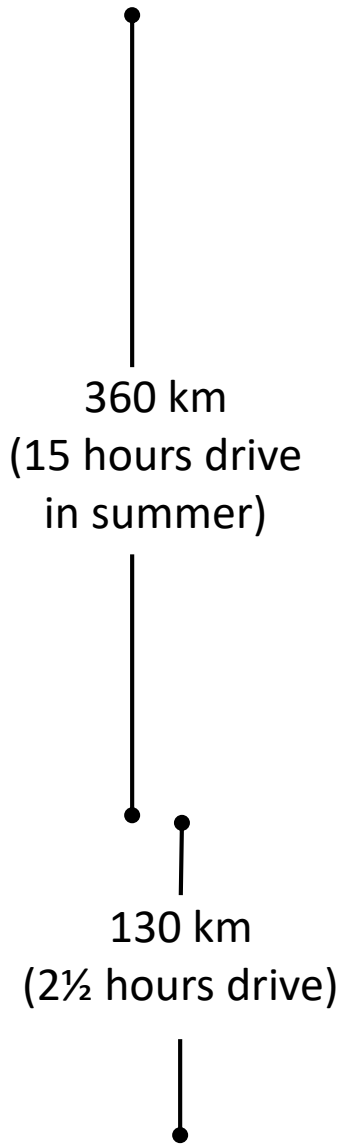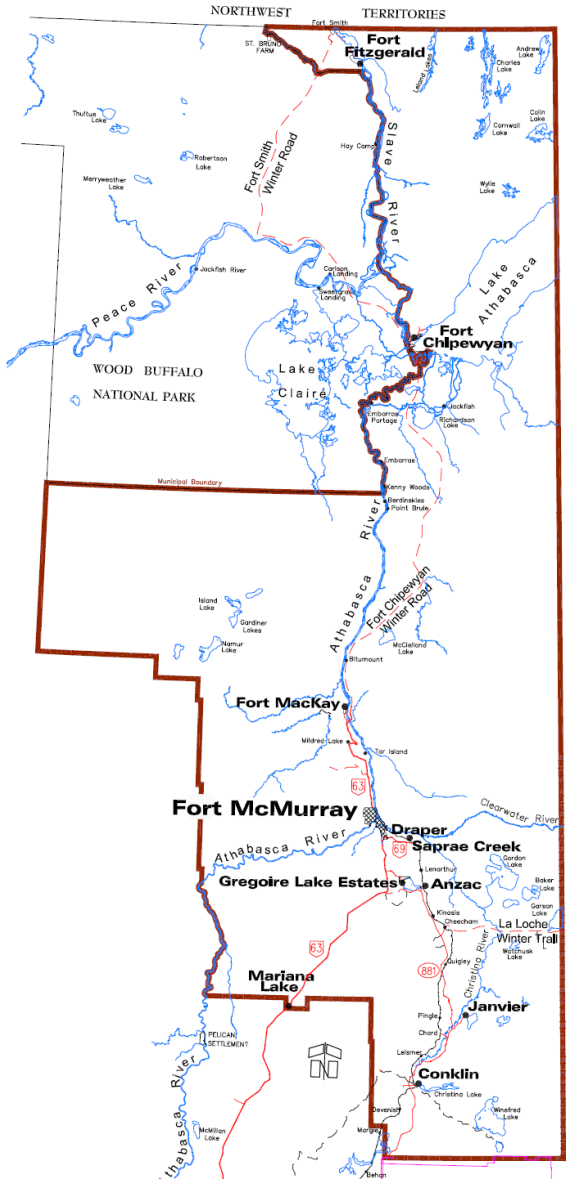# An Atypical RTM - Development of the RM of Wood Buffalo Regional Travel Model
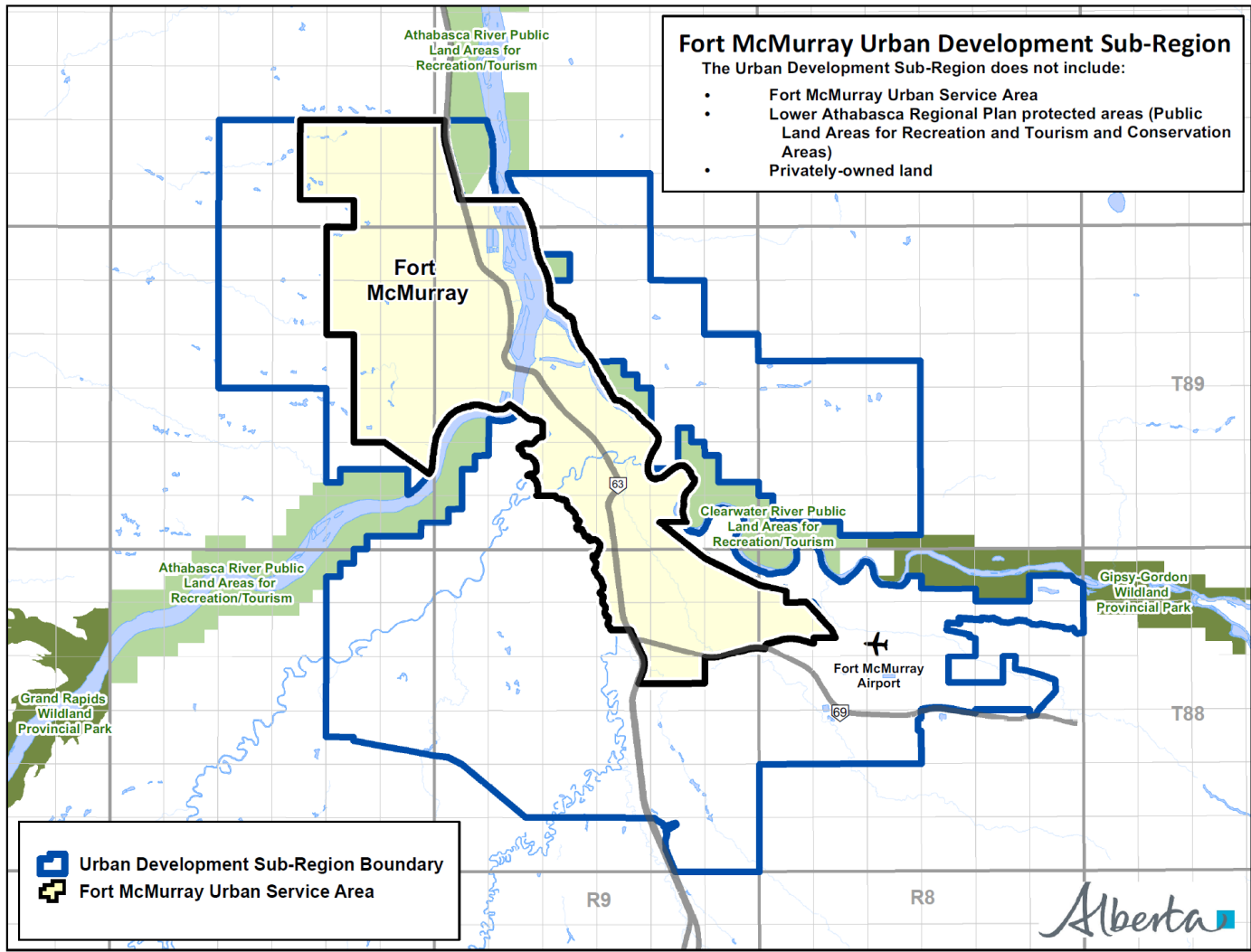

Jason Hawkins EIT, MSc
Presentation to University of Toronto Chapter of ITE – September 29, 2017
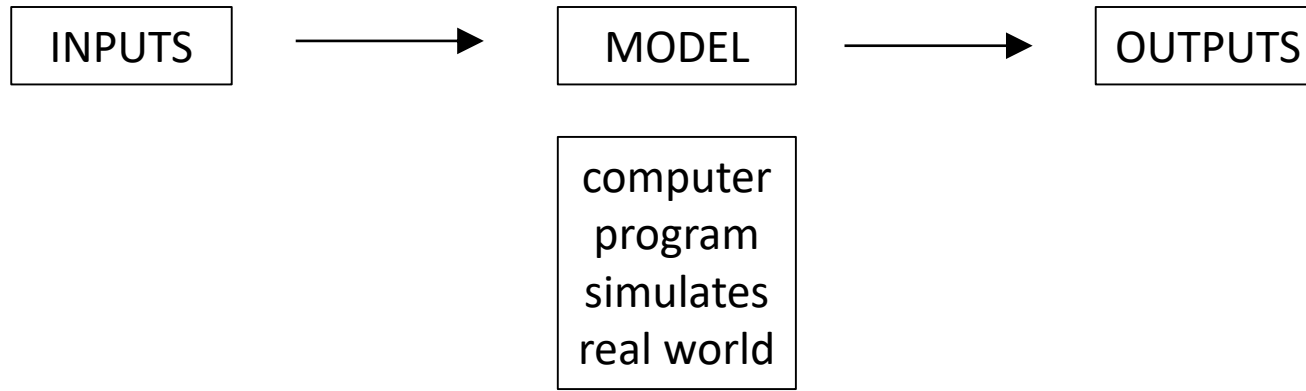
Study Area: Overall

360 km
(15 hours drive
in summer)

130 km
(2½ hours drive)

Study Area: UDSR

Fort McMurray Urban Development Sub-Region

The Urban Development Sub-Region does not include:

- Fort McMurray Urban Service Area
- Lower Athabasca Regional Plan protected areas (Public Land Areas for Recreation and Tourism and Conservation Areas)
- Privately-owned land

Athabasca River Public Land Areas for Recreation/Tourism

Fort McMurray

Clearwater River Public Land Areas for Recreation/Tourism

Athabasca River Public Land Areas for Recreation/Tourism

Gipsy-Gordon Wildland Provincial Park

Grand Rapids Wildland Provincial Park

Fort McMurray Airport

Urban Development Sub-Region Boundary
Fort McMurray Urban Service Area

Alberta

What is a Transportation Model?

What is a Transportation Model?

| INPUTS | → | MODEL | → | OUTPUTS |

What is a Transportation Model?

INPUTS → MODEL → OUTPUTS

computer program simulates real world

What is a Transportation Model?

INPUTS ⟶ MODEL ⟶ OUTPUTS

computer descriptions of:

computer
program
simulates
real world

What is a Transportation Model?

INPUTS → MODEL → OUTPUTS

computer descriptions of:

population → computer program simulates real world

What is a Transportation Model?

| INPUTS | → | MODEL | → | OUTPUTS |

computer descriptions of:

computer program simulates real world

population

employment

What is a Transportation Model?

| INPUTS | → | MODEL | → | OUTPUTS |

computer descriptions of:

population

employment

computer program simulates real world

transportation policy

transportation infrastructure

What is a Transportation Model?

INPUTS ⟶ MODEL ⟶ OUTPUTS

computer descriptions of:

computer program simulates real world

simulations of:

population

employment

transportation policy

transportation infrastructure

What is a Transportation Model?

INPUTS	→	MODEL	→	OUTPUTS

computer descriptions of:

population

employment

transportation policy

transportation infrastructure

MODEL: computer program simulates real world

simulations of:

travel: trips, tours, modes and times

What is a Transportation Model?

INPUTS	→	MODEL	→	OUTPUTS

computer descriptions of:

population

employment

transportation policy

transportation infrastructure

computer program simulates real world

simulations of:

travel: trips, tours, modes and times

vehicle flows on roads and persons using transit

What is a Transportation Model?

INPUTS → MODEL → OUTPUTS

computer descriptions of:

population

employment

transportation policy

transportation infrastructure

computer program simulates real world

simulations of:

travel: trips, tours, modes and times

vehicle flows on roads and persons using transit

congestion and levels of service (LoS)

What is a Transportation Model?

| INPUTS | → | MODEL | → | OUTPUTS |

computer descriptions of:

population

employment

transportation policy

transportation infrastructure

computer program simulates real world

simulations of:

travel: trips, tours, modes and times

vehicle flows on roads and persons using transit

congestion and levels of service (LoS)

transportation emissions

Specific Model Uses for RMWB

Alternatives Analysis in Support of Identified Planning Goals

- R.2.1: Develop Rapid Transit – to encourage permanent residency in the region by reducing commuting time from communities to oil sands operations throughout the region

- R.2.2: Expand Regional Road Transportation Systems – to facilitate the efficient movement of people and goods throughout the region and to connect to outside markets

- R.2.3: Explore Expansion of Rail Transportation – to potentially provide alternative land transportation options for both shipping and passenger travel use

- R.2.4: Support Aerodromes to Facilitate Remote Access – to help promote safe and efficient use of air transport

- R.2.5: Support the Development of Multi-Use Corridors – to develop integrated mobility solutions for people, goods and services
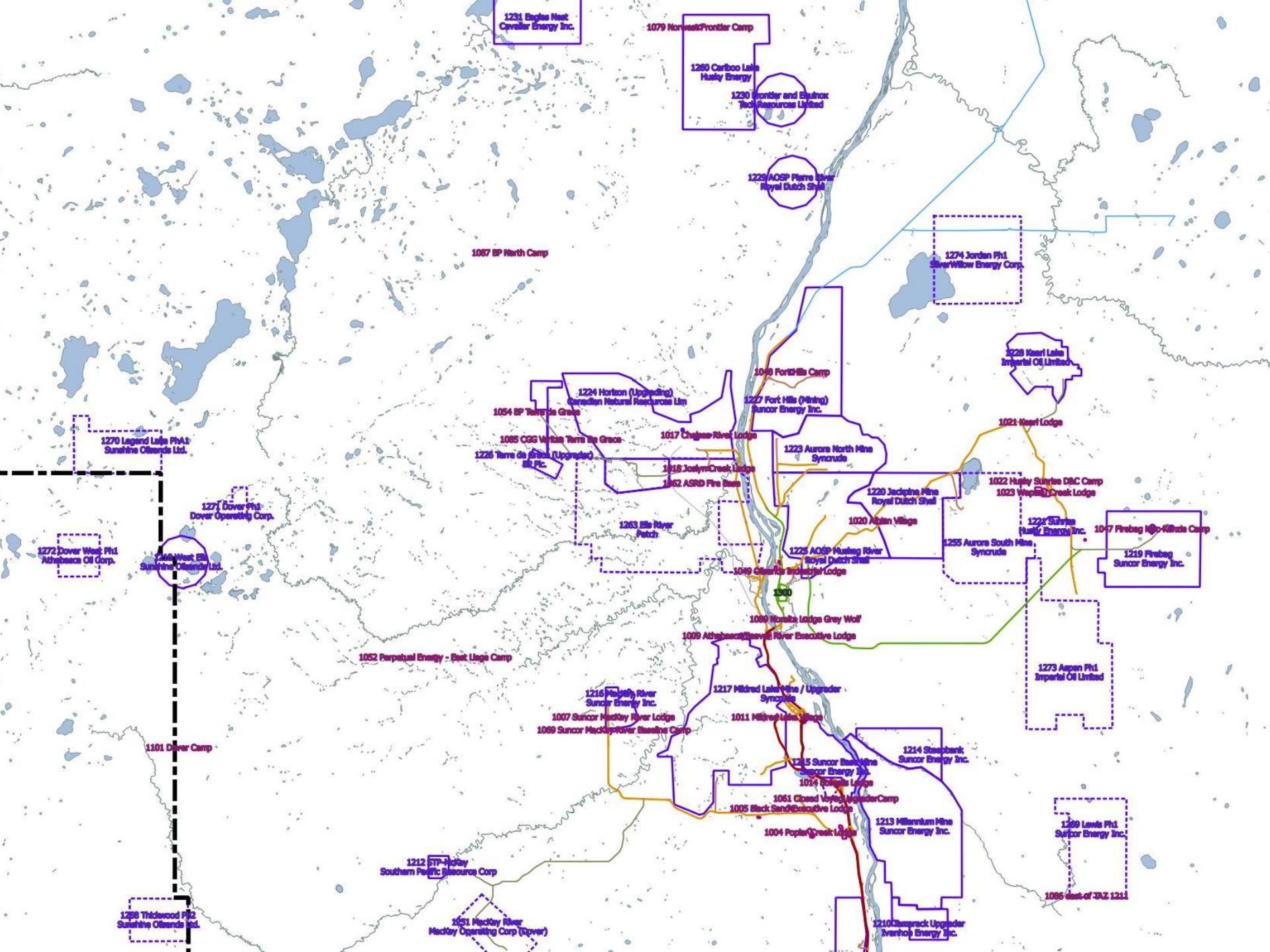
Specific Model Uses for RMWB

To support a number of transportation planning activities, including:

- Traffic forecasting (private, transit and truck)
- Future volumes and flows for road design
- Corridor analysis
- Investment studies
- Interchange evaluations
- External and through trip analysis
- Pavement Management System
- Safety analysis
- Transit network planning

Zones

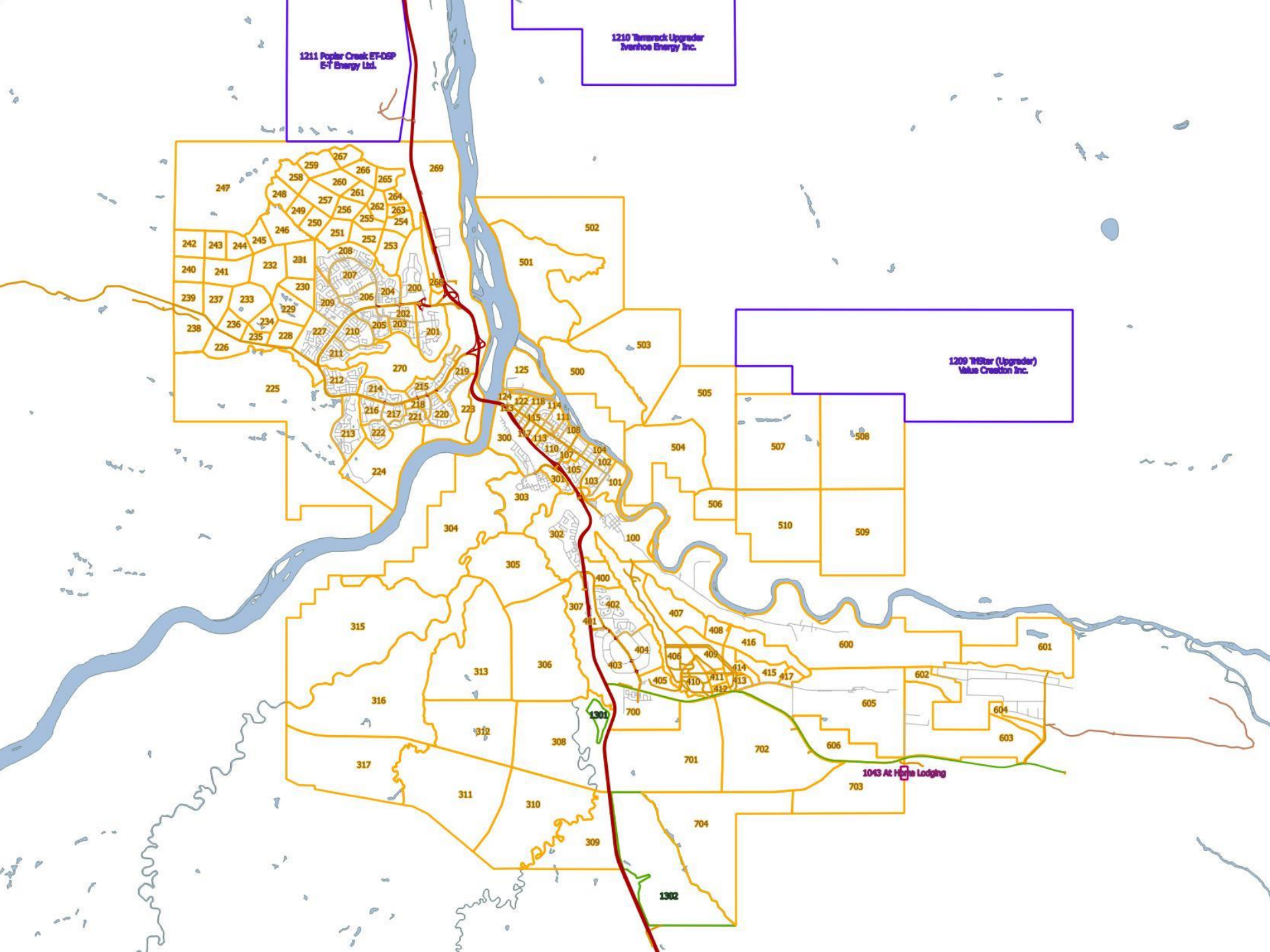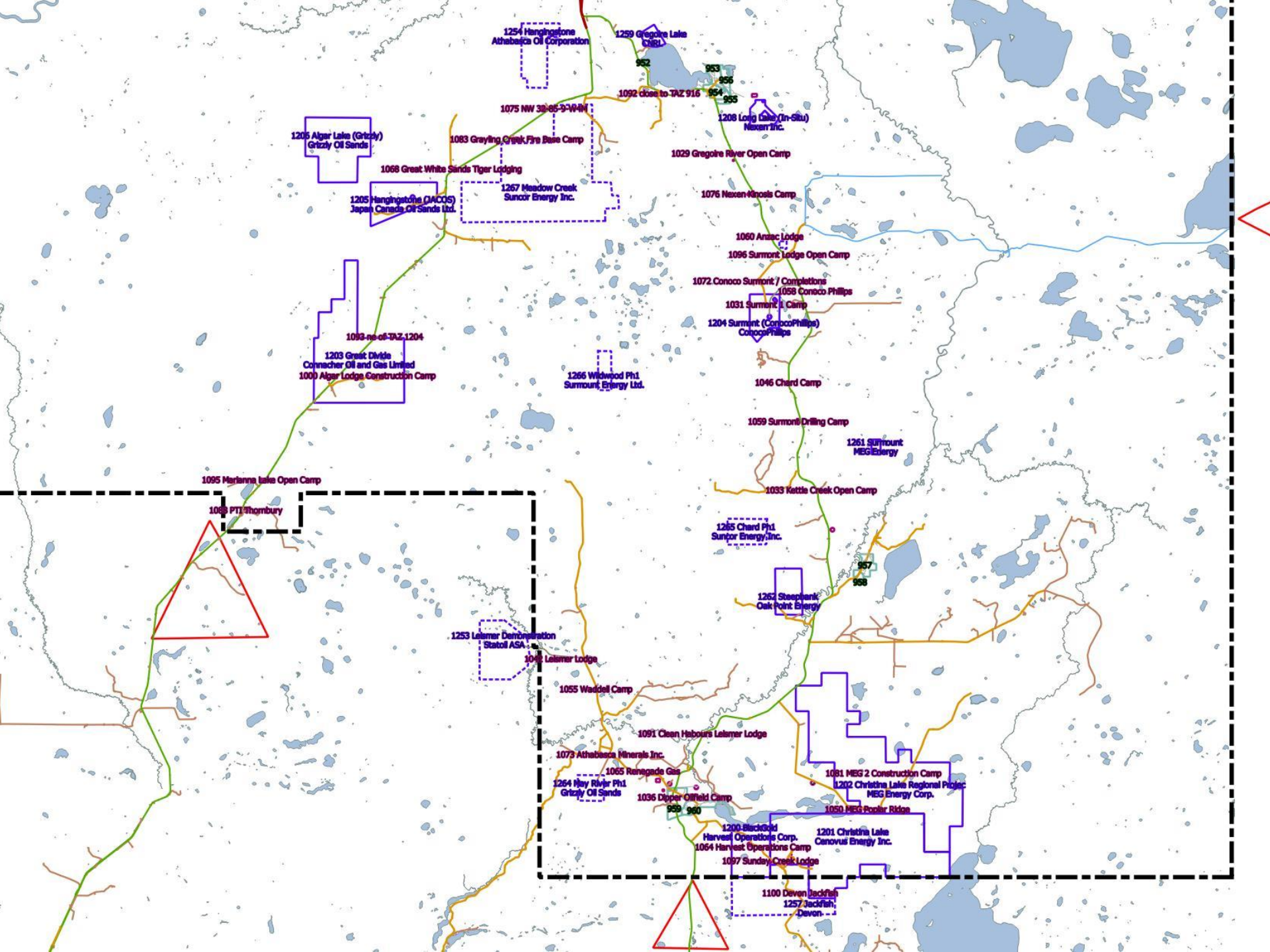- Study area divided into "zones" for analysis purposes
- Special zones:
  - Plants
  - Camps
  - External

1231 Eagles Nest
Cavalier Energy Inc.

1079 Norwest/Frontier Camp

1260 Cariboo Lake
Husky Energy

1230 Frontier and Equinox
Tech Resources Limited

1229 AOSP Pierre River
Royal Dutch Shell

1087 BP North Camp

1274 Jorden Ph1
SilverWillow Energy Corp.

1048 Fort Hills Camp

1226 Kearl Lake
Imperial Oil Limited

1224 Horizon (Upgrading)
Canadian Natural Resources Lim

1227 Fort Hills (Mining)
Suncor Energy Inc.

1054 BP Terre de Grace

1021 Kearl Lodge

1270 Legend Lake Ph1
Sunshine Oilsands Ltd.

1085 CGG Veritas Terre de Grace

1017 Chelsea River Lodge

1223 Aurora North Mine
Syncrude

1228 Terre de Grace (Upgrading)
BP Plc.

1018 Joslyn Creek Lodge

1022 Husky Sunrise D&C Camp
1023 Wapisiw Creek Lodge

1271 Dover Ph1
Dover Operating Corp.

1062 ASRD Fire Base

1220 Jackpine Mine
Royal Dutch Shell

1221 Sunrise
Husky Energy Inc.

1047 Firebag Nisu-Kihcis Camp

1263 Ells River
Patch

1020 Albian Village

1272 Dover West Ph1
Athabasca Oil Corp.

1268 West Ells
Sunshine Oilsands Ltd.

1255 Aurora South Mine
Syncrude

1219 Firebag
Suncor Energy Inc.

1225 AOSP Muskeg River
Royal Dutch Shell

1049 Glacier Technician Lodge

1300

1089 Noralta Lodge Grey Wolf

1009 Athabasca/Beaver River Executive Lodge

1273 Aspen Ph1
Imperial Oil Limited

1052 Perpetual Energy - East Lags Camp

1216 MacKay River
Suncor Energy Inc.

1217 Mildred Lake Mine / Upgrader
Syncrude

1101 Dover Camp

1007 Suncor MacKay River Lodge
1069 Suncor MacKay River Baseline Camp

1011 Mildred Lake Village

1214 Steepbank
Suncor Energy Inc.

1215 Suncor Baseline
Suncor Energy Inc.

1014 Borealis Lodge

1061 Closed Voyageur Upgrader Camp

1269 Lewis Ph1
Suncor Energy Inc.

1005 Black Sand Executive Lodge

1004 Poplar Creek Lodge

1213 Millennium Mine
Suncor Energy Inc.

1212 STP-McKay
Southern Pacific Resource Corp

1086 east of TAZ 1211

1258 Thickwood Ph2
Sunshine Oilsands Ltd.

1051 MacKay River
MacKay Operating Corp (Dover)

1210 Dimerock Upgrader
Ivenhoe Energy Inc.

1254 Hangingstone
Athabasca Oil Corporation

1259 Gregoire Lake
CNRL

952

953
956
954 955

1092 close to TAZ 916

1208 Long Lake (In-Situ)
Nexen Inc.

1075 NW 38-85-3-WHM

1206 Algar Lake (Grizdy)
Grizzly Oil Sands

1083 Grayling Creek Fire Base Camp

1029 Gregoire River Open Camp

1076 Nexen Kinosis Camp

1068 Great White Sands Tiger Lodging

1267 Meadow Creek
Suncor Energy Inc.

1060 Anzac Lodge

1096 Surmont Lodge Open Camp

1205 Hangingstone (JACOS)
Japan Canada Oil Sands Ltd.

1072 Conoco Summit / Completions

1058 Conoco Phillips

1031 Surmont 1 Camp

1204 Surmont (ConocoPhillips)
ConocoPhillips

1093-ne-of-TAZ 1204

1203 Great Divide
Connacher Oil and Gas Limited

1000 Algar Lodge Construction Camp

1266 Wildwood Ph1
Surmont Energy Ltd.

1046 Chard Camp

1059 Surmont Drilling Camp

1261 Surmount
MEG Energy

1095 Marianna Lake Open Camp

1033 Kettle Creek Open Camp

1088 PTI Thornbury

1265 Chard Ph1
Suncor Energy Inc.

957
958

1262 Steepbank
Oak Point Energy

1253 Leismer Demonstration
Statoil ASA

1042 Leismer Lodge

1055 Waddell Camp

1091 Clean Habours Leismer Lodge

1073 Athabasca Minerals Inc.

1081 MEG 2 Construction Camp

1065 Renegade Gas

1202 Christina Lake Regional Projec
MEG Energy Corp.

1264 May River Ph1
Grizzly Oil Sands

1036 Dipper Oilfield Camp

959 960

1050 MEG Poplar Ridge

1200 BlackGold
Harvest Operations Corp.

1201 Christina Lake
Cenovus Energy Inc.

1064 Harvest Operations Camp

1097 Sunday Creek Lodge

1100 Devon Jackfish

1257 Jackfish
Devon

Modes

- Auto:
  - Single Occupant Vehicle
  - HOV (2 person and 3+)
- Transit:
  - Public transit
  - Work bus
  - Park and ride (future)
- Active:
  - Walk
  - Bike

- Light commercial vehicles
- Medium commercial vehicles (single unit trucks)
- Heavy commercial vehicles (tractor-trailer)

11 Time Periods

- Off-peak:
  - Midnight to 5 AM
- AM Peak:
  - 5 to 6 AM
  - 6 to 7 AM
  - 7 to 8 AM
  - 8 to 9 AM
- Midday:
  - 9 AM to 4 PM

- PM Peak:
  - 4 to 5 PM
  - 5 to 6 PM
  - 6 to 7 PM
  - 7 to 8 PM
- Off-Peak:
  - 8 PM to midnight

How Does The Model Work?

Worker Allocation
Sub-Model

Personal Travel
Sub-Model

Commercial Vehicles
Sub-Model

Airport Special Generator
Sub-Model

External Vehicles
Sub-Model

Traffic Assignment
Sub-Model

Vehicle Emissions
Sub-Model
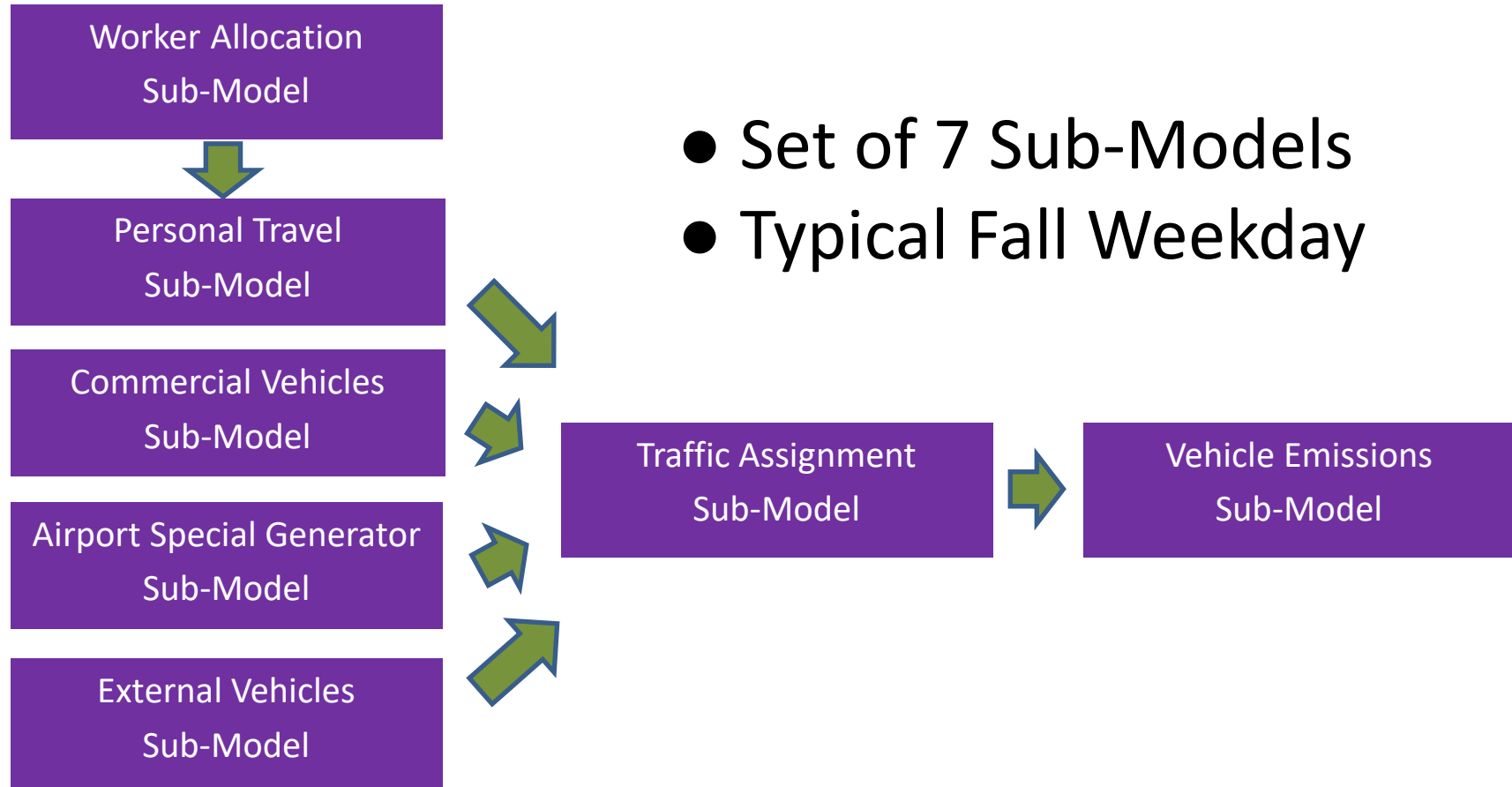
- Set of 7 Sub-Models
- Typical Fall Weekday

- Represent different aspects of transportation demand and the impacts of transportation

HOUSEHOLDS
and
PEOPLE
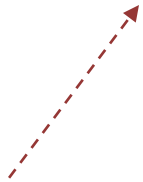
Personal Travel
Sub-Model

HOUSEHOLDS
and
PEOPLE
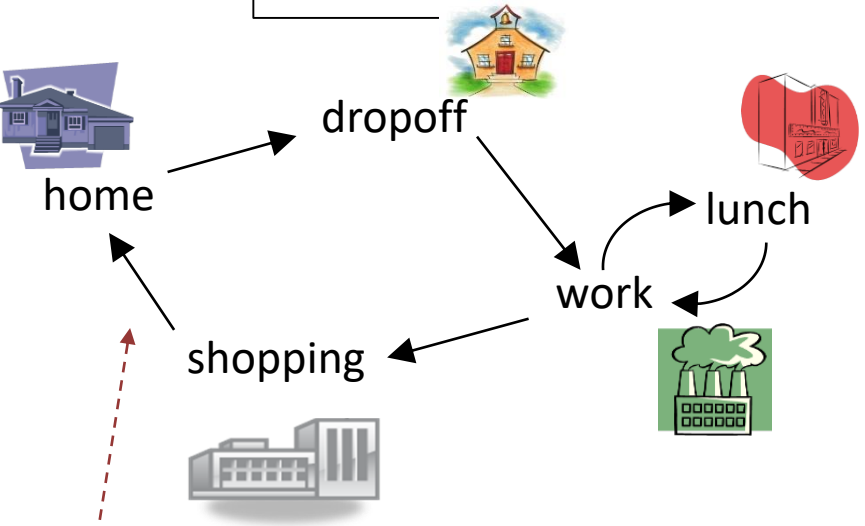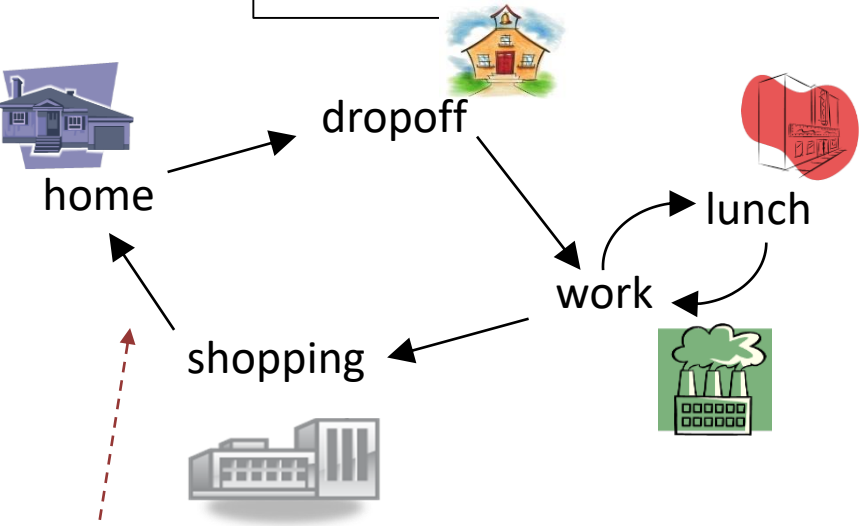
home

dropoff

lunch

work

shopping

trips
- start time
- end time
- mode

HOUSEHOLDS
and
PEOPLE

EMPLOYEES
at
WORKPLACES

home

dropoff

lunch

work

shopping

Commercial Vehicles
Sub-Model

*trips
- start time
- end time
- mode*

HOUSEHOLDS
and
PEOPLE

EMPLOYEES
at
WORKPLACES

dropoff

home

lunch

work

shopping
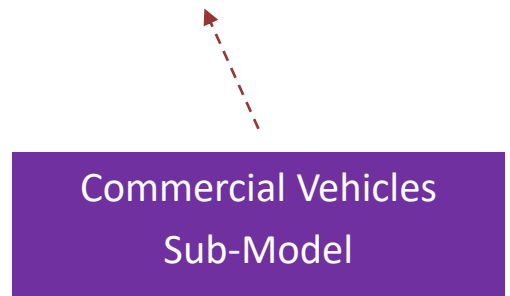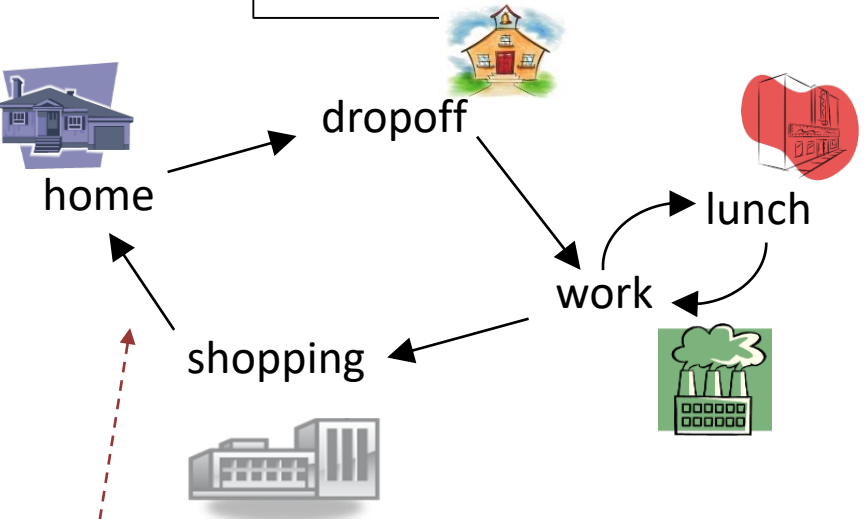
establishment

trips
- start time
- end time
- mode

Establishments

- Oil Sands Plants

- Other Industrial

- Manufacturing

- Retail

- Services

- Transportation and Handling

- Government

- Airport

HOUSEHOLDS
and
PEOPLE
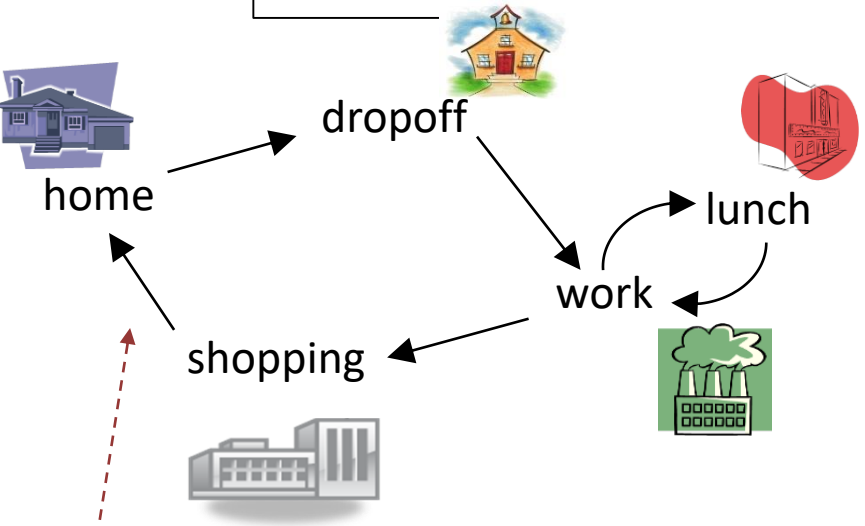
EMPLOYEES
at
WORKPLACES

dropoff

home

lunch

establishment

work

shopping

trips
- start time
- end time
- mode

HOUSEHOLDS
and
PEOPLE

EMPLOYEES
at
WORKPLACES

home

dropoff

lunch

work

shopping

client 1

client 2

establishment

inputs to
production

trips
- start time
- end time
- mode

to

from
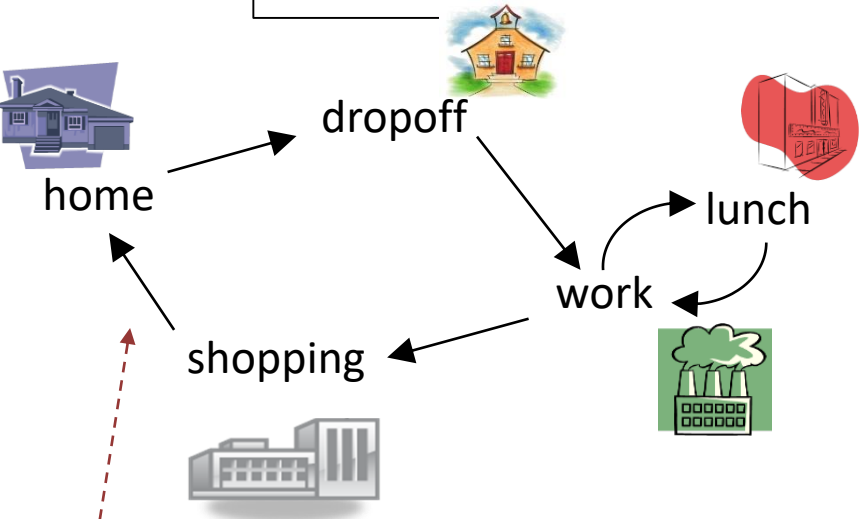
trips
- start time
- end time
- mode
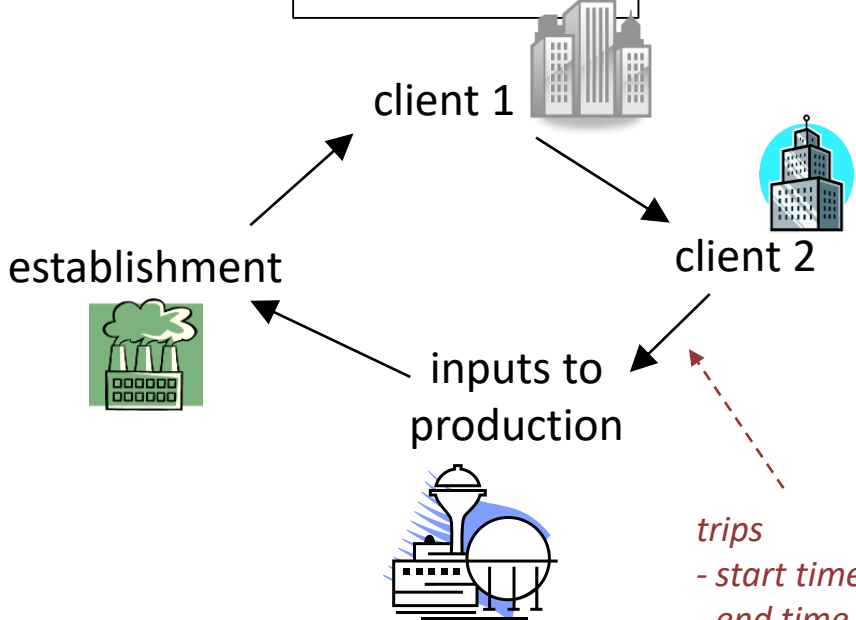
trip tables
- origin
- destination
- start time
- end time
- mode
- vehicle type
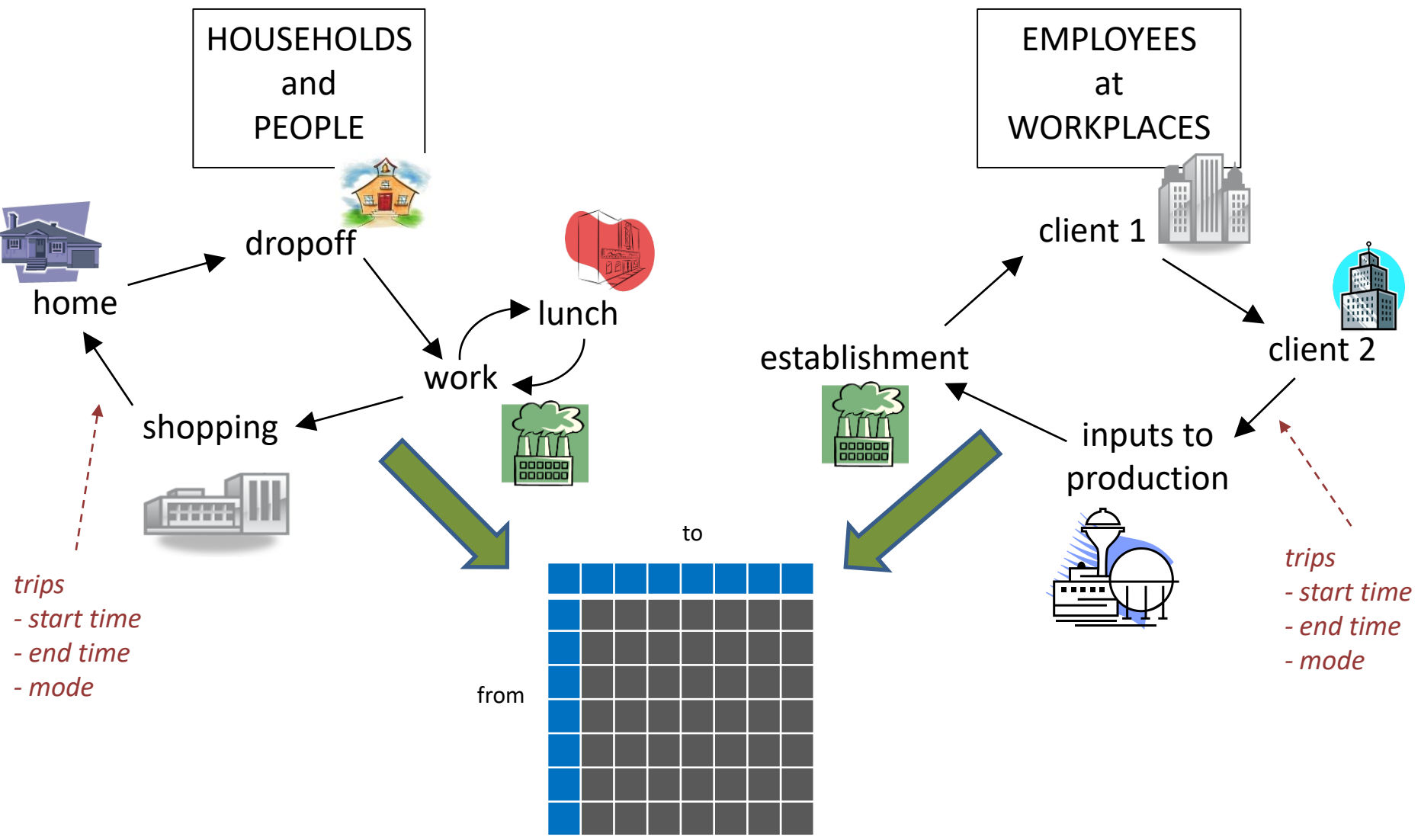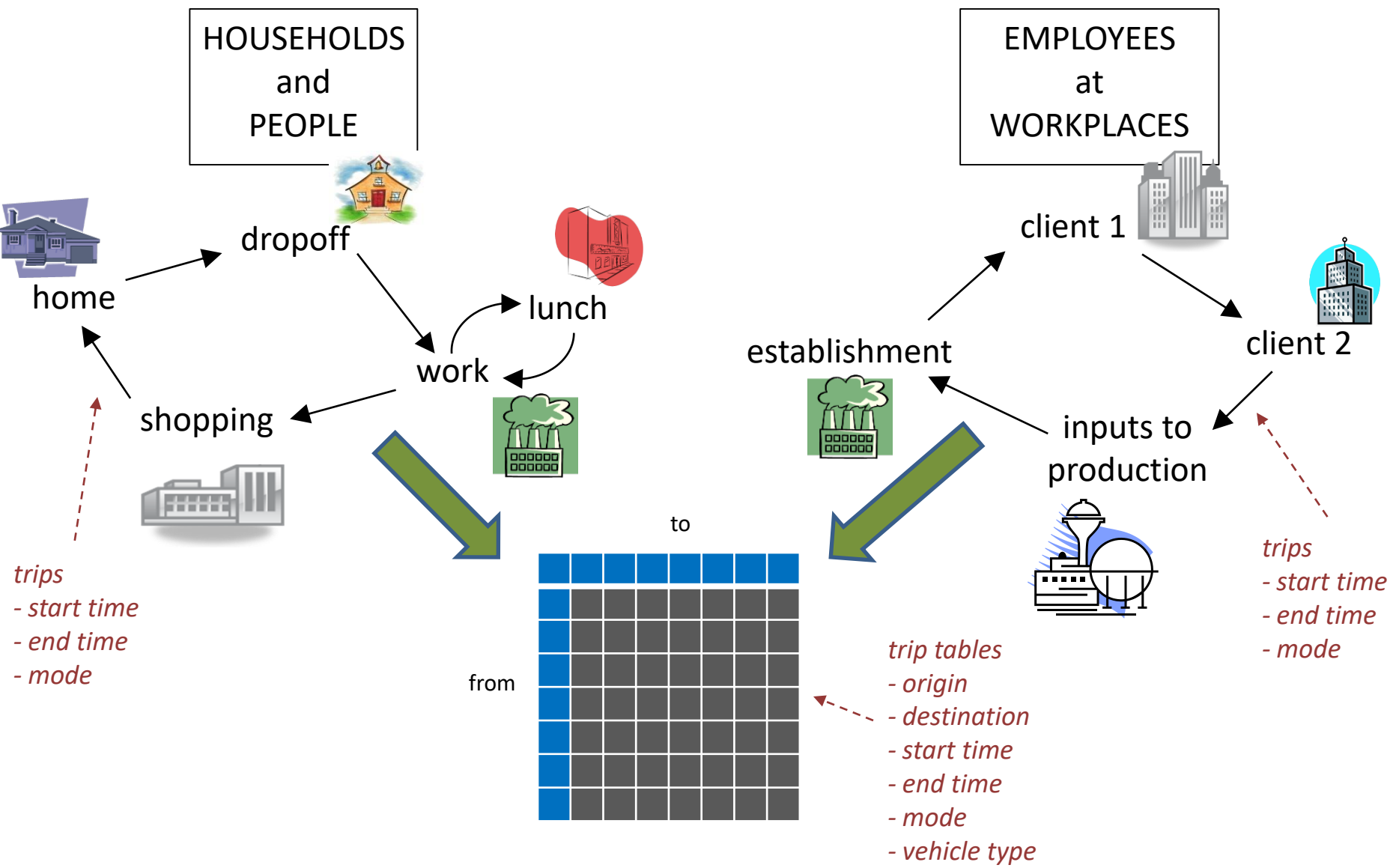
Worker Allocation Sub-Model

- Workers working in plants:
  - Living in camps
  - Living outside camps
- Connects workers to home and work location
- Incorporates plant-specific shift patterns

Model inputs

- Population

- Employment

- Networks

- Plant operation details

Model inputs

- Population
  - Households and persons at home end
  - Camp residences
- Employment
- Networks
- Plant operation details

Model inputs

- Population

- Employment
  - Employment by industry
  - School enrolment by level

- Networks

- Plant operation details

Model inputs

- Population

- Employment

- Networks

  - Road

  - Transit

- Plant operation details

Model inputs

- Population

- Employment

- Networks

- Plant operation details

    - Plant employment

    - Shift time periods

Model inputs

- Population

- Employment

- Networks

- Plant operation details

- Need above for present "base" year and future scenarios
  - RSAS report key source for future scenarios
  - AT for strategic roadway improvements

Counts
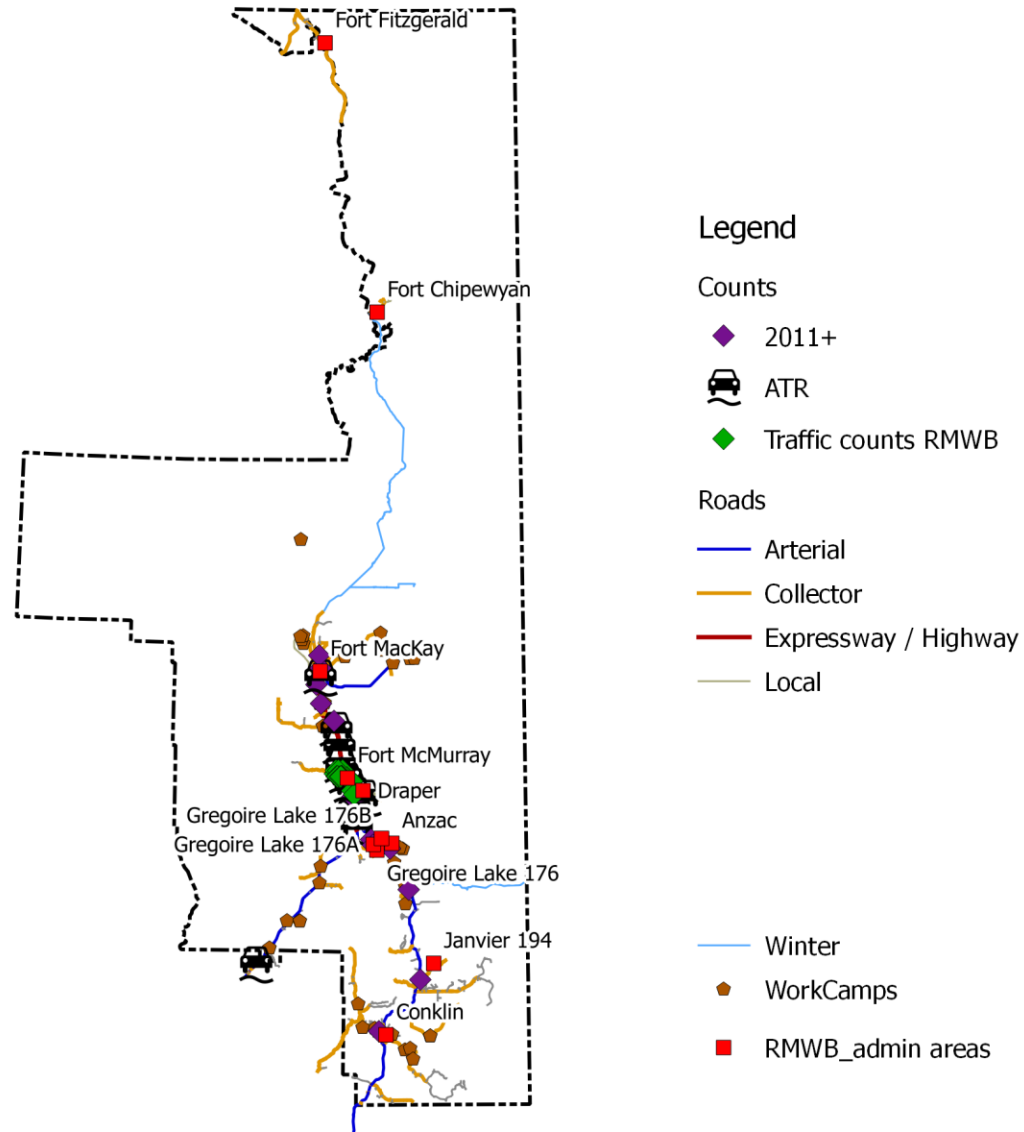
Counts
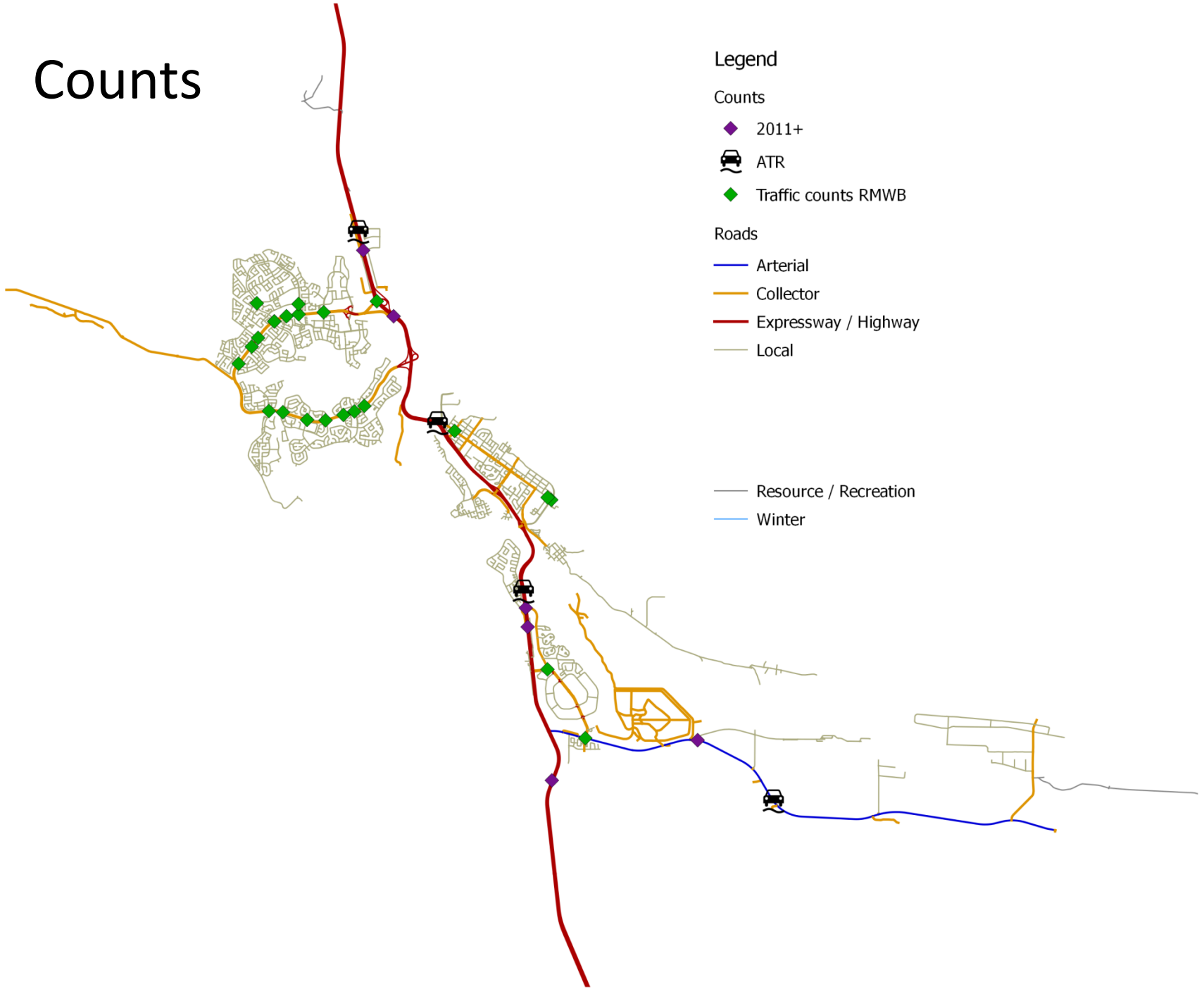
Legend

Counts

◆ 2011+

🚗 ATR

◆ Traffic counts RMWB

Roads

— Arterial

— Collector

— Expressway / Highway

— Local

— Resource / Recreation

— Winter

Traffic Flow by Time of Day

Hwy 63 @ Athabasca River 2-Way Hourly Flow
Wednesday, Sept 14, 2011
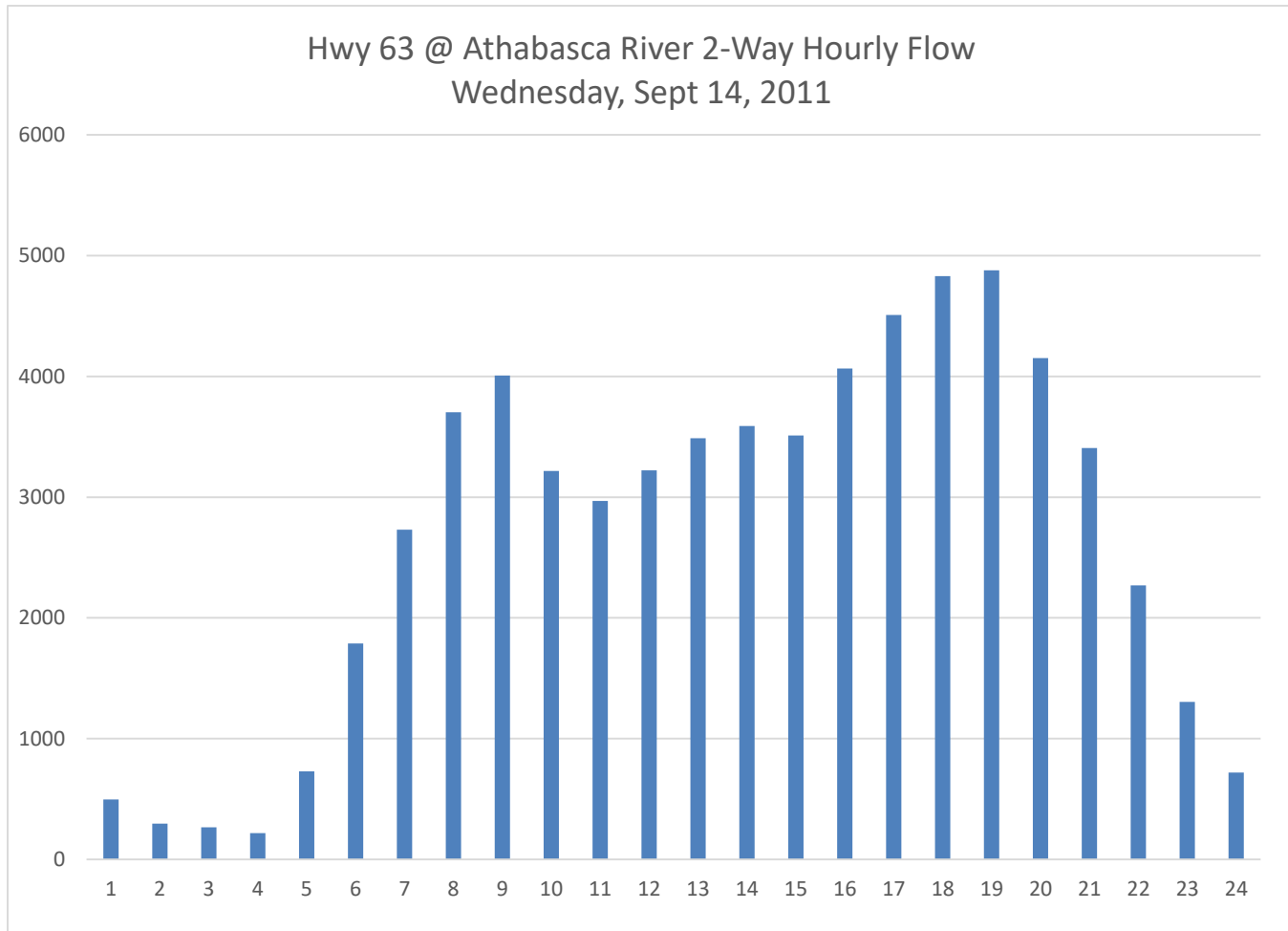
RMWB Household Travel Survey

Driver's license rate by age
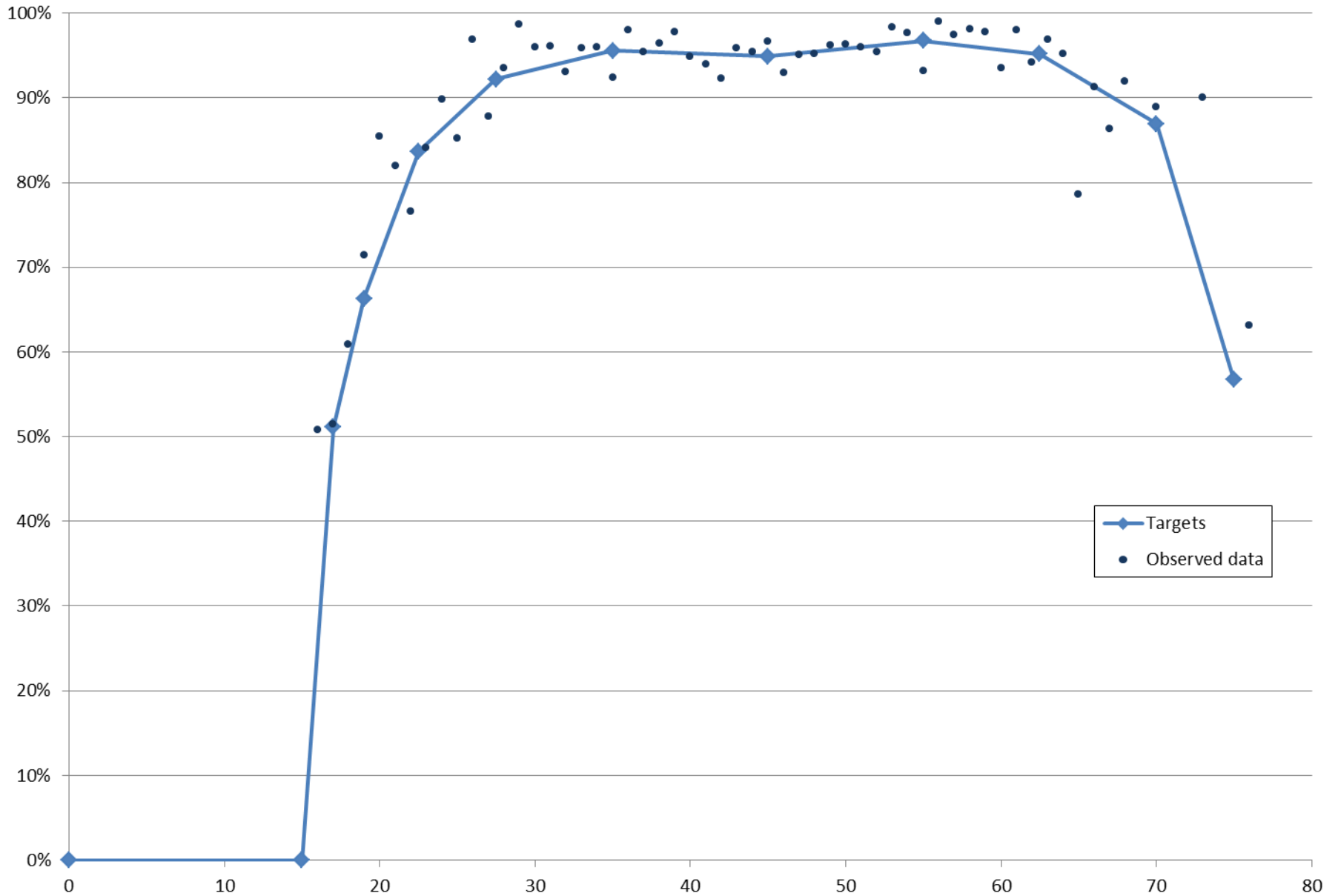
Tour Mode Choice
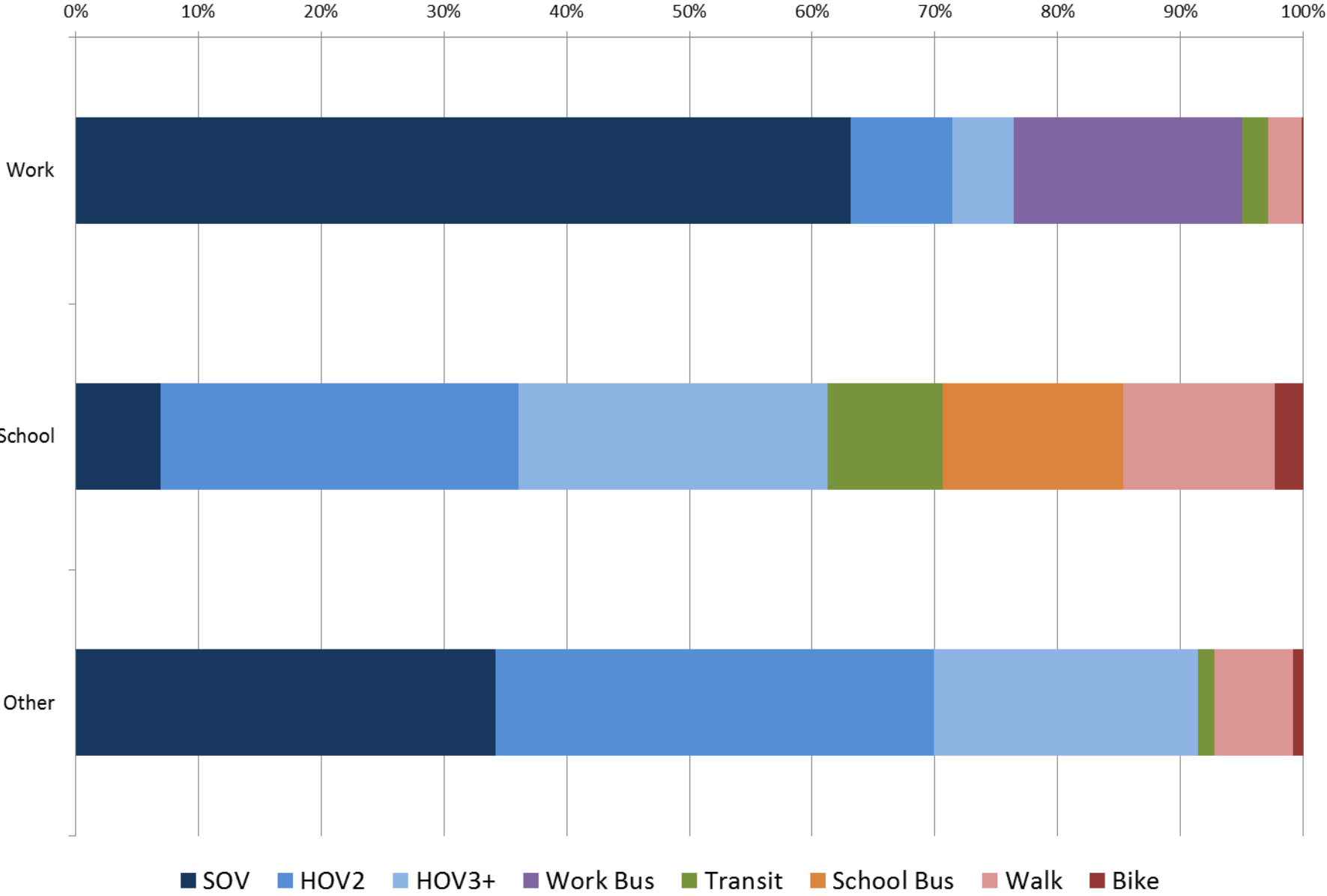
Legend: SOV, HOV2, HOV3+, Work Bus, Transit, School Bus, Walk, Bike

Tour Mode Choice

| | Work - Nonplant | Work - Plant | School - Preschool/daycare | School - Elem./Jr. High | School - High school | School - PSE | Other - Escort | Other - Shop | Other - Personal Business | Other - Social / Recreation | Other - Eat |
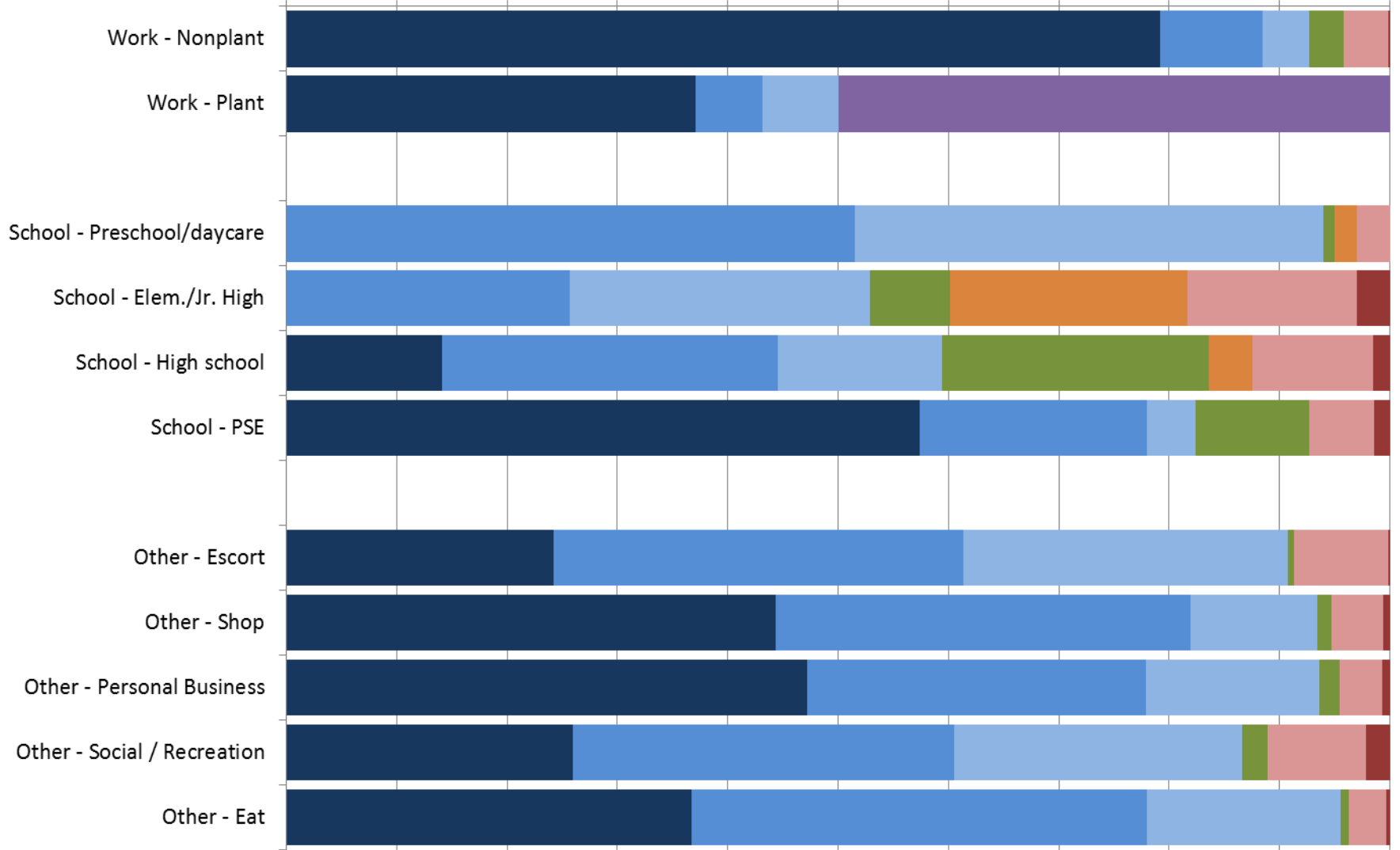
Legend: ■ SOV ■ HOV2 ■ HOV3+ ■ Work Bus ■ Transit ■ School Bus ■ Walk ■ Bike

Auto ownership by number of drivers

Legend: 0 vehicles · 1 vehicle · 2 vehicles · 3 vehicles · 4 vehicles · 5+ vehicles

Categories: 1 driver (Target, Model), 2 drivers (Target, Model), 3 drivers (Target, Model), 4 drivers (Target, Model)
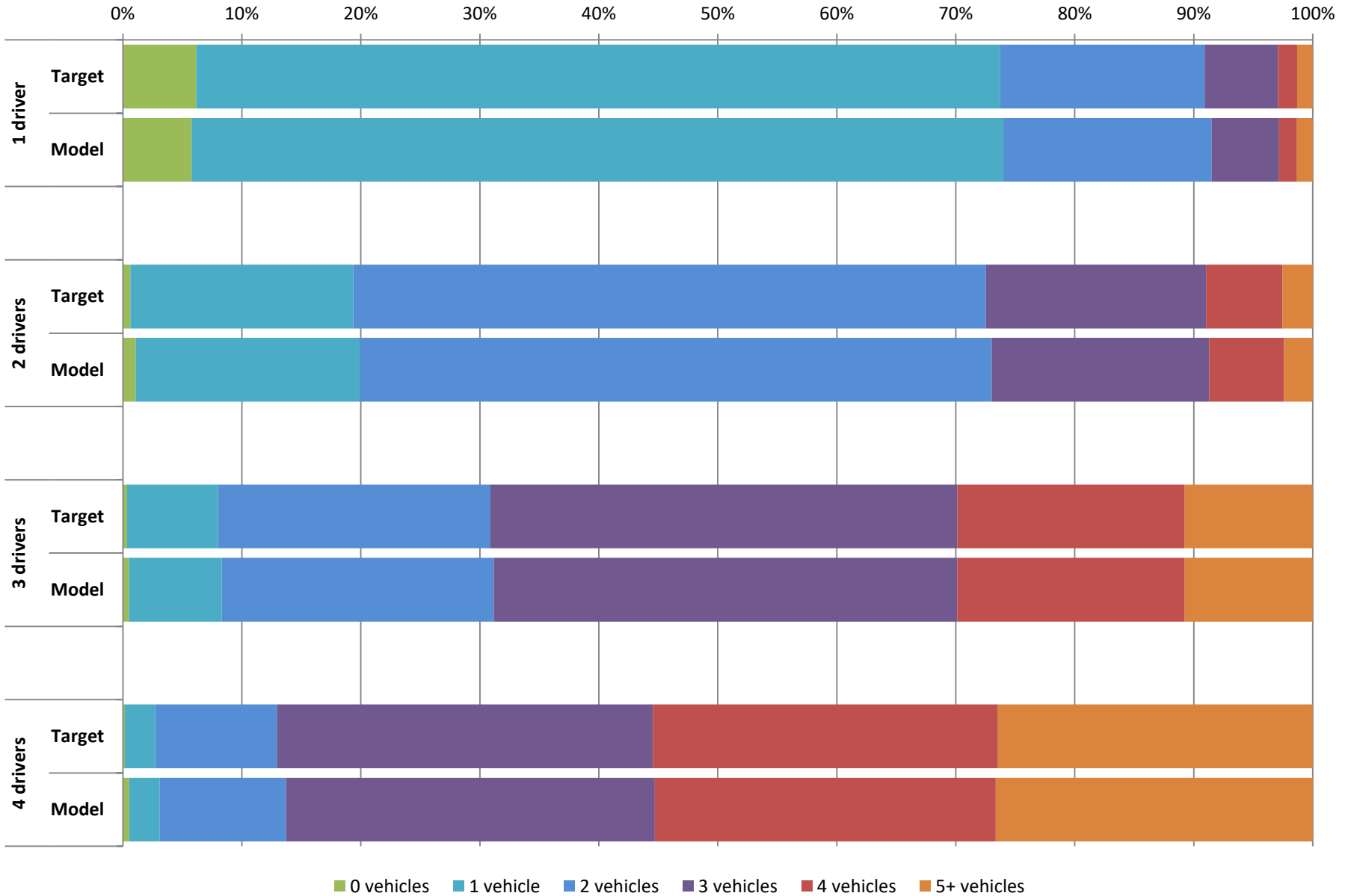
Work location distance distribution
non-plant workers
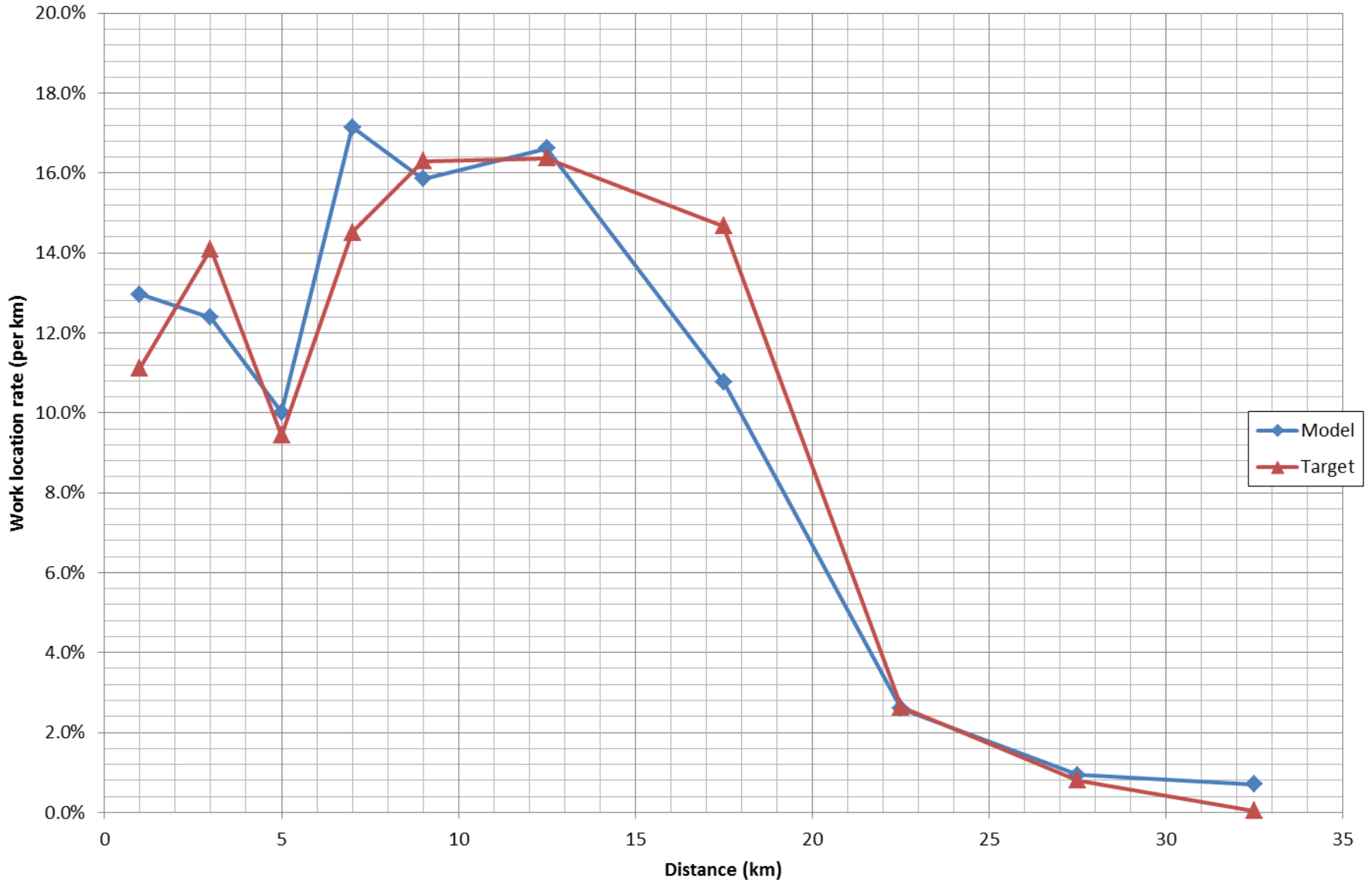
Pattern Group Complexity by Person Type and Day Role

Legend: ■ Simple (1-3 trips) ■ Moderate (4-6 trips) ■ Complex (7+ trips)

Categories (each with Target and Model bars): YO, GS - School, GS - Other, PSE, WFT - Work, WFT - Other, WPlant - Work, WPlant - Other, WPT, AO, Sen
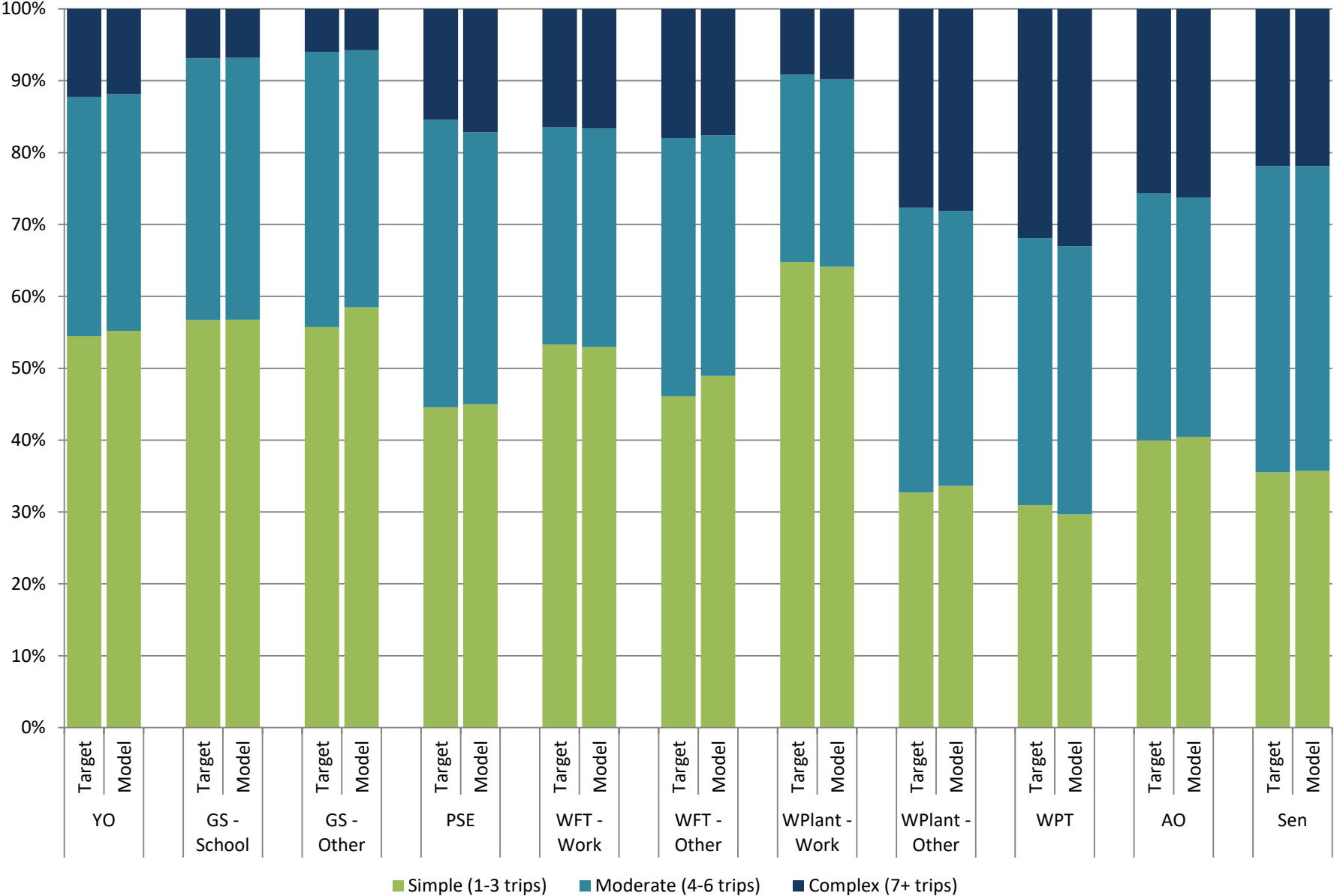
Work and School Tour Mode Choice
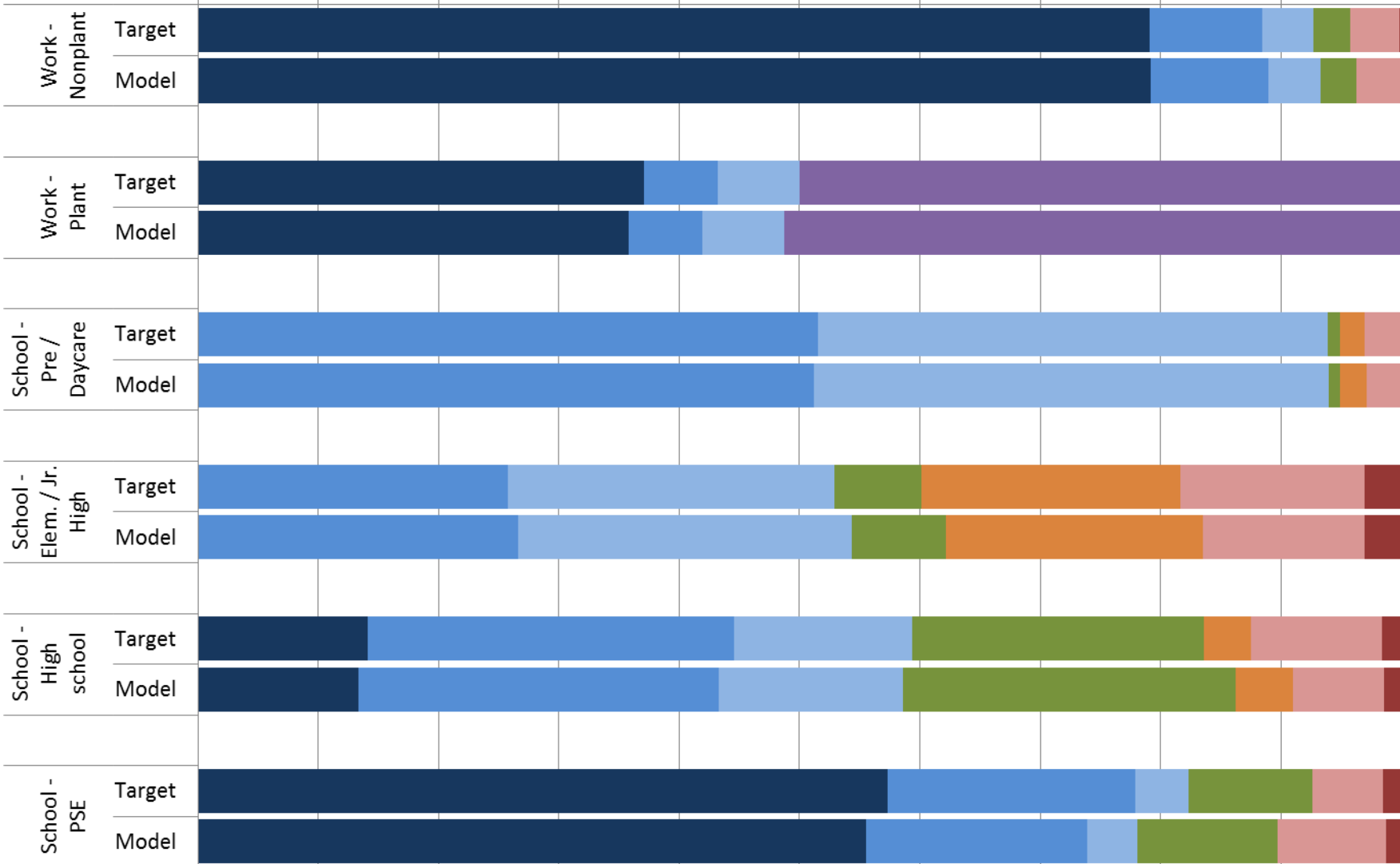
Legend: SOV, HOV2, HOV3+, Work Bus, Transit, School Bus, Walk, Bike

Other Tour Mode Choice By Purpose
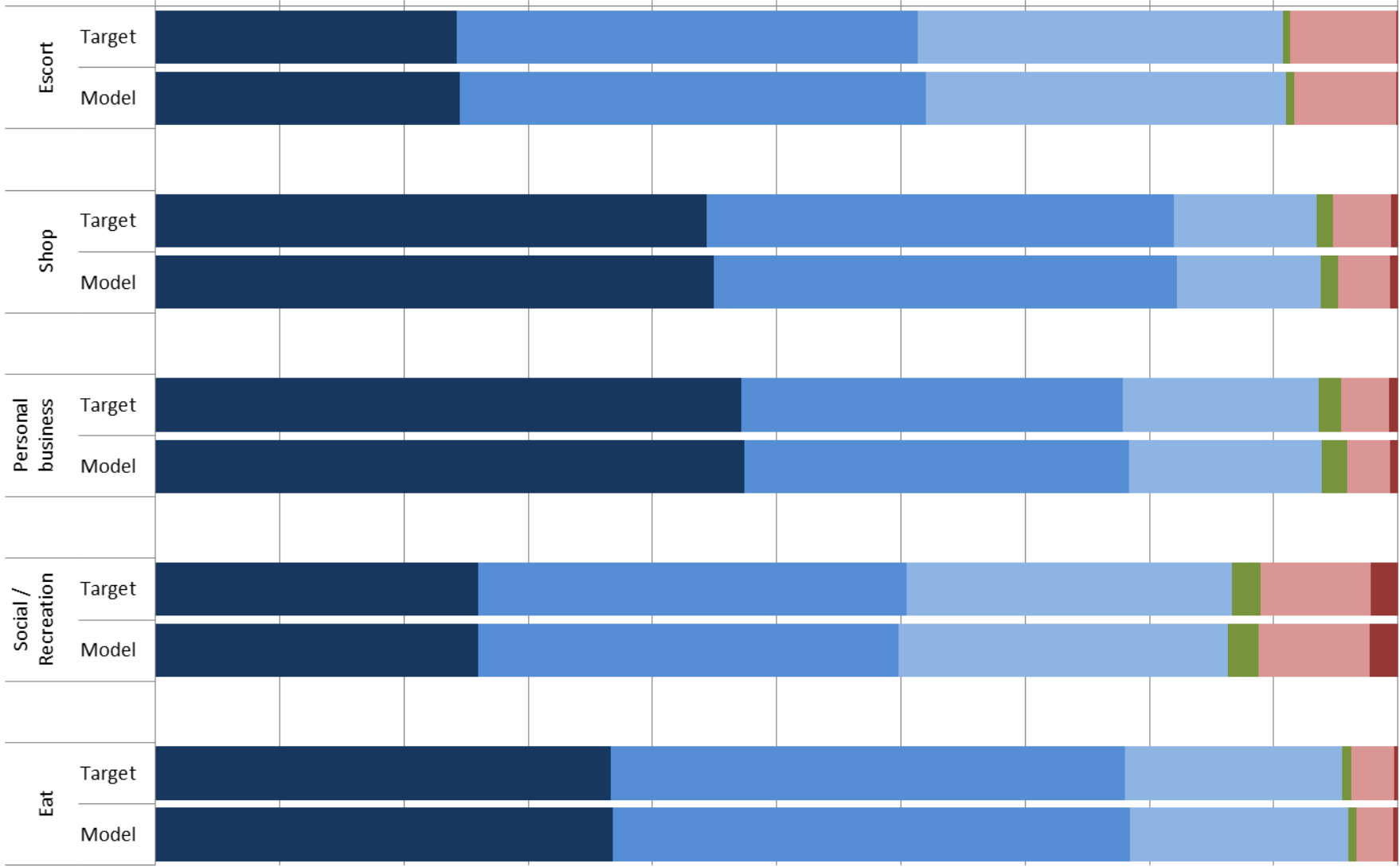
Legend: SOV, HOV2, HOV3+, Transit, Walk, Bike

Challenges in Worker Allocation Model Development

- Lack of data for calibration, so forced to perform validation with few adjustment 'levers' from uncalibrated data

- Explicit mode shifts built into PTM to shift trips toward bus (i.e. fewer vehicle trips per worker trip) for more distant plants

- Atypical land use pattern with roughly 70 km separation b/w residential home locations and industrial work locations. Work trips across periods.

Validation

- Compare model performance versus "external" sources of data

- Traffic count comparison

- Challenge: rapid changes in RMWB area
  - Counts predating major infrastructure projects
  - Uncertainty about levels of oilsands activity and shadow population
  - Variability in oilsands activity

AADT - Highway 63
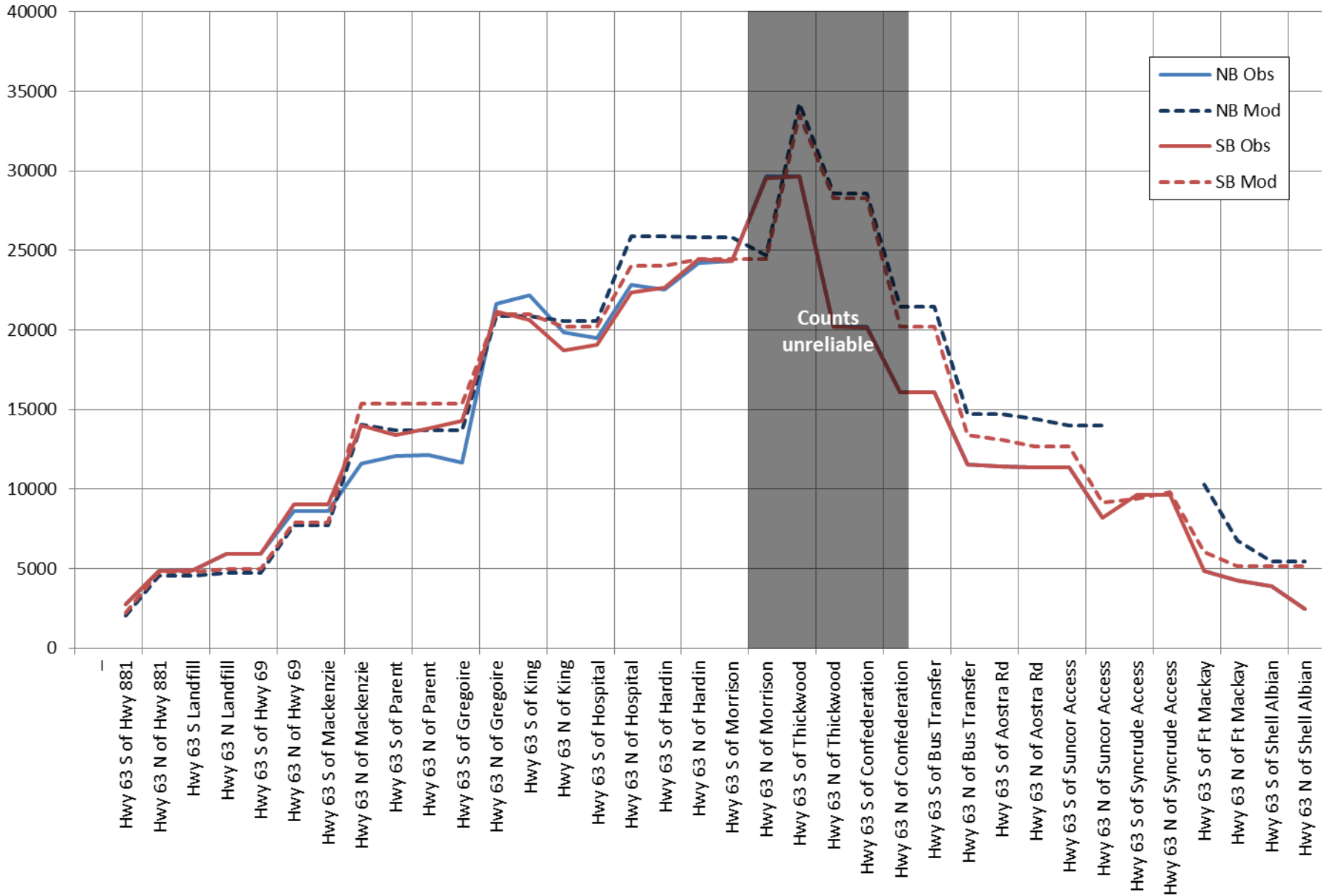
AADT - Highway 63 - Medium & Heavy
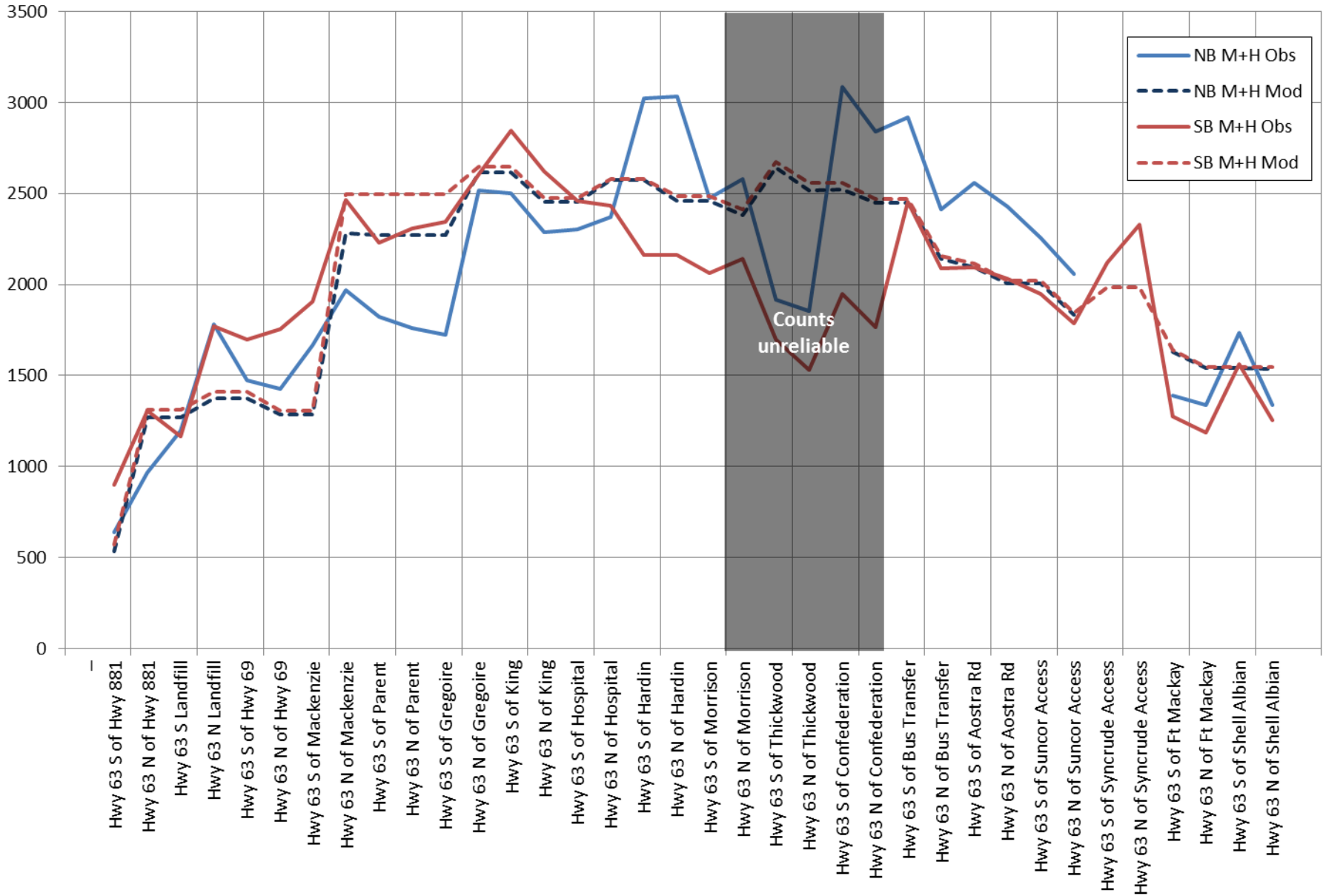
Major roads at intersection with Hwy 63
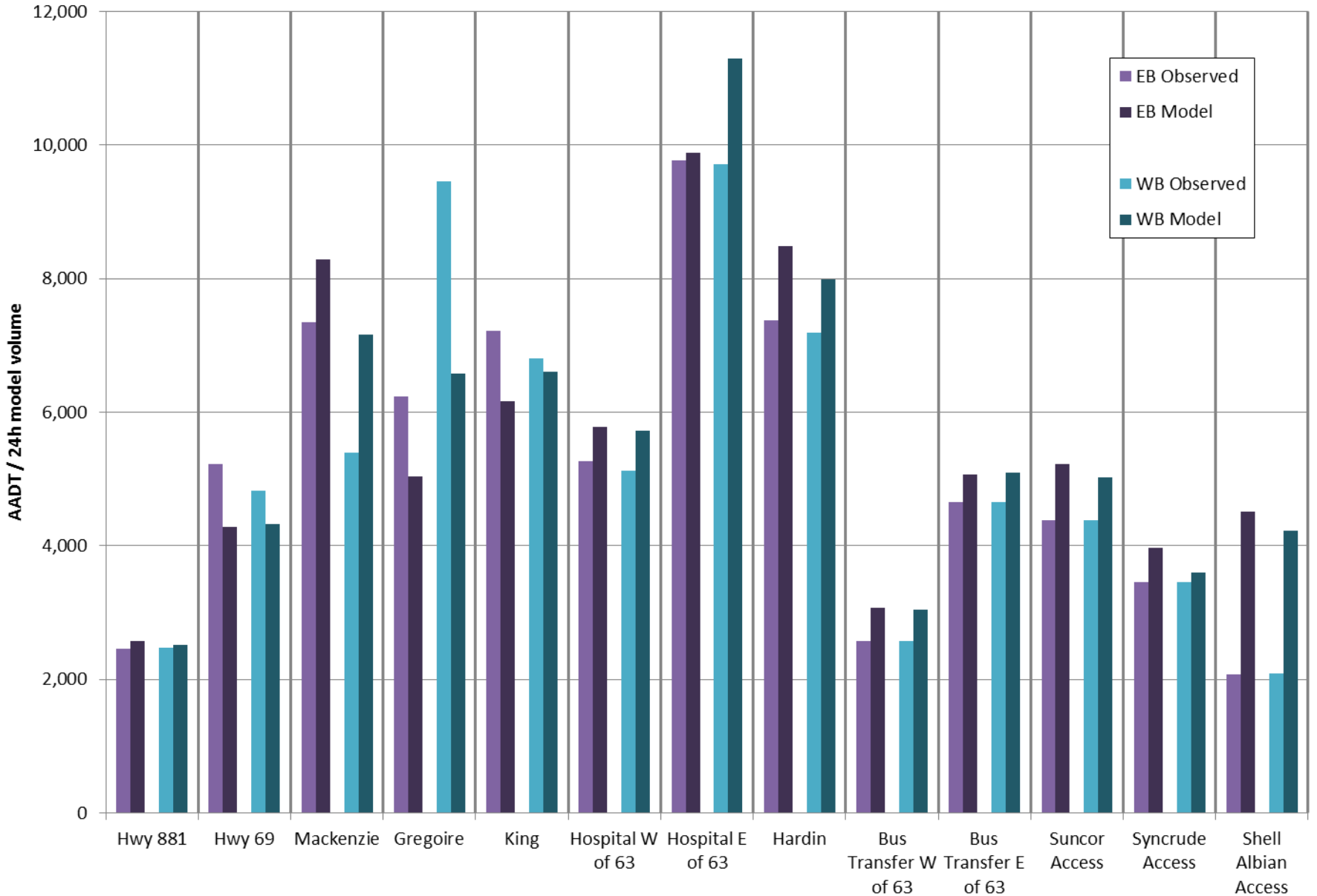
Hourly volumes - Hwy 63 @ Athabasca River (Grant MacEwan Bridge)
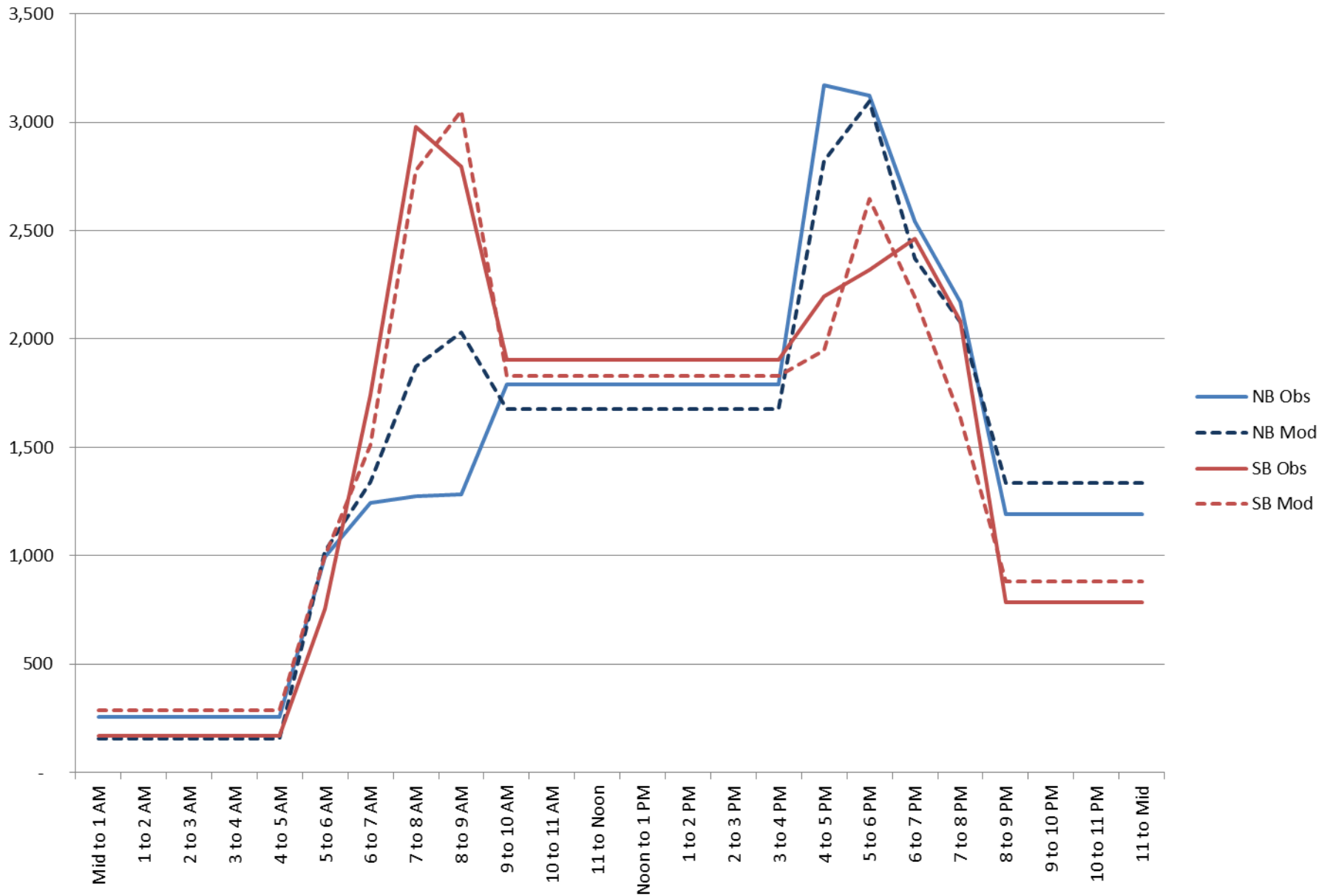
Hourly volumes - Hwy 63 North of Confederation Way

Legend:
- NB Obs
- NB Mod
- SB Obs
- SB Mod
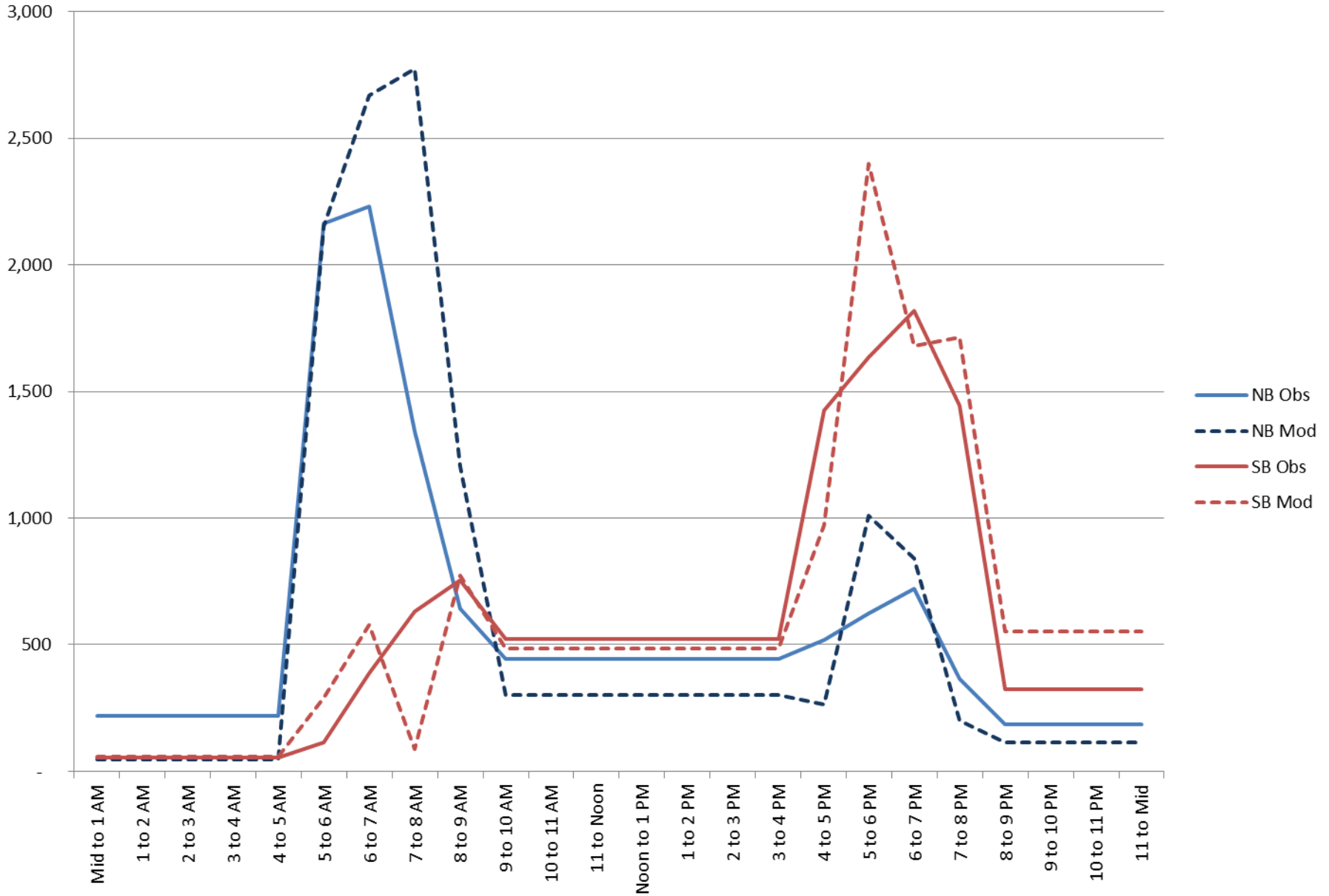
Root Mean Squared Error (RMSE)

Count category	Model	Objective
All counts	27%	39%
Lower volume (<2500 veh/day)	67%	100%
Medium low volume (2500-5000 veh/day)	36%	54%
Medium high volume (5000-10000 veh/day)	26%	42%
Higher volume (10000-15000 veh/day)	28%	34%
High volume (>15000 veh/day)	12%	28%

Lower RMSE indicates better performance;
objective values from 2002 Ohio DOT manual

$$RMSE = \frac{\sqrt{\frac{\sum error^2}{num_{counts} - 1}}}{average\ volume}$$

NHCRP 255 standard

Scatter plot

Model (y-axis): 0, 5,000, 10,000, 15,000, 20,000, 25,000, 30,000, 35,000

Observed (x-axis): 0, 5,000, 10,000, 15,000, 20,000, 25,000, 30,000, 35,000
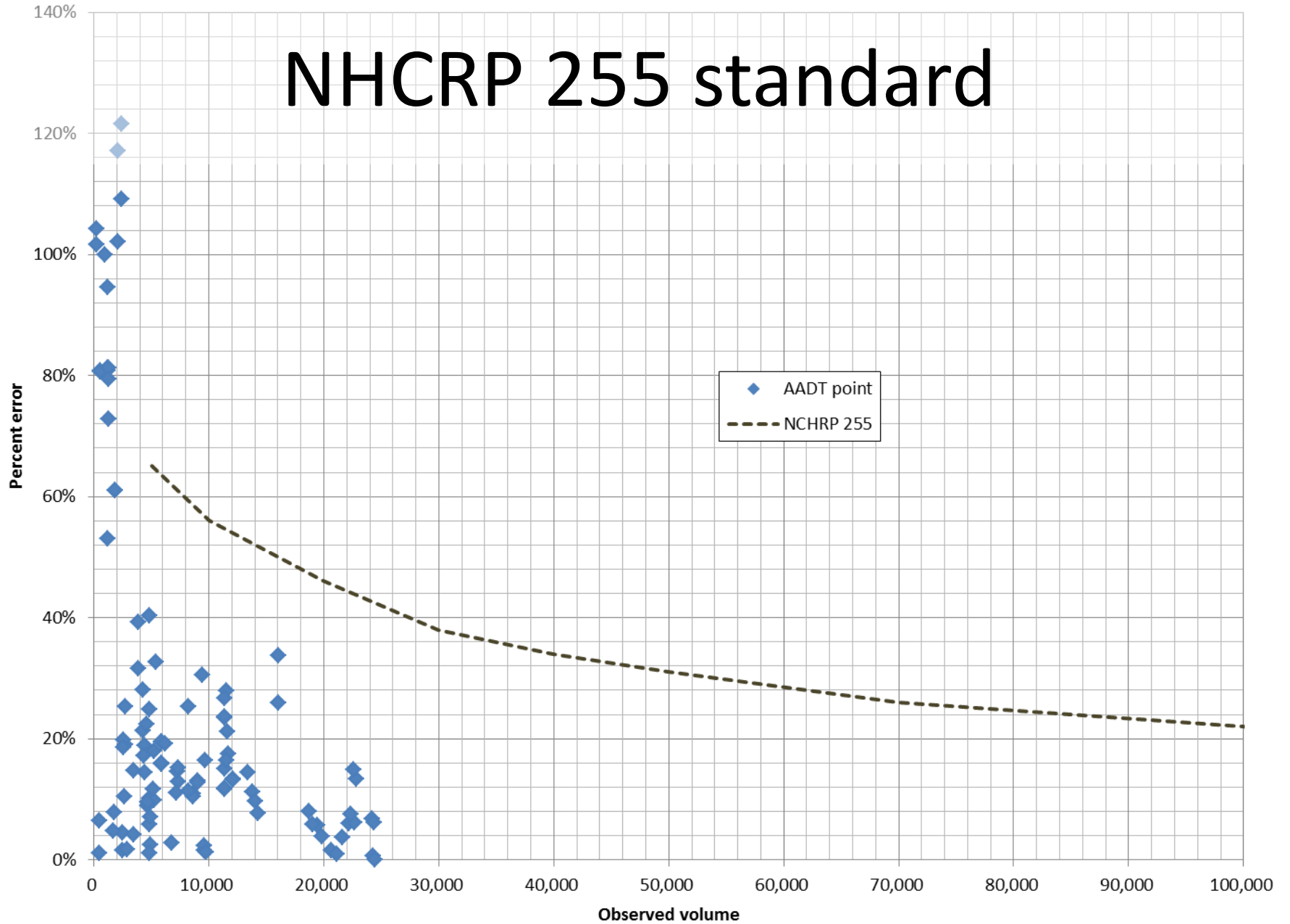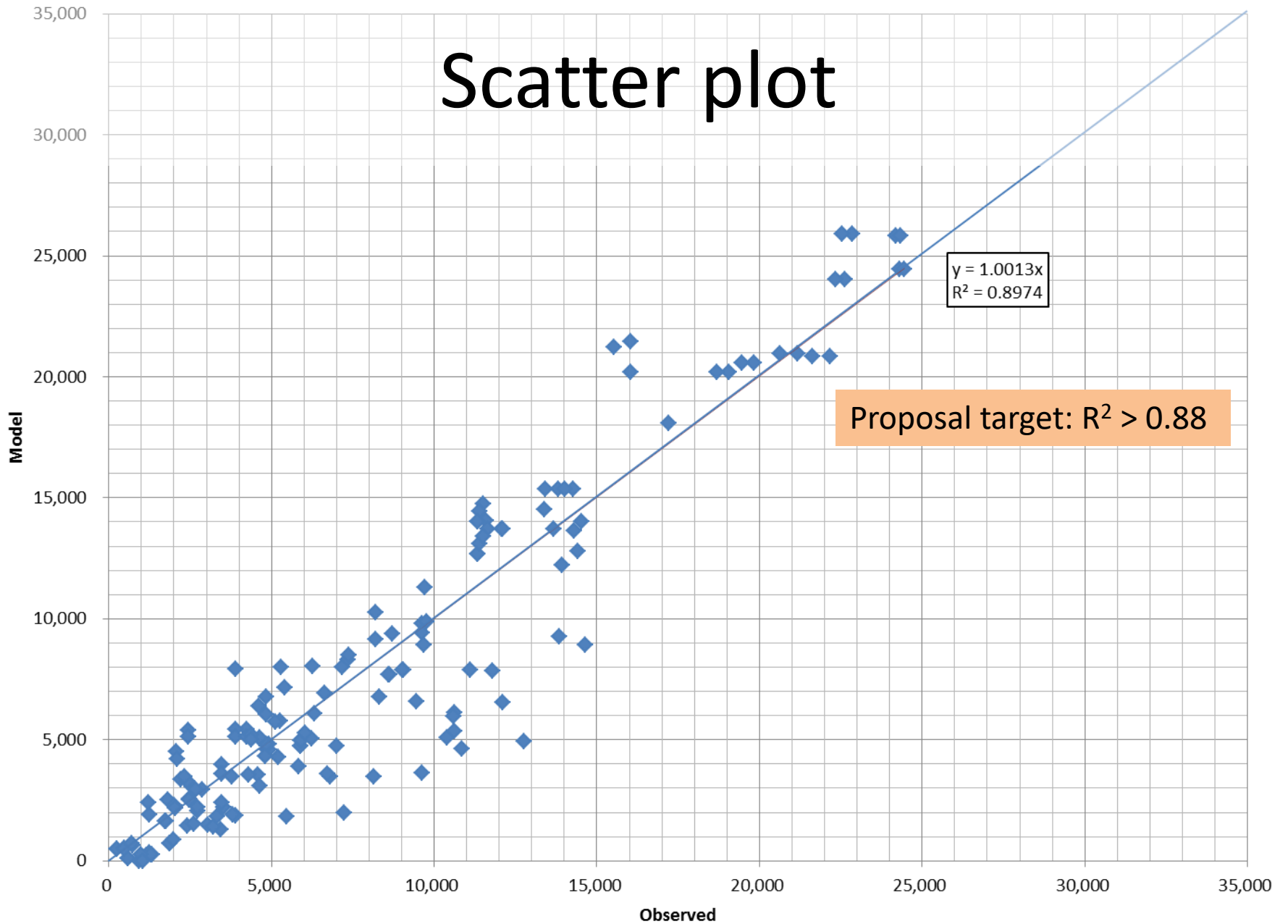
$y = 1.0013x$
$R^2 = 0.8974$

Proposal target: $R^2 > 0.88$

Key project phases

- Data collection / processing

- Model development / calibration / validation

- Future scenario series
  - Develop future land use scenarios
    - Population, employment, school enrollment
  - Develop future transportation system alternatives
    - Roads and transit
  - Multiple years: 2021, 2031, 2041 ("full build out")
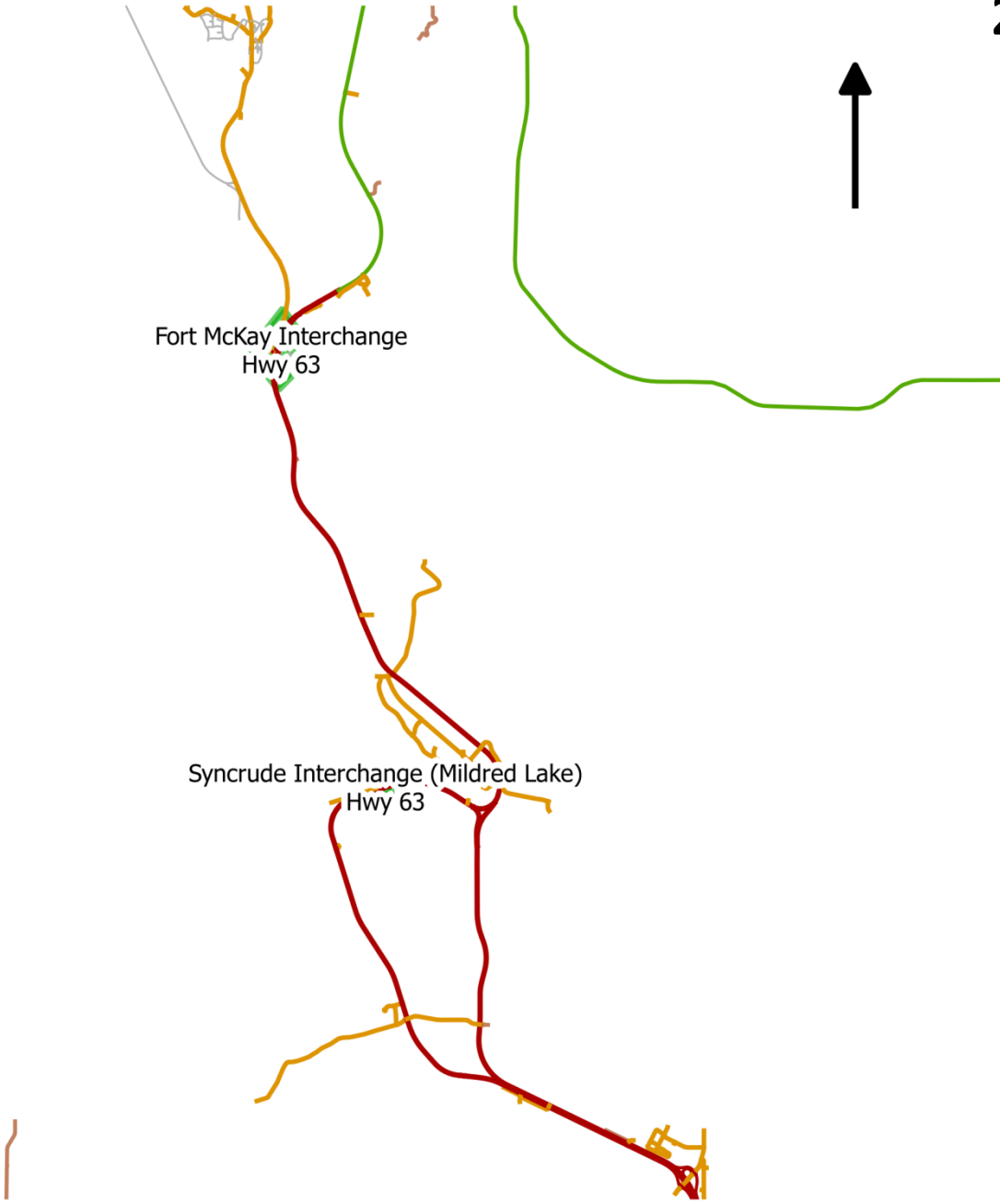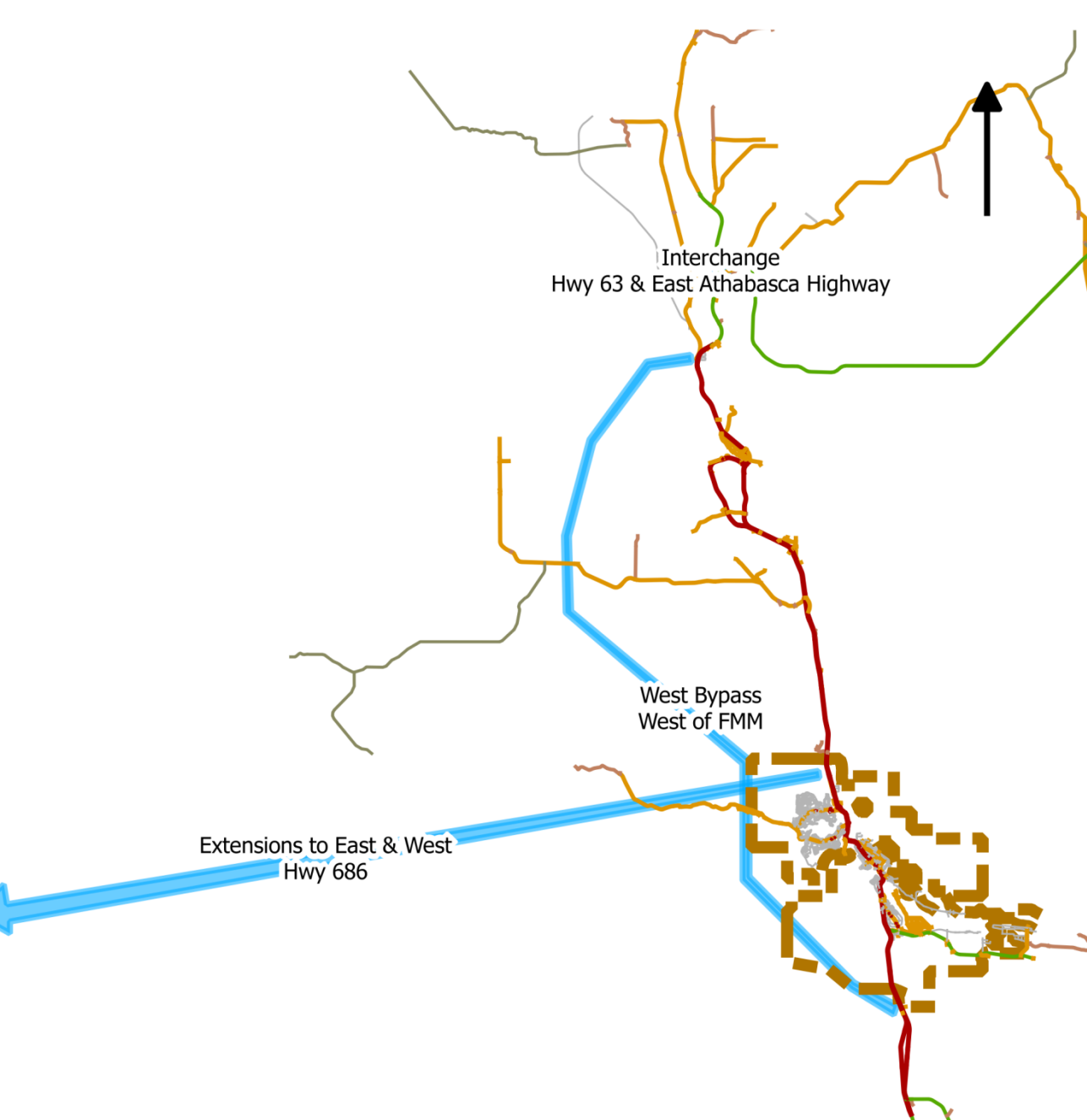
2021 improvements

Legend

RMWB ROADS & FLOWS (NRN)

— Alleyway / Lane
— Arterial
— Collector
— Expressway / Highway
— Local / Street
— Local / Unknown
— Ramp
  Rapid Transit
— Resource / Recreation
  Service Lane
— Winter
— Resource (new)

Future Infrastructure

▭ 2021
▭ 2031
▭ 2041

Parsons Creek Interchange
Hwy 63

Six Laning fron Hospital St. to Morrison
Hwy 63 - Hospital St to Morrison St

Six Laning from Hwy 69 to Hospital St
Hwy 63

Twinning to W. Boundry Airport Rd
Hwy 69

Interchange Access to Prairie Creek Business Park
Crown Ave

Improvement N of Gregoire Lake (North of Anzac Option)
Hwy 881

2021 improvements

Twinning from Peter Lougheed Bridge to Syncrude Aurora Road
Hwy 63

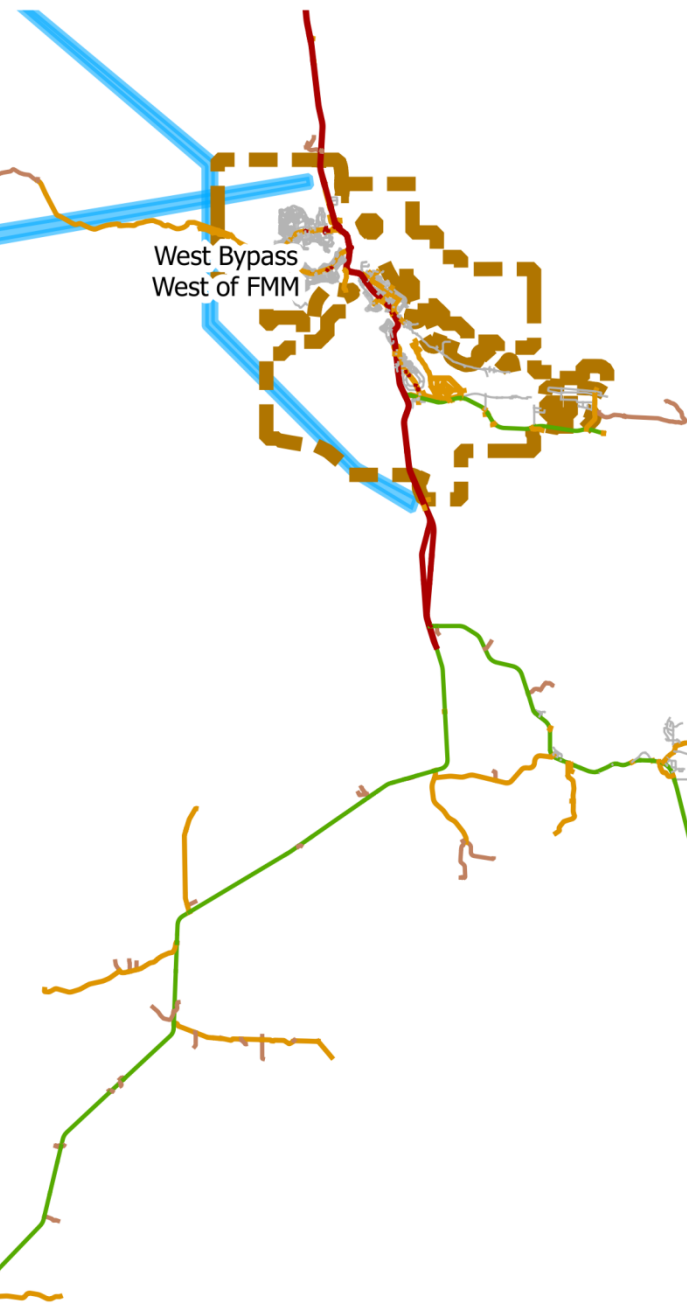Twinning from Syncrude to Peter Lougheed Bridge
Hwy 63

Legend

RMWB ROADS & FLOWS (NRN)

— Alleyway / Lane
— Arterial
— Collector
— Expressway / Highway
— Local / Street
— Local / Unknown
— Ramp
— Rapid Transit
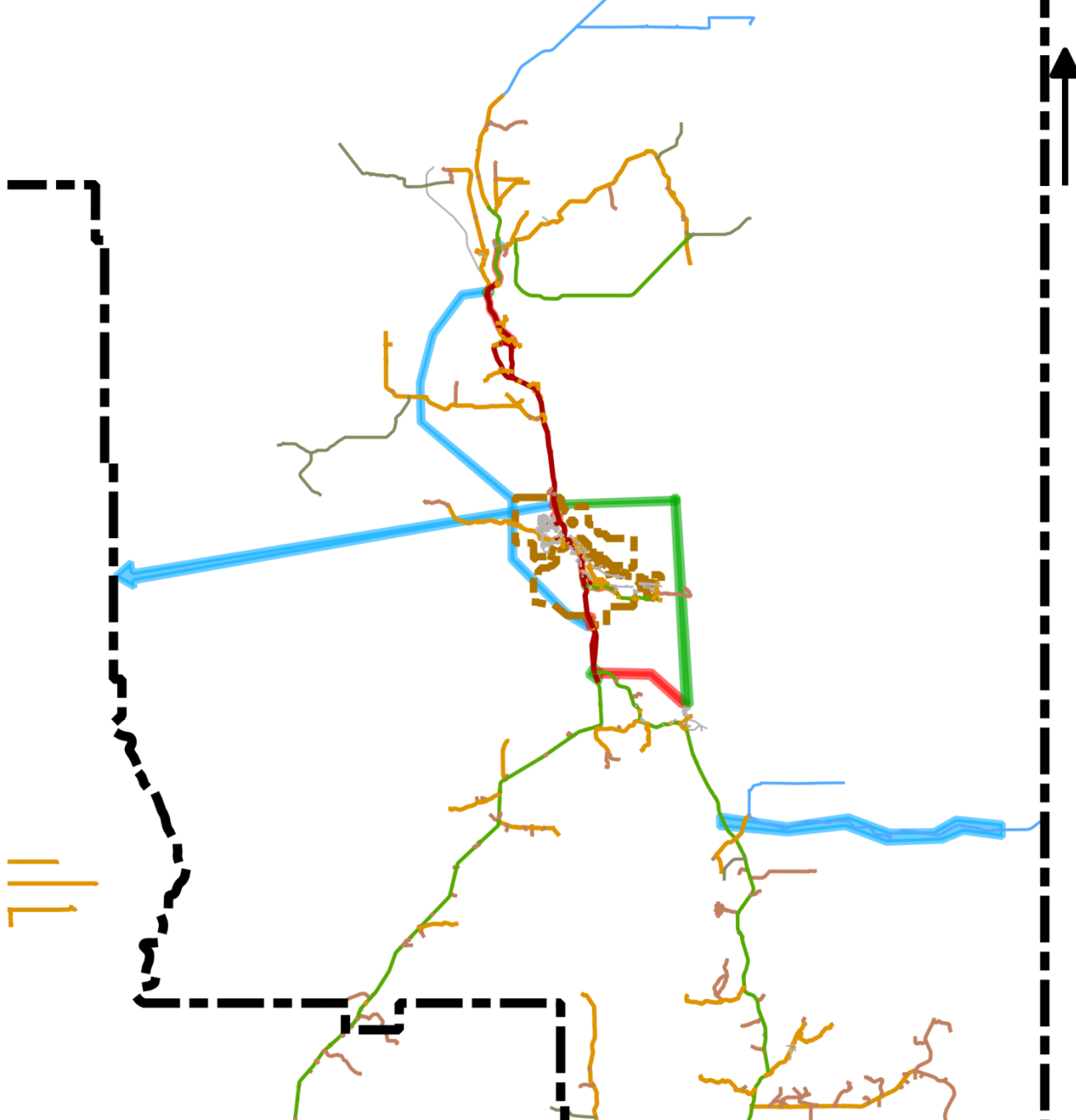— Resource / Recreation
— Service Lane
— Winter
— Resource (new)

Future Infrastructure

▮ 2021
▮ 2031
▮ 2041

2031 improvements

Extension East to Future Corridor
Hwy 686

Interchange
Hwy 63 & Hardin St

Interchange (diamond)
Hwy 62 & Beacon Hill Rd

Interchange
Hwy 63 & Hwy 69

East Corridor Extension
Hwy 881 to Hwy 69 over Clearwater River

Interchange
Hwy 63 & Hwy 881

Legend

RMWB ROADS & FLOWS (NRN)

— Alleyway / Lane
— Arterial
— Collector
— Expressway / Highway
— Local / Street
— Local / Unknown
— Ramp
  Rapid Transit
— Resource / Recreation
  Service Lane
— Winter
— Resource (new)

Future Infrastructure

🟥 2021
🟩 2031
🟦 2041

2031 improvements

Fort McKay Interchange
Hwy 63

Syncrude Interchange (Mildred Lake)
Hwy 63

2041 improvements

Interchange
Hwy 63 & East Athabasca Highway

West Bypass
West of FMM

Extensions to East & West
Hwy 686

Legend

RMWB ROADS & FLOWS (NRN)

⎯	Alleyway / Lane
⎯	Arterial
⎯	Collector
⎯	Expressway / Highway
⎯	Local / Street
⎯	Local / Unknown
⎯	Ramp
	Rapid Transit
⎯	Resource / Recreation
	Service Lane
⎯	Winter
⎯	Resource (new)

Future Infrastructure

🟥	2021
🟩	2031
🟦	2041

2041 improvements

Legend

RMWB ROADS & FLOWS (NRN)

— Alleyway / Lane
— Arterial
— Collector
— Expressway / Highway
— Local / Street
— Local / Unknown
— Ramp
    Rapid Transit
— Resource / Recreation
    Service Lane
— Winter
— Resource (new)

Future Infrastructure

▉ 2021
▉ 2031
▉ 2041

West Bypass
West of FMM

Extension to East
La Loche Rd

Legend

RMWB ROADS & FLOWS

—— Alleyway / Lane
—— Arterial
—— Collector
—— Expressway / Highwa
—— Local / Street
—— Local / Unknown
—— Ramp
　　 Rapid Transit
—— Resource / Recreatio
　　 Service Lane
—— Winter
—— Resource (new)

Future Infrastructure

▭ 2021
▭ 2031
▭ 2041

Thank you!

Special thanks to Dr. Alan Brownlee
for many late night phone calls.

Downtown Cordon

Direction	Observed	Model	% diff
Inbound (N/E)	37,200	42,400	14%
Outbound (S/W)	36,500	44,700	23%
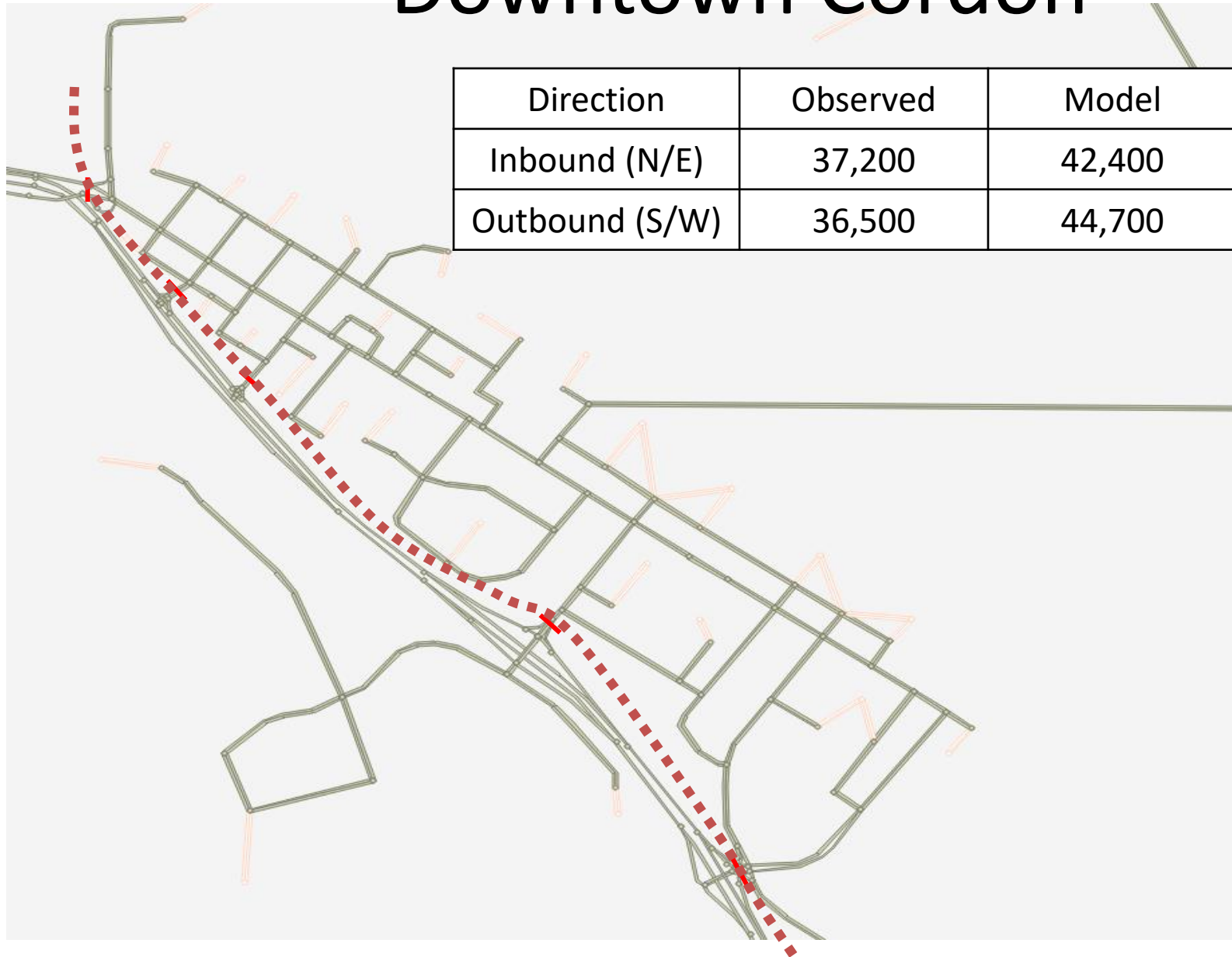
Thickwood/Confederation Cordon
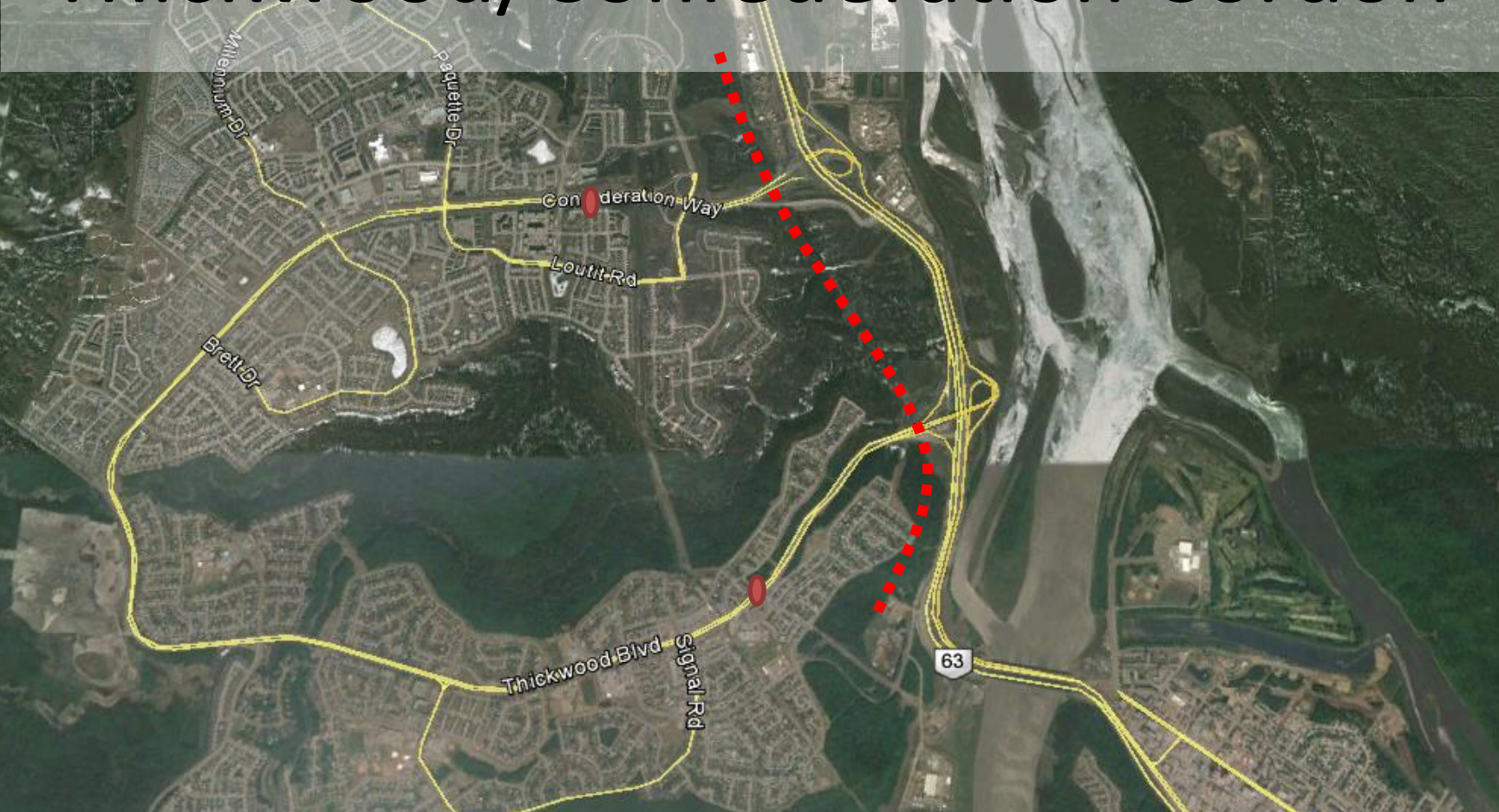
Direction	Observed (14hr)	Model (14 hr)	% diff
Eastbound	25,000	29,600	17%
Westbound	26,900	27,300	1%

Airport Sub-Model

- Land Side Impacts on Surface Transportation
- Air Passenger Volumes given exogenously

Airport Special Generator
Sub-Model
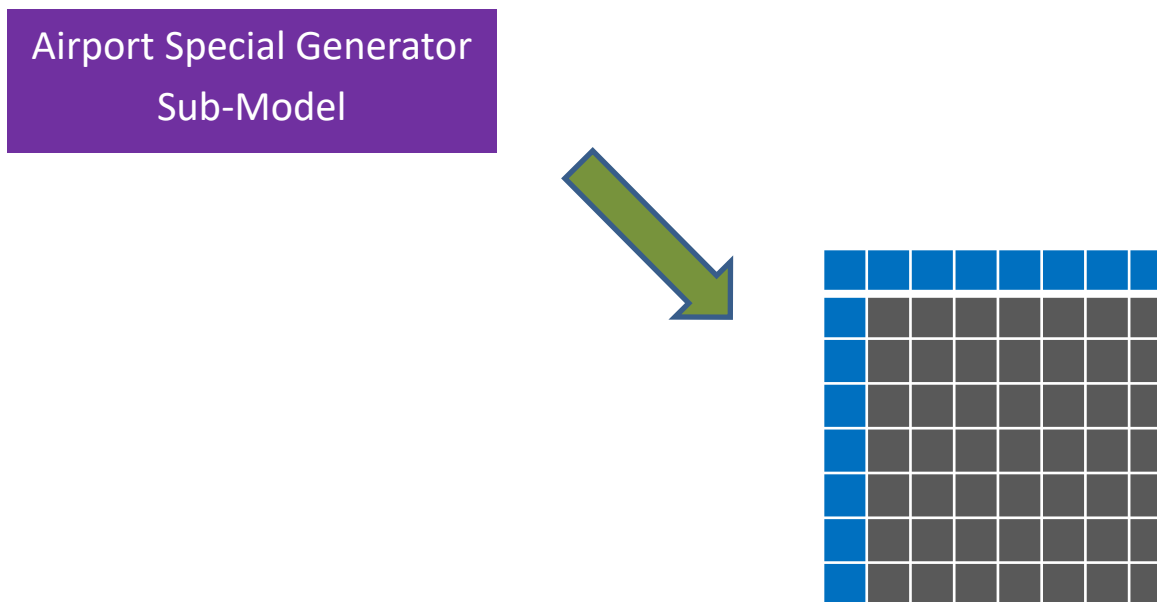
External Vehicle Sub-Model

- Internal ends of external vehicle flows allocated based on distance and zone attractiveness

- Mobile worker flows given exogenously
  - camps, modes, and aerodromes

to

from

zone

*flows
of trips*

zone
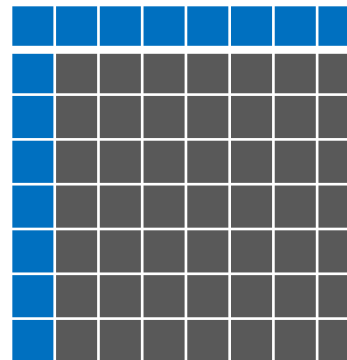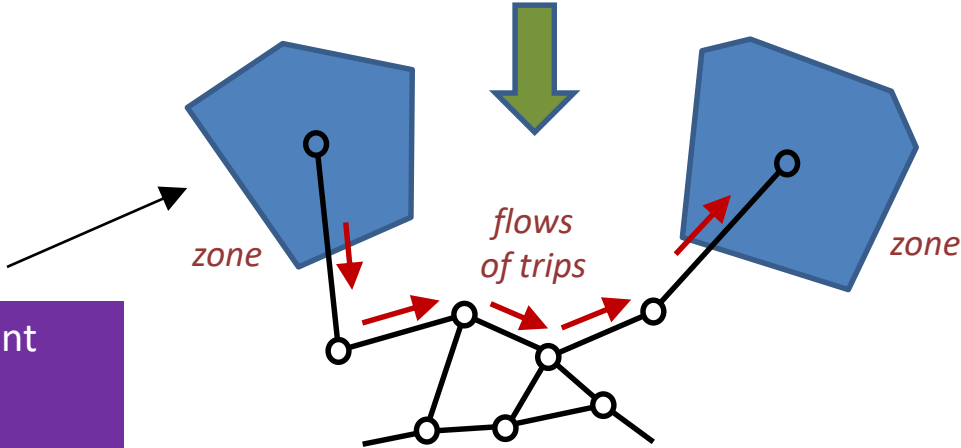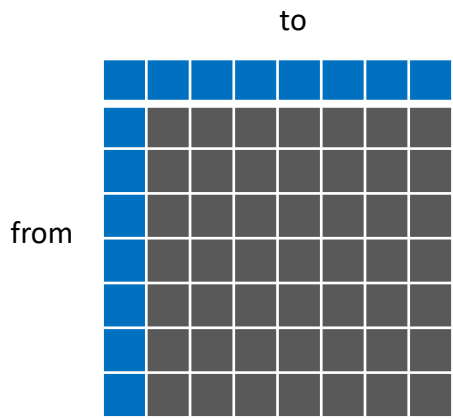
Traffic Assignment
Sub-Model

Vehicle Emissions
Sub-Model

Network output example:
Volume "bandwidth" plot
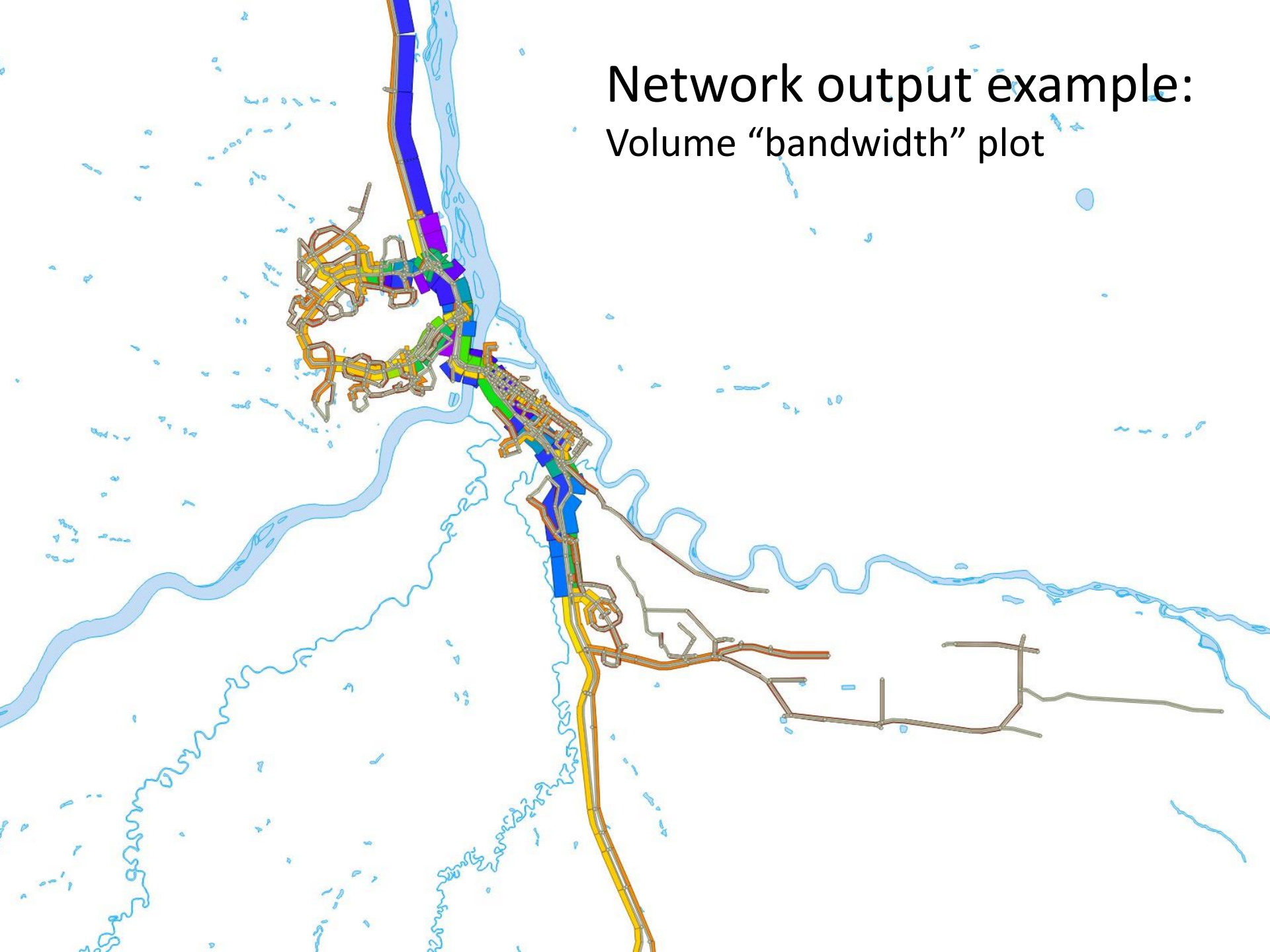
Vehicle Emissions Sub-Model
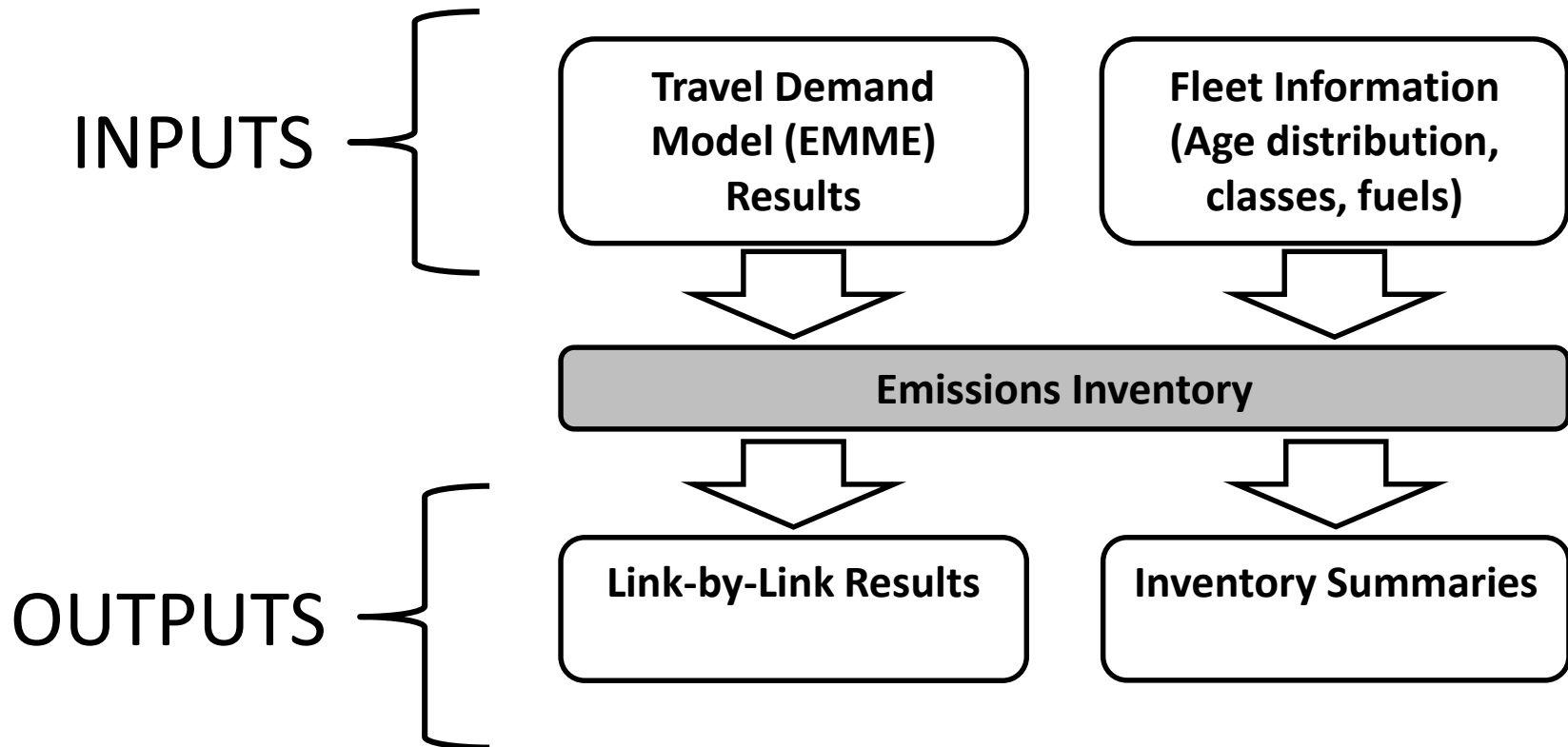
Vehicle Emissions Sub-Model
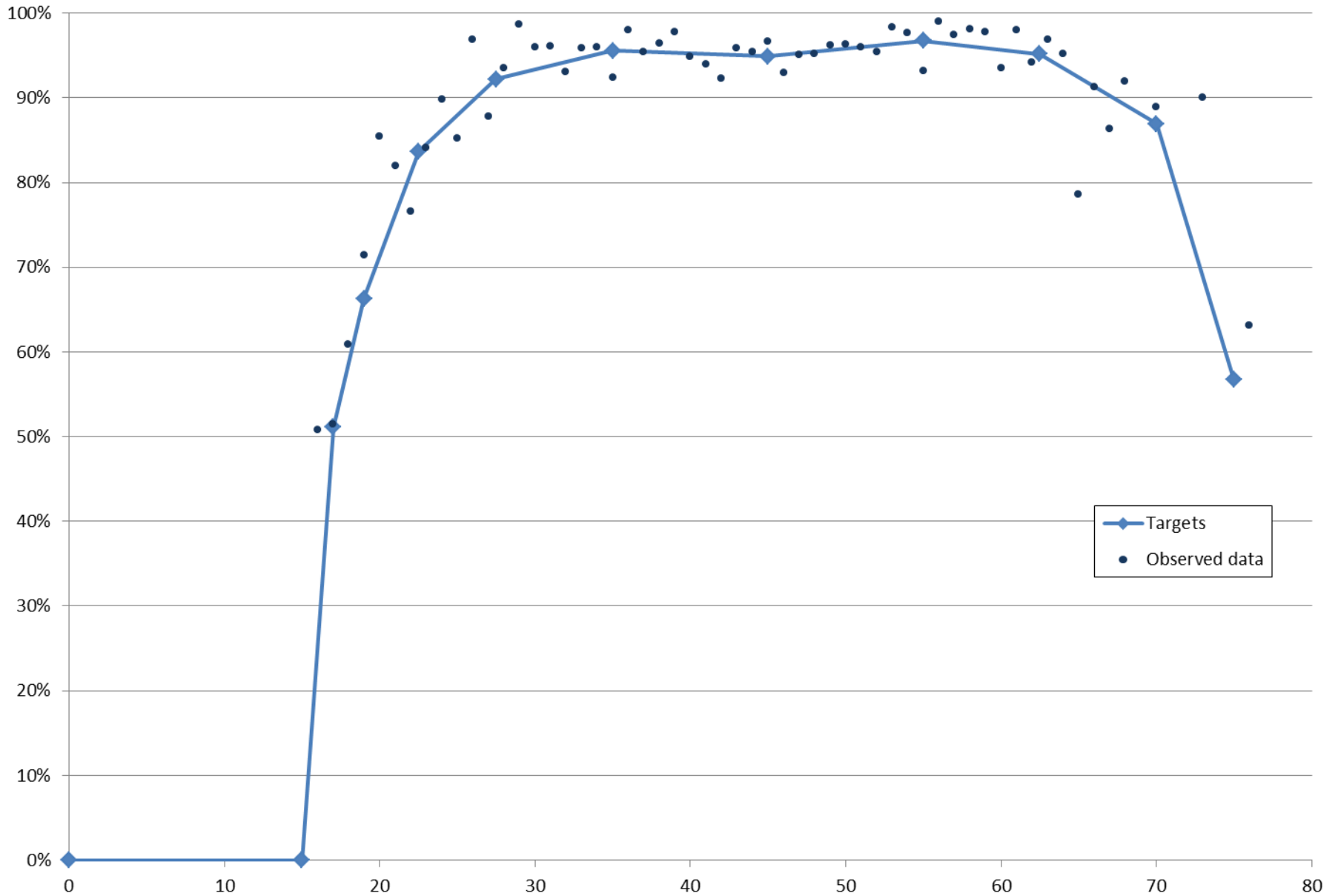## Example Output: Link-by-Link Results

PM Peak CO_2 Emission Rates for typical Light-Duty Vehicles

490 g/km

250 g/km

170 g/km

150 g/km

190 g/km

430 g/km
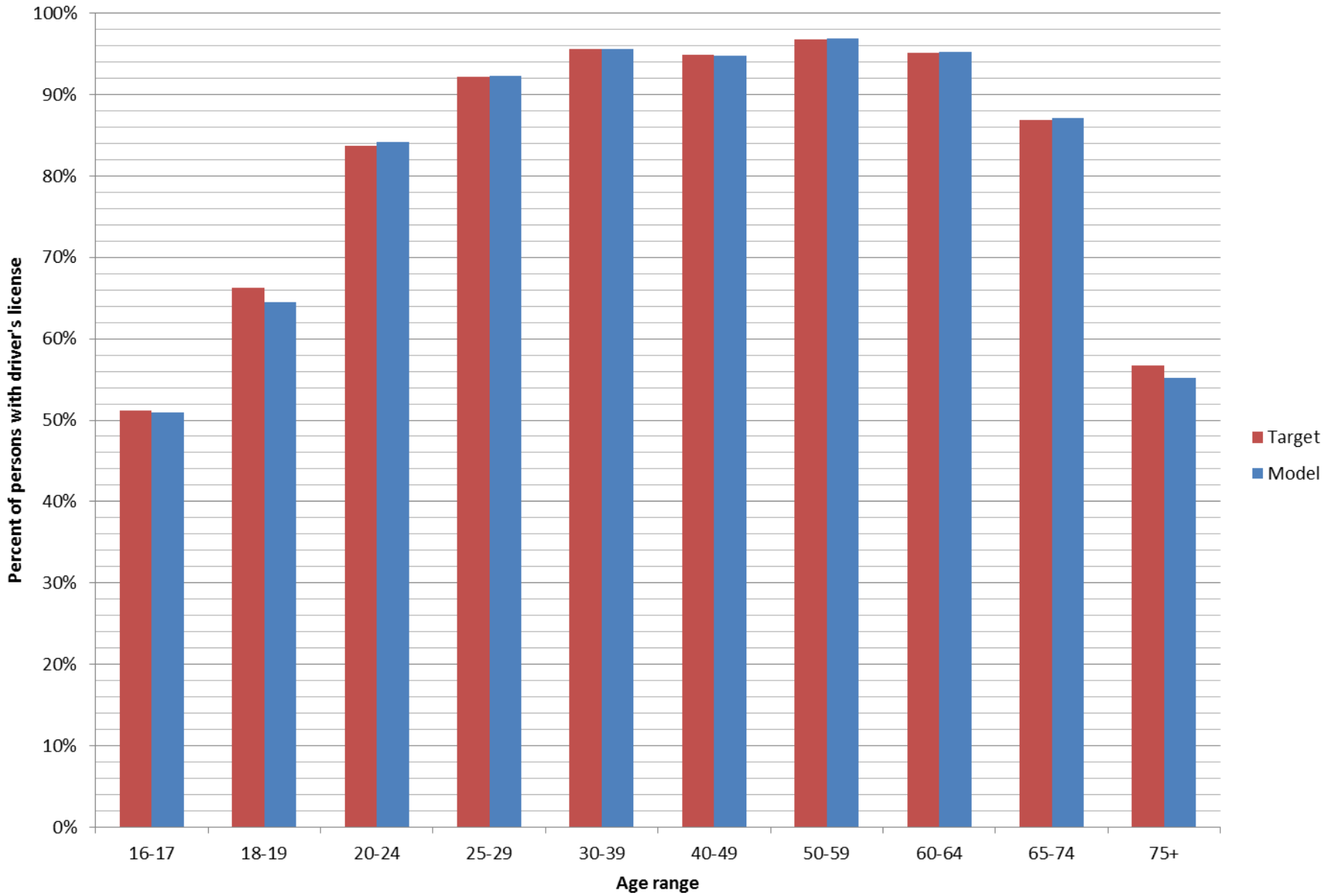
Image Regional Municipality of Wood Buffalo

Google earth
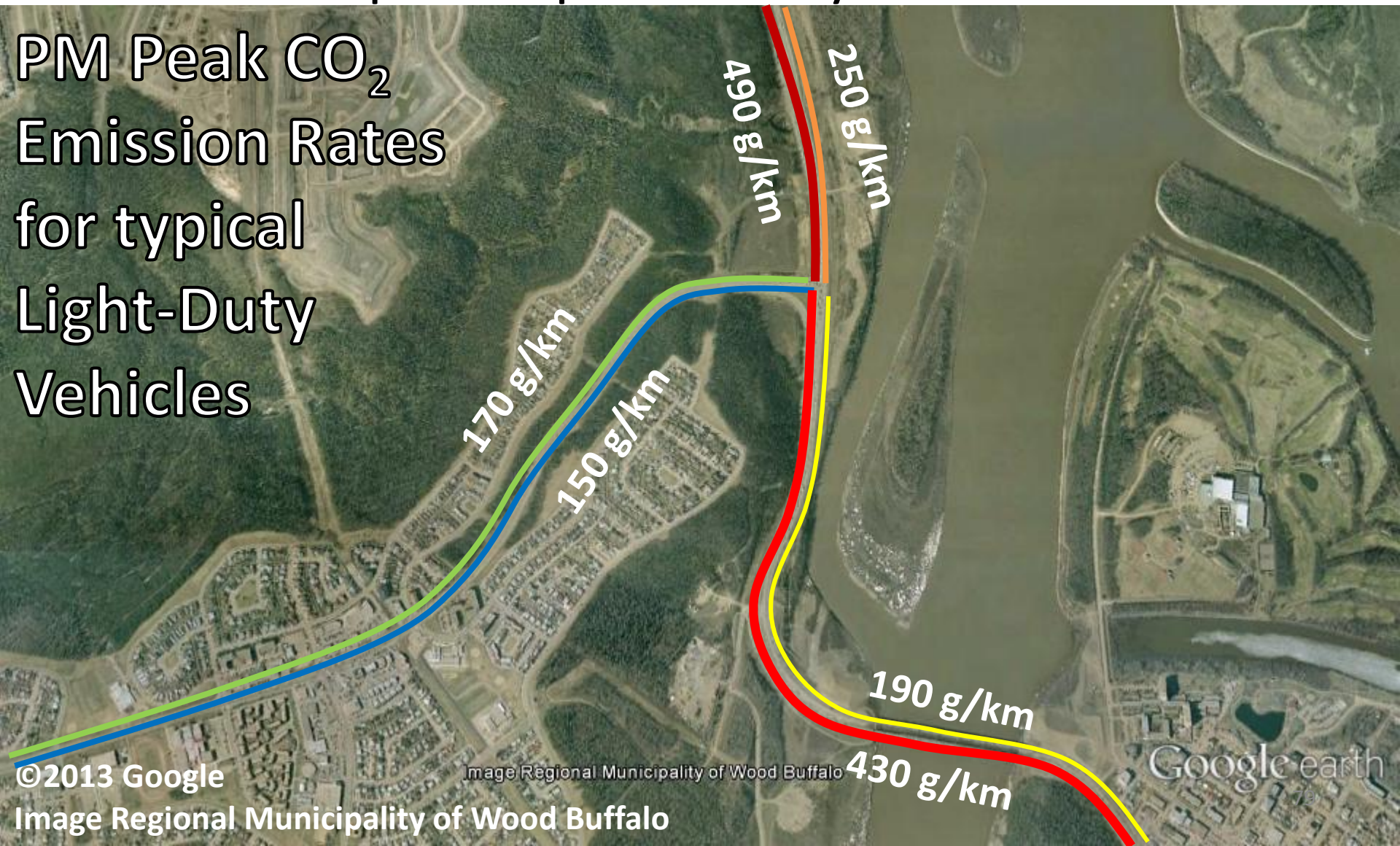
Calibration

- Use "targets" developed from household survey data

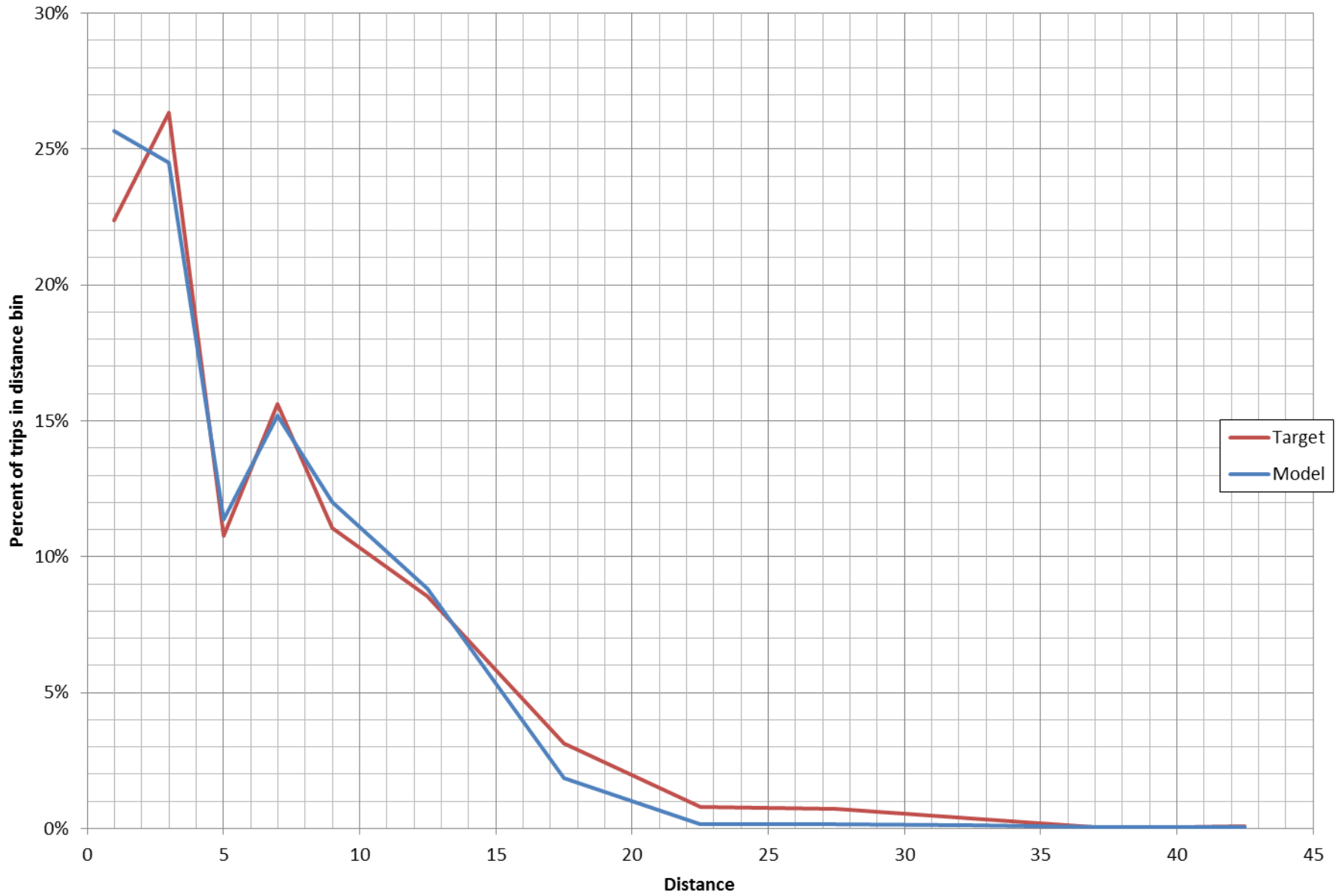- Adjust model parameters to match distributions seen in household survey targets

Driver's license rate by age

Legend:
- Targets
- Observed data
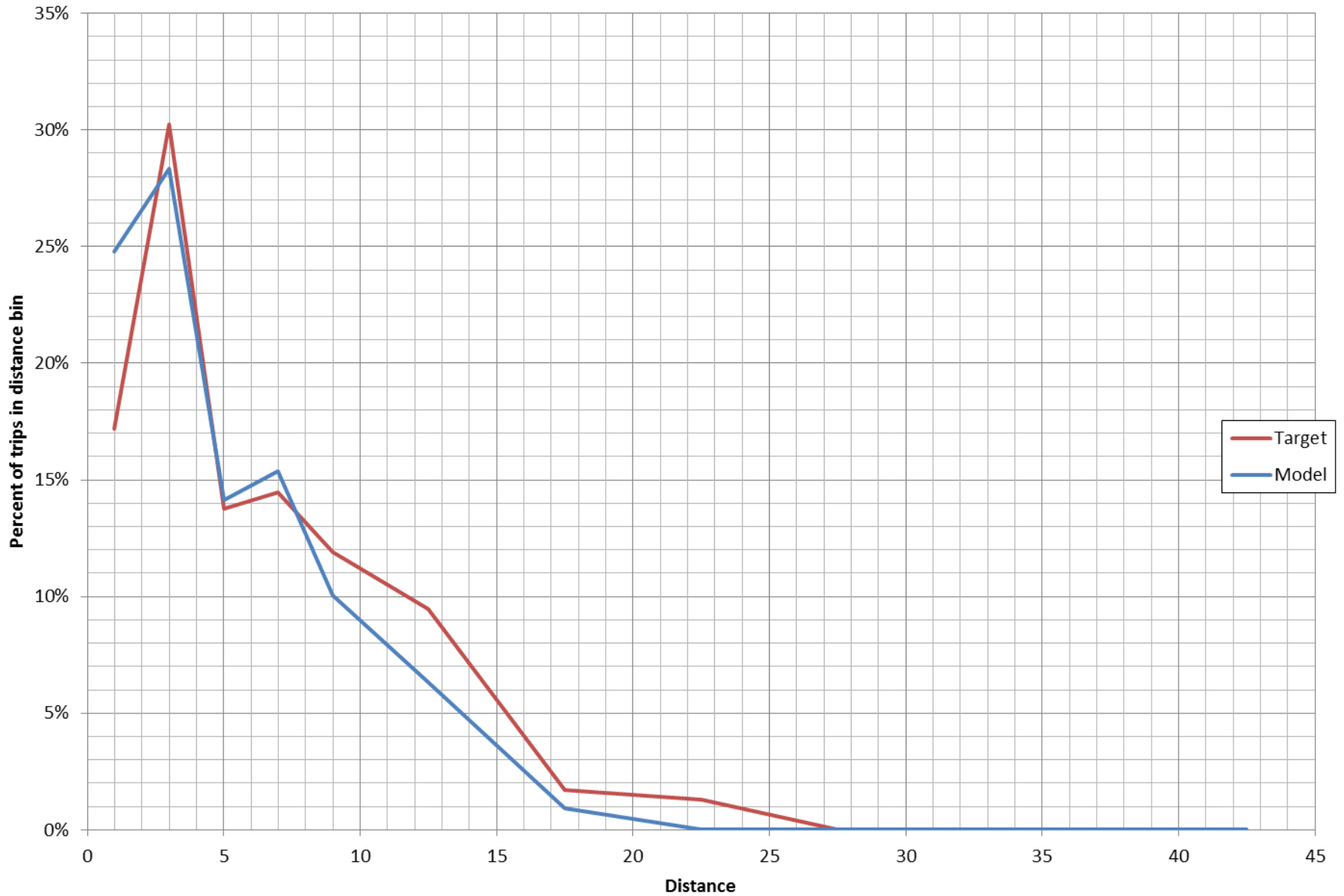
Driver's License Rate by Age

A grouped bar chart titled "Driver's License Rate by Age". The x-axis is labeled "Age range" and the y-axis is labeled "Percent of persons with driver's license" ranging from 0% to 100%. Two series are shown: Target (red) and Model (blue).

Age range	Target	Model
16-17	51%	51%
18-19	66%	64%
20-24	84%	84%
25-29	92%	92%
30-39	96%	96%
40-49	95%	95%
50-59	97%	97%
60-64	95%	95%
65-74	87%	87%
75+	57%	55%

Other tour primary destination distance distribution - SOV

Other tour primary destination distance distribution - HOV 2

Percent of trips in distance bin (y-axis, 0% to 30%)

Distance (x-axis, 0 to 45)
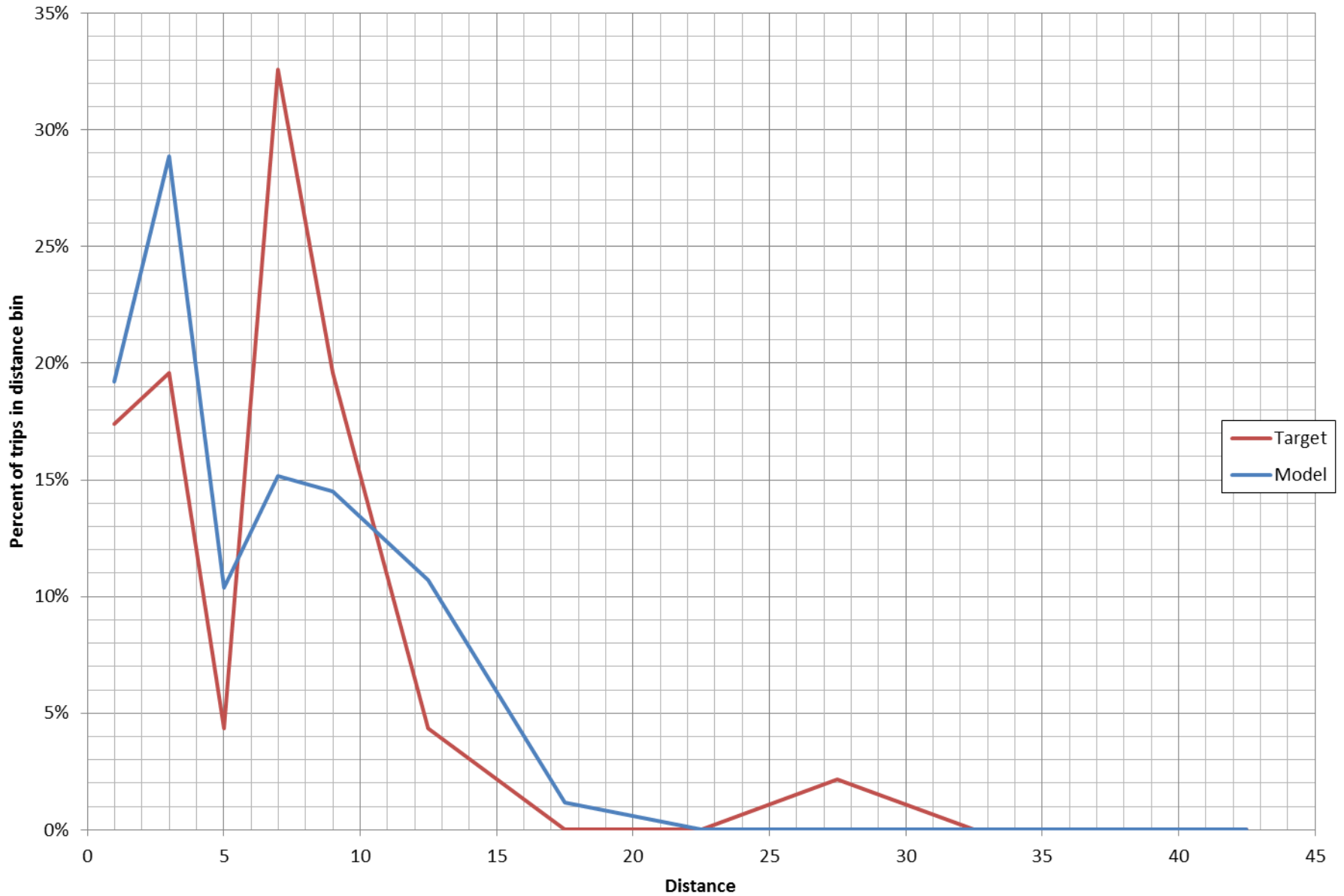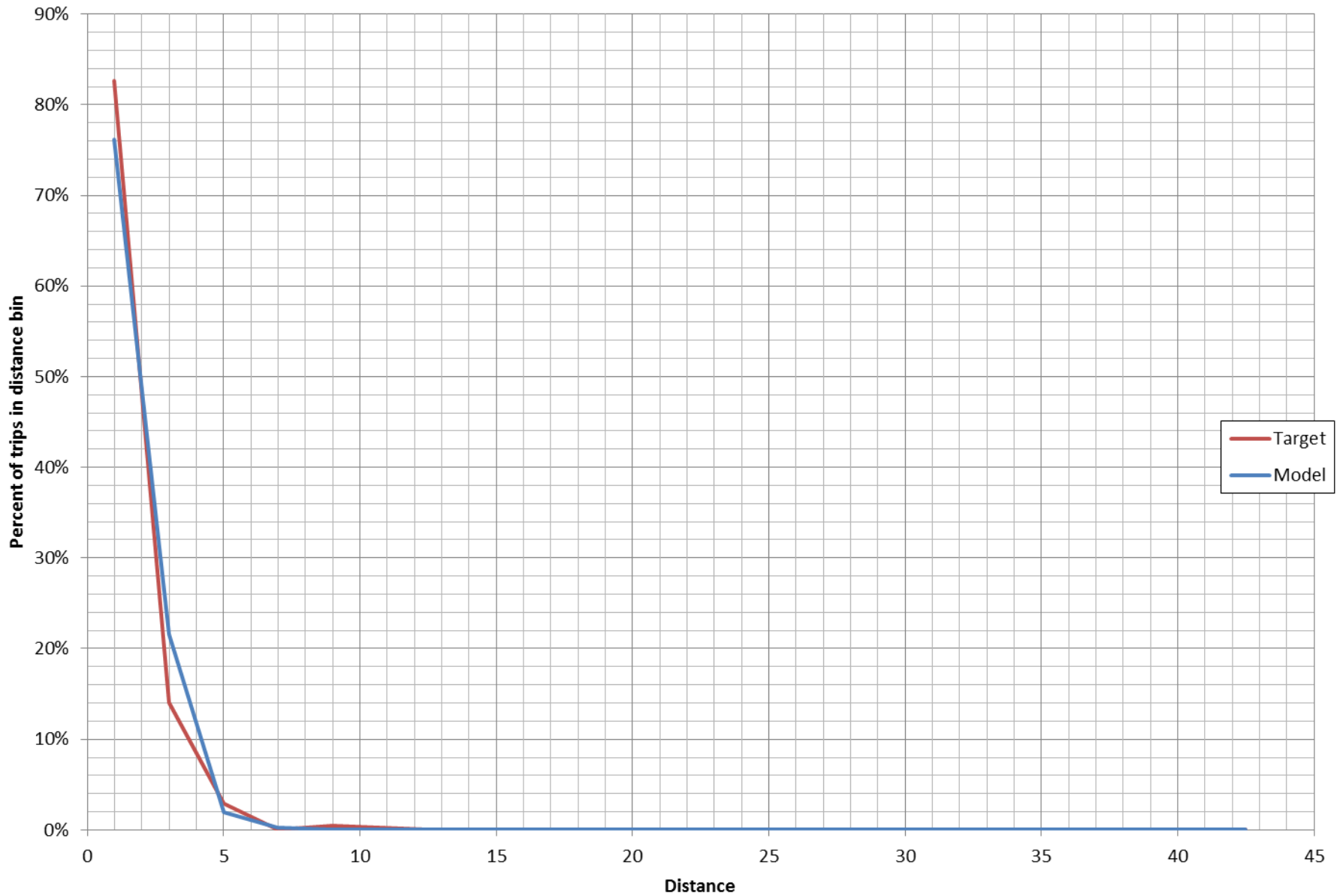
Legend: Target, Model
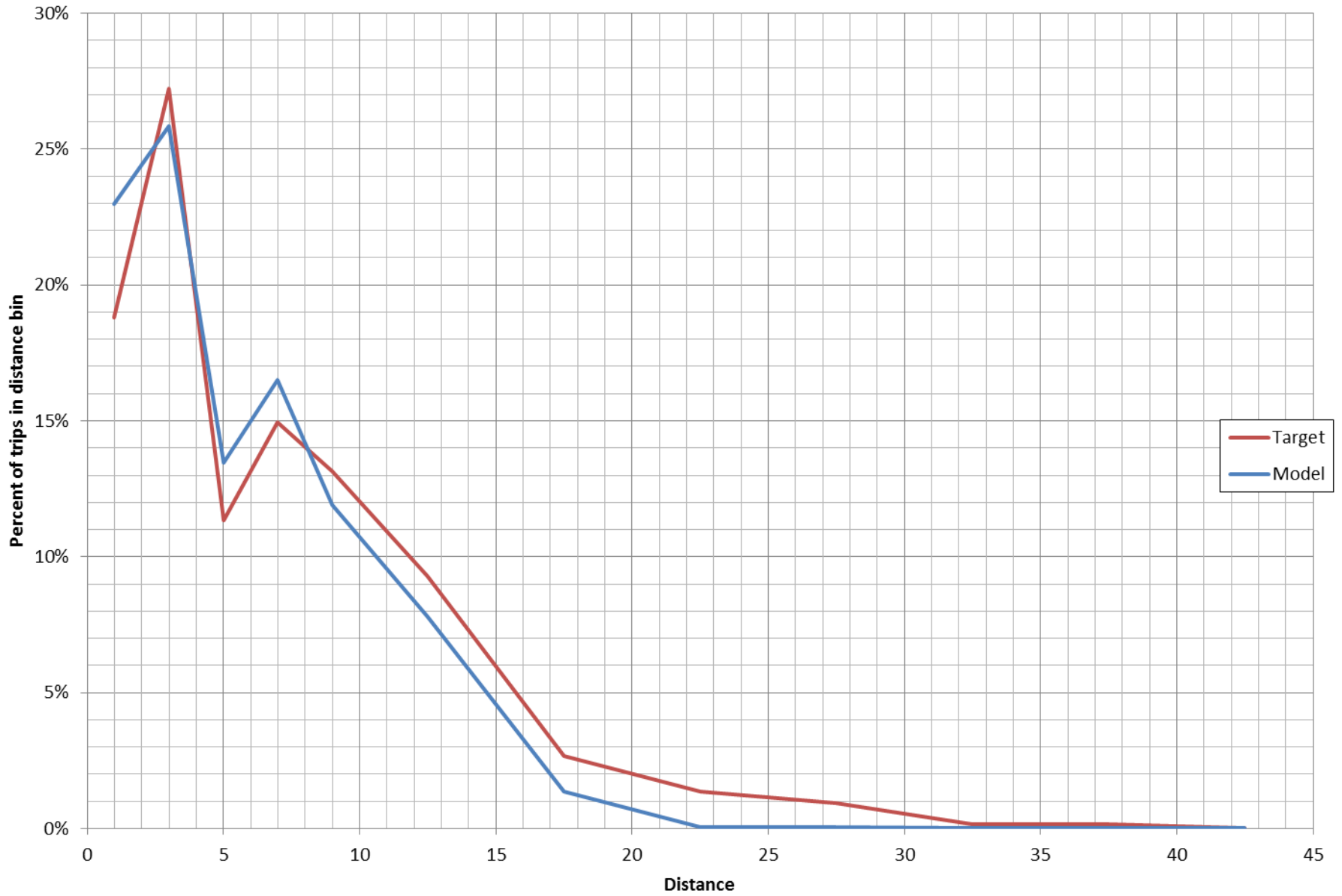
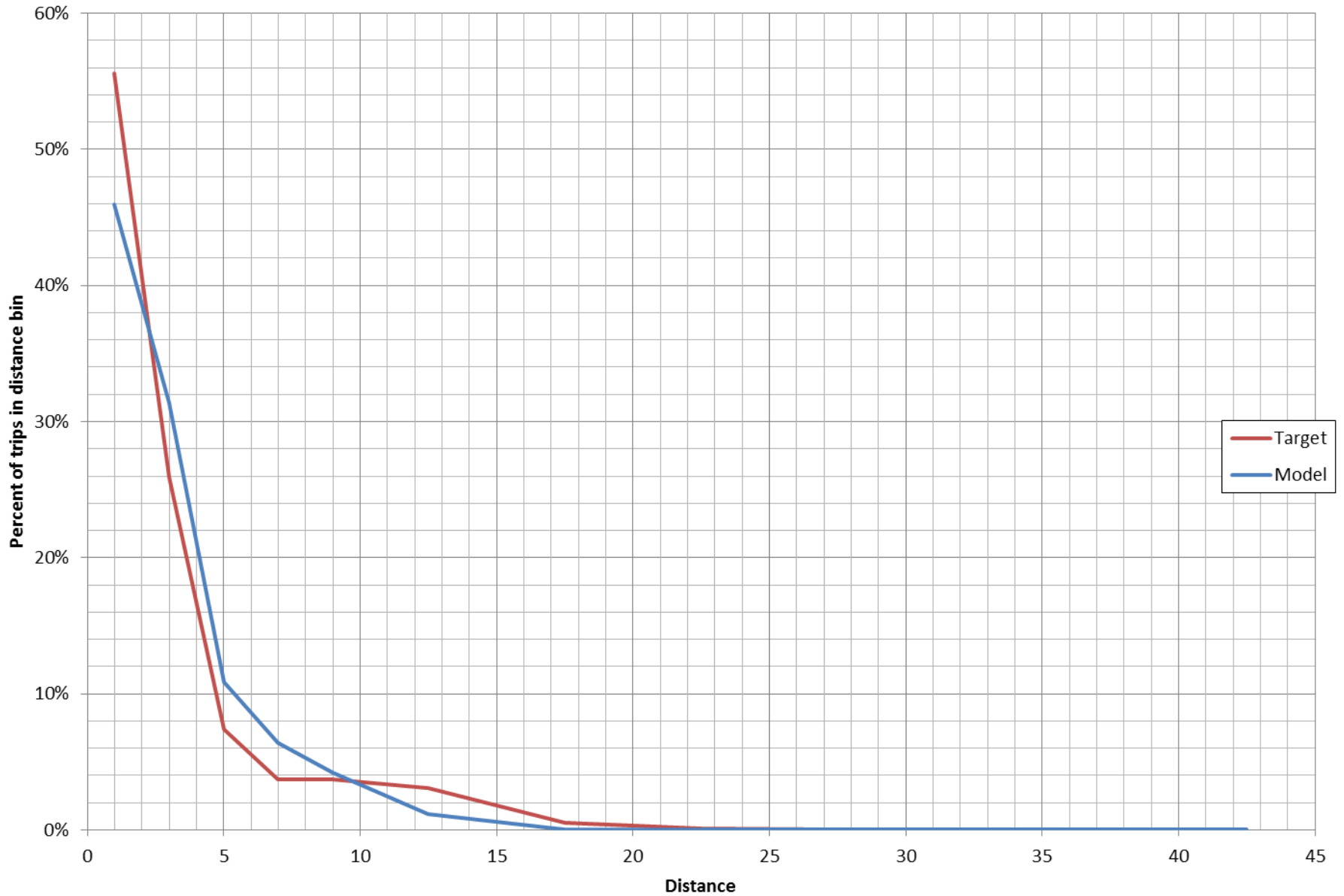Other tour primary destination distance distribution - HOV 3+

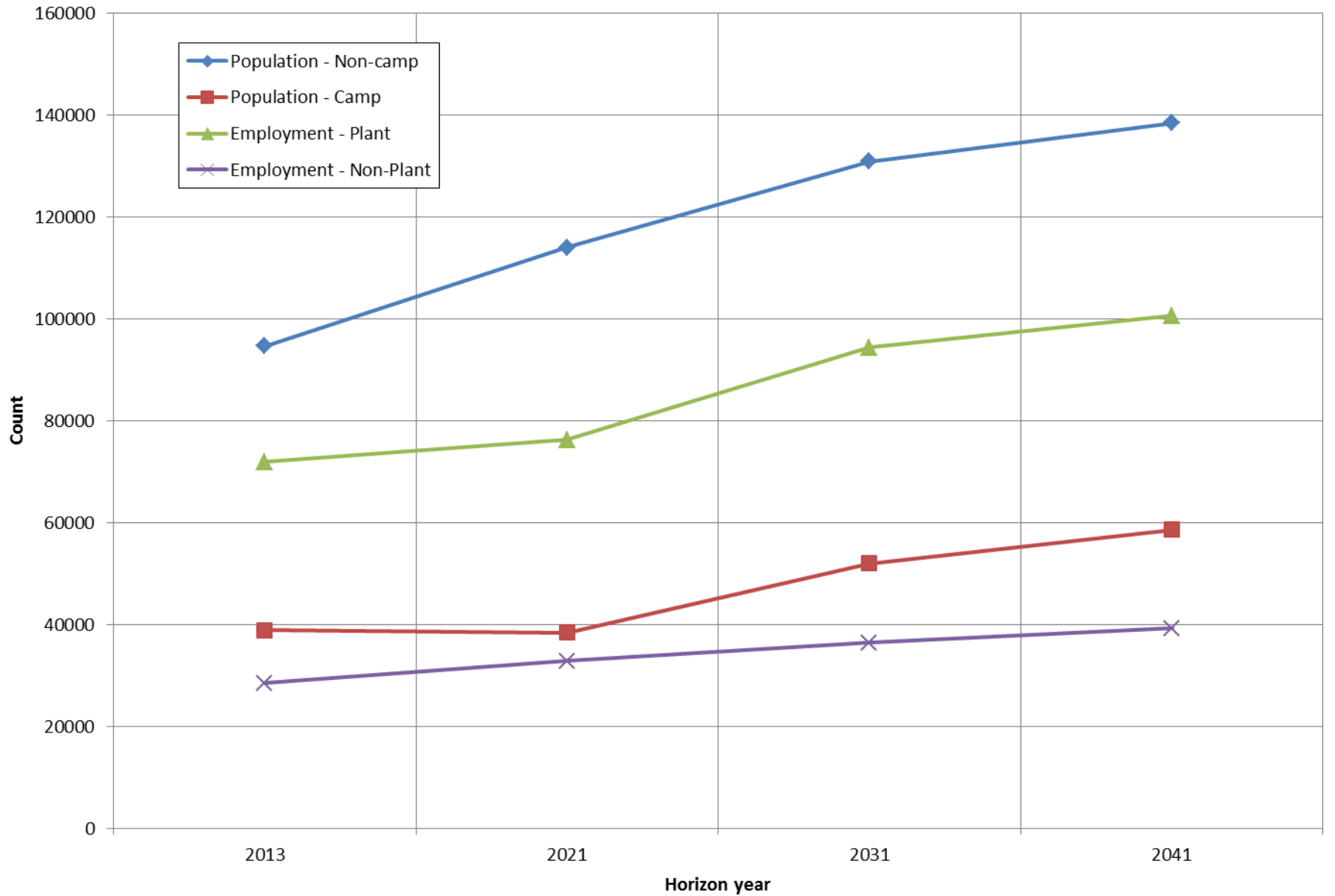# Other tour primary destination distance distribution - Transit

Other tour primary destination distance distribution - Walk

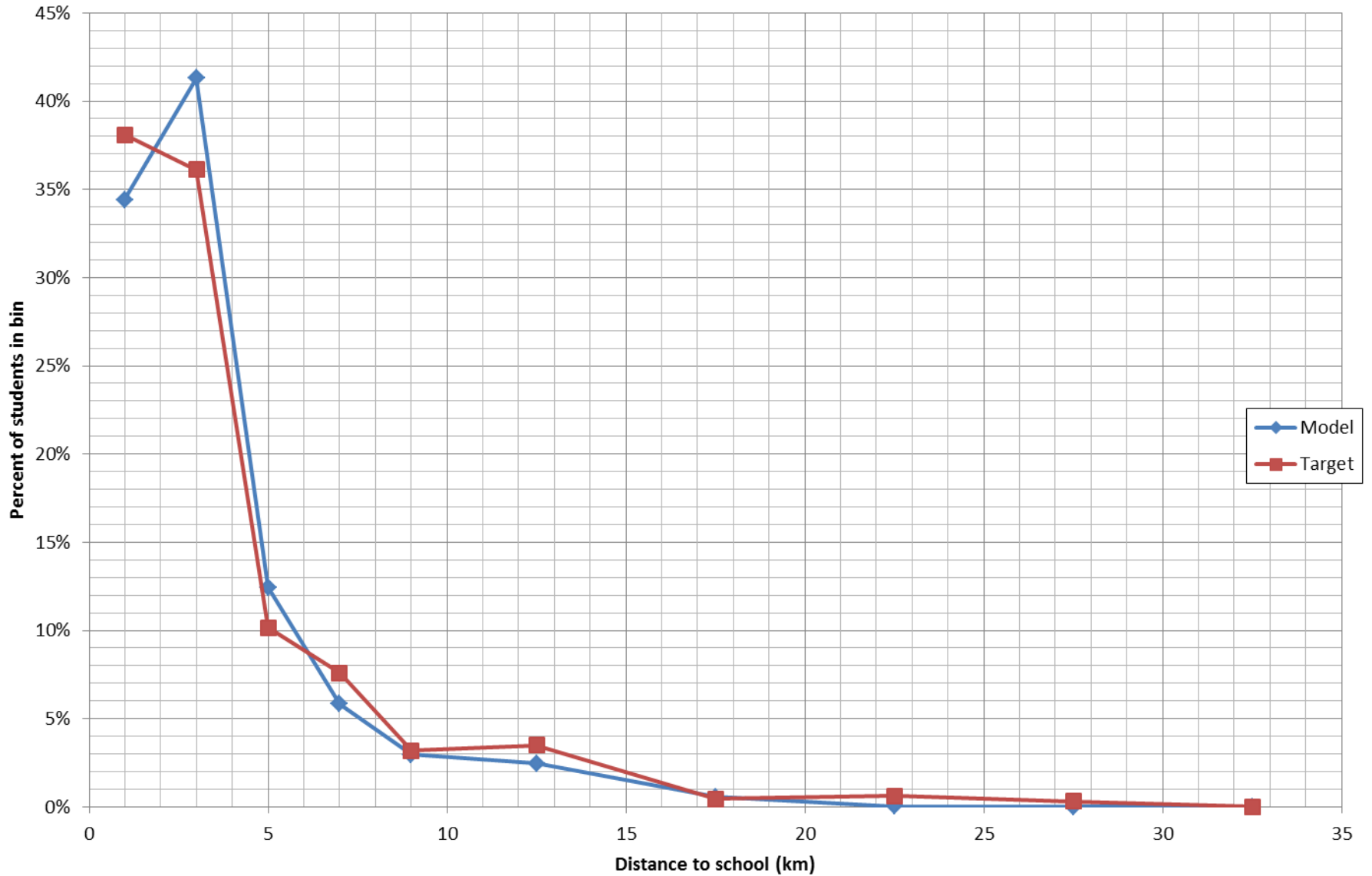**Other tour primary destination distance distribution - Bike**

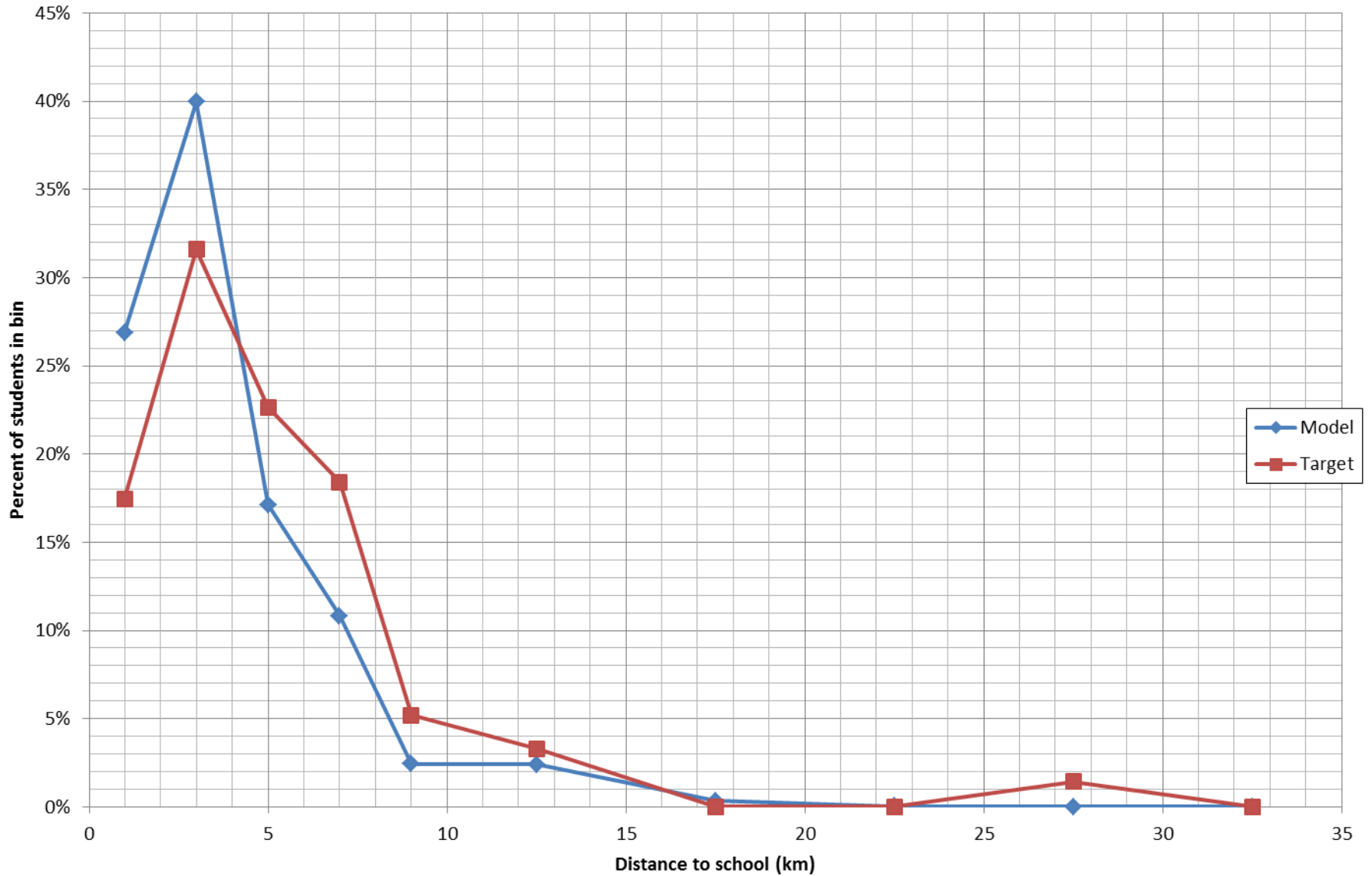**Population and employment - base and future scenarios**

School location distance distribution
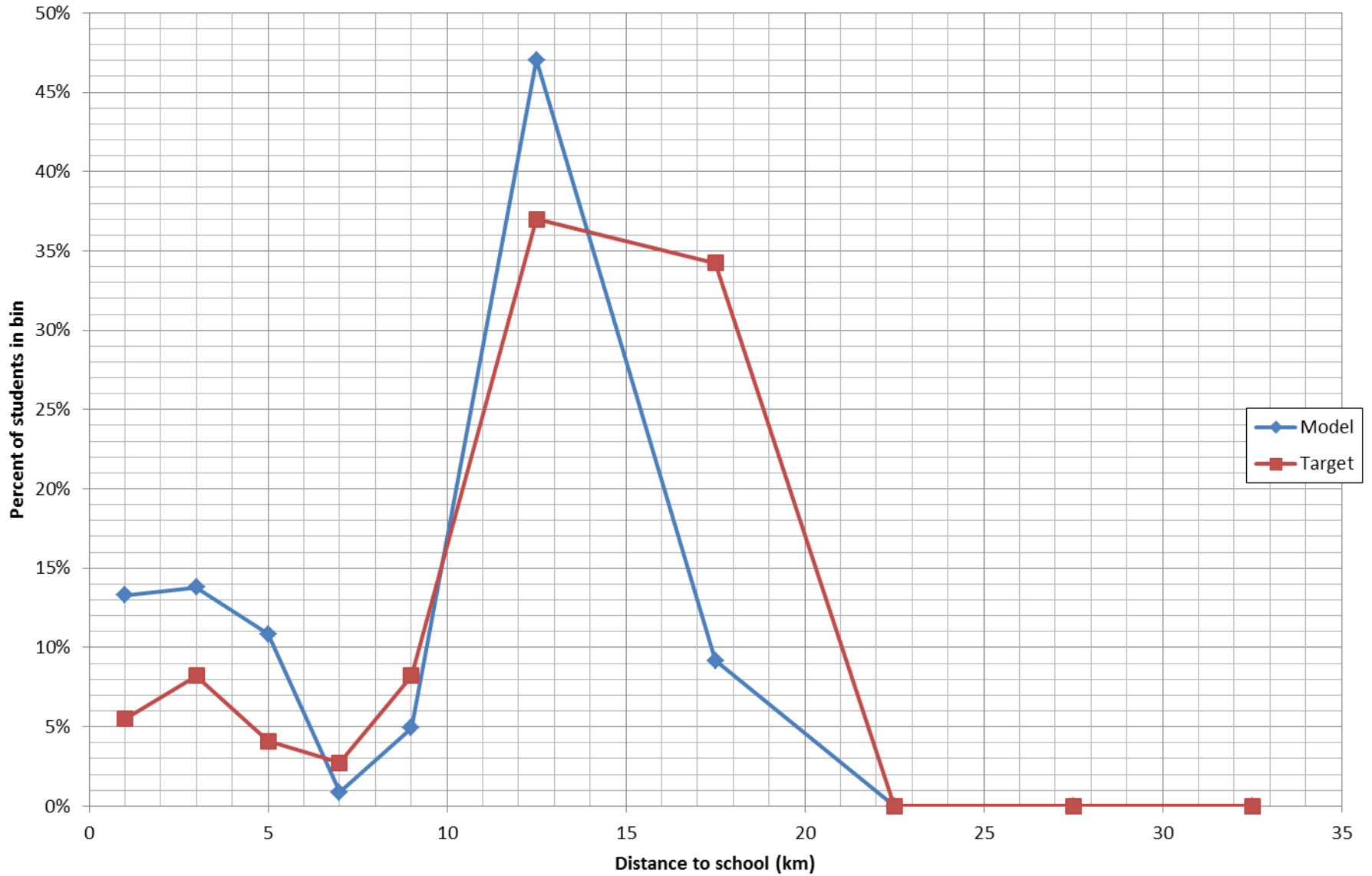**Elementary / Jr. High students**

School location distance distribution
High school students

School location distance distribution
Postsecondary students

Day role by person type

	Target	Model		Target	Model		Target	Model		Target	Model		Target	Model		Target	Model		Target	Model		Target	Model
	Youth (YO)			Grade School (GS)			Post Secondary (PSE)			Worker- Full Time (WFT)			Worker - Plant (WPlant)			Worker - Part Time (WPT)			Adult Other (AO)			Senior (Sen)	

Legend: ■ Do Not Travel ■ Work ■ School ■ Both ■ Other