a process to assign that demand to the modal networks that serve that geographic demand.

- [Chapter 6](#) describes the simplest method, using forecasts that are prepared by others.
- [Chapter 7](#) discusses how to use existing forecasts to produce new forecasts
- [Chapter 8](#) outlines how to acquire and process freight demand.
- [Chapter 9](#) details how to develop trip based models.
- [Chapter 10](#) explores how to develop supply chain tour models.
- [Chapter 11](#) considers non-freight trucks along with freight by all modes

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You may need [Adobe® Reader®](#) to view the PDFs on this page. [Feedback](#)

# WEBSITE CONTENT NAVIGATION

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• Non-Freight Trucks	
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## Quick Response Freight Methods

Third Edition

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- [Figure 2. Diagram, Progression and complexity of freight/truck models](#)
- [Figure 3. Diagram, Federal Highway Administration 13 vehicle category classification](#)
- [Figure 4. Photo, Rail Freight](#)
- [Figure 5. Photo, Container Ship](#)
- [Figure 6. Map, Freight analysis framework zones](#)
- [Figure 7. Sample one pager, Example work day travel log](#)
- [Figure 8. Screenshot, Example of a survey smartphone application](#)
- [Figure 9. Equation, Link volume formulation](#)
- [Figure 10. Flowchart, Growth factor method example](#)
- [Figure 11. Equation, Annual growth factor definition](#)
- [Figure 12. Equation, Calculation of future freight demand based on average annual growth factor](#)
- [Figure 13. Equation, Example of an annual growth factor calculation](#)
- [Figure 14. Equation, 2020 truck trips forecast based on 2015 traffic and the annual growth factor](#)
- [Figure 15. Equation, Regression equation forecasting freight demand using the annual growth factor](#)
- [Figure 16. Equation, Example of a linear regression equation forecasting freight tons](#)
- [Figure 17. Equation, Compound annual freight growth definition](#)
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# WEBSITE – FIGURE AND TABLES

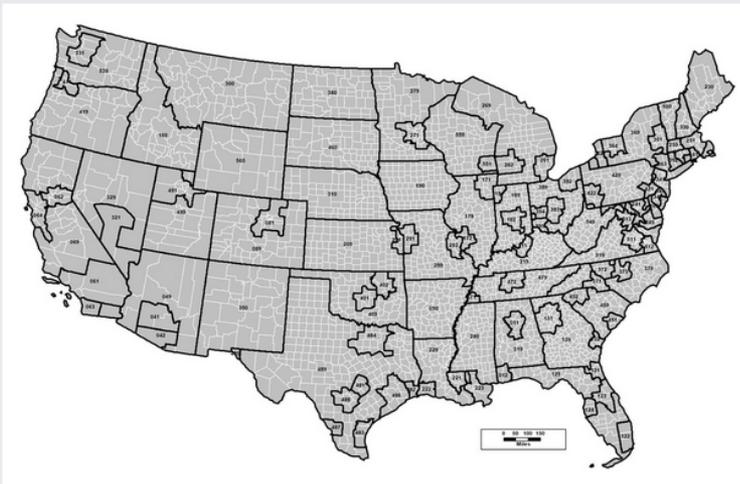
## Quick Response Freight Methods

Third Edition

### Disaggregation of Commodity Origin-Destination Tables

The commodity Q<sub>D</sub> data described in chapter 3 are available for specific geographies. In the case of the FAF, the 132 internal U.S. and 8 international regions that are available may be too coarse for estimating freight demand and usage (see figure 6). Practitioners have proposed and applied various methods to disaggregate these Q<sub>D</sub> flows into smaller geographies.

Figure 6. Map. Freight analysis framework zones.



Source: [FAF4 Network Database and Flow Assignment: 2012 and 2045](#).

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# WEBSITE – FIGURE AND TABLES

FAF4 Network Database and Flow Assignment

U.S. Department of Transportation  
Federal Highway Administration

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**FREIGHT MANAGEMENT AND OPERATIONS**

OFFICE OF OPERATIONS 21<sup>ST</sup> CENTURY OPERATIONS USING 21<sup>ST</sup> CENTURY TECHNOLOGIES

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Truck Size and Weight

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## FAF4 Network Database and Flow Assignment: 2012 and 2045

The Freight Analysis Framework (FAF) network assignment estimates commodity movements by truck over specific highways. Models are used to disaggregate interregional flows from the Origin-Destination Database into flows between localities and to assign these flows to individual highways using average payloads per truck, and truck counts on individual highway segments. Using route number and milepost, functional classification of the highway, number of lanes, and other highway characteristics for individual highway links, truck tonnage is assigned to the network segments. Models used to disaggregate flows are based on geographic distributions of economic activity rather than a detailed understanding of local conditions and the resulting network flows should not be used as a substitute for local data to support local planning and project development.

### Network Data

If you have GIS software, download the network and boundary layers that correspond to your GIS software:

- Network
  - ESRI Format (shapefile):
    - [faf4\\_esri\\_arcgis.zip](#) [Zip 177 MB]
    - [assignment\\_results](#) [Zip 33 MB]
    - [gis\\_metadata.txt](#) [TXT 26 KB]
  - TransCAD Format: [faf4\\_transcad.zip](#) [Zip 61 MB]
  - [data\\_attributes\\_definition](#) [Zip 124 KB]
- FAF4 Regions Boundary Layer
  - [CFS Area \(shapefile\)](#) [Zip 66 MB]

To use the results in software other than GIS, download the FAF Output database file.

- FAF Output
  - [Network Data](#) [Zip 21 MB]
  - [assignment\\_results](#) [Zip 33 MB]
  - [data\\_attributes\\_definition](#) [ZIP 124 KB]

PDF files can be viewed with the [Acrobat® Reader®](#).

If you need a version of a Zip extracting tool, you may use [WinZip®](#) as an option.

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United States Department of Transportation - Federal Highway Administration

Last modified: November 5, 2018

# WEBSITE – SEARCH FUNCTION

Quick Response Freight Methods

Third Edition

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- [Chapter 1. Introduction](#)
- [Chapter 9. Trip-Based Freight Forecasting](#)
- [List of Acronyms](#)
- [Technical Report Documentation Page](#)
- [Chapter 5. Local Data Collection](#)
- [Chapter 12. Applications Issues](#)
- [Chapter 8. Direct Acquisition of Commodity Flows](#)
- [Chapter 10. Freight Supply Chain and Non-Freight Truck Tour Forecasting](#)
- [Chapter 4. Existing Data](#)
- [Chapter 6. Existing Forecasts](#)
- [Chapter 7. Growth Factor Methods](#)
- [Chapter 2. Freight Forecasting: History and Definitions](#)
- [Chapter 13. Case Studies](#)

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## Search the QRFM

KEYWORD SEARCH

FAF

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# Q&A

via Chat Pod and Phone

# SUMMARY



- Informational and descriptive resource
- Broad audience of planners
- Data sources and analysis methods
- QRFM availability
  - Hard copy print version
  - Downloadable PDF  
<https://ops.fhwa.dot.gov/freight/resources/bookshelf/index.cfm>
  - Interactive website

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[QRFM@dot.gov](mailto:QRFM@dot.gov)