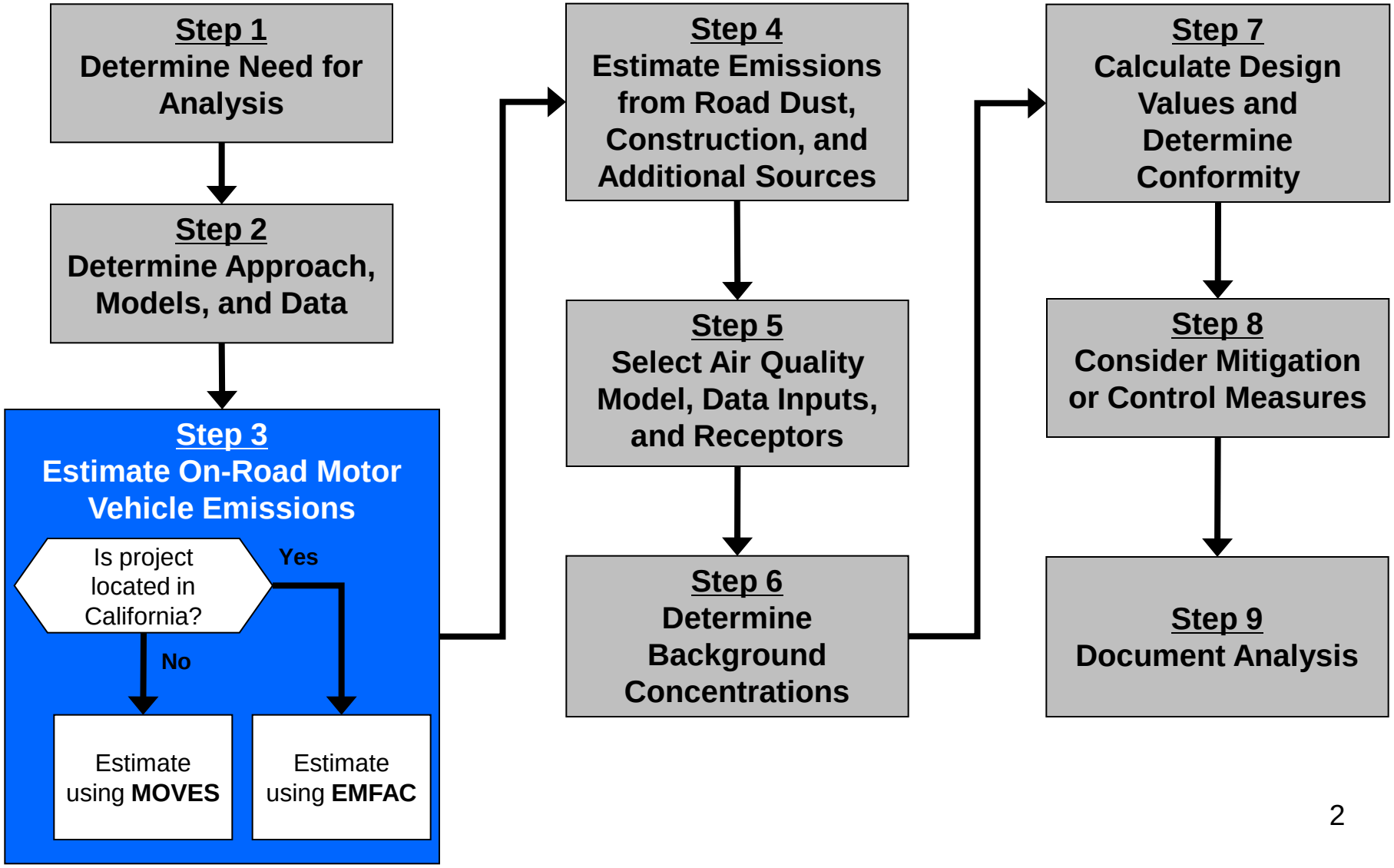
Module 2

Using MOVES for PM Hot-spot Analyses

Completing a PM Hot-spot Analysis



Module Overview

- Understand how MOVES works at the project level
- Discuss how highways, intersections, and off-network areas can be characterized as MOVES links
- Discuss how MOVES can incorporate activity information for each link

Module Overview

- Determine the number of MOVES runs needed for an analysis
- Review the PM Hot-spot Guidance for each MOVES panel and input option
- Set up, execute, and review a MOVES “mini-run”
- Complete a MOVES run for our example analysis

Key References

- PM Hot-spot Guidance, Section 4
- Conformity rule sections 93.105(c)(1)(i), 93.110 and 93.123(c)
- MOVES2010b User Guide and supporting documentation
- EPA MOVES website: www.epa.gov/otaq/models/moves/index.htm#generalinfo
- Receive MOVES updates through listserver: www.epa.gov/OMS/models/mobilelist.htm

What is MOVES?

- MOtor Vehicle Emission Simulator
  - » MOVES2010b was released in April 2012
- Significant expansion of capabilities compared to MOBILE
- State-of-the-art modeling framework
- Based on review of millions of in-use vehicle tests
- Includes a “project-level” scale of analysis
  - » Allows detailed link-level analyses

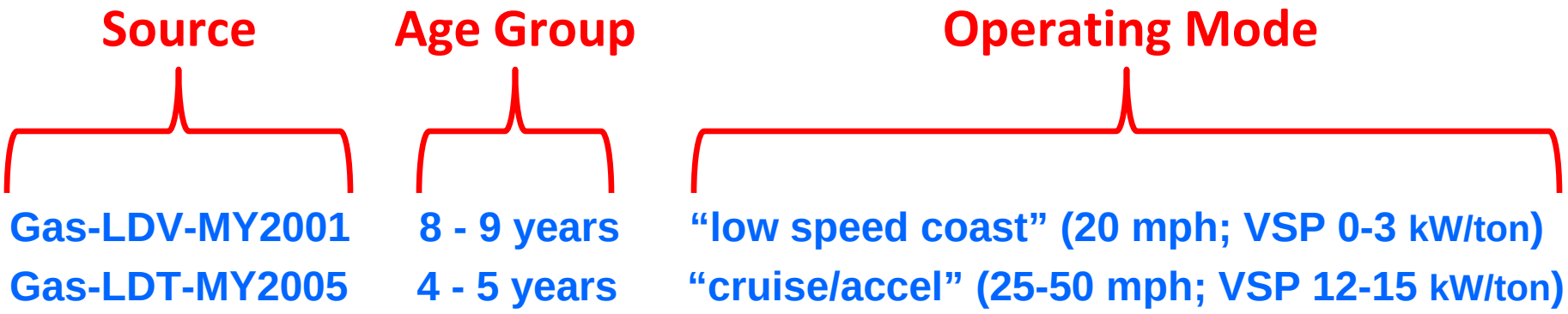
How Does MOVES Work at the Project Level?

What Does MOVES Calculate?

- Emissions for…
  - » All relevant PM processes (e.g., running, starting, crankcase, extended idling)
  - » All defined vehicle types
  - » All links defined for one specific hour per MOVES run
    - – E.g., emissions are calculated for one hour of one month of one analysis year
    - – Multiple time periods require multiple runs

How Does MOVES Calculate Emissions?

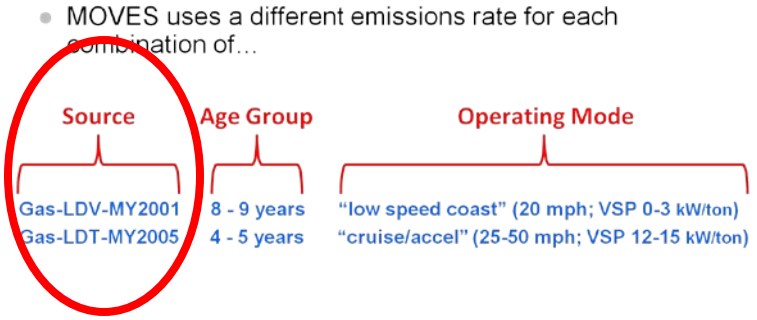
- MOVES uses a different emissions rate for each combination of…



- MOVES can calculate an emission inventory internally, or users can do this outside of MOVES by multiplying emission rates from MOVES by the appropriate activity factors

Emissions by Source Type (MOVES Source Types vs. HPMS Vehicle Types)

Highway Performance Monitoring System (HPMS) Vehicle Type	MOVES Source Type
Motorcycle	Motorcycle
Passenger Car	Passenger car
Other 4-tire, 2 axle	Passenger Truck Light Commercial Truck
Bus	Intercity Bus Transit Bus School Bus
Single Unit Truck	Refuse Trucks Short-haul Single Unit Long-haul Single Unit Motorhomes
Combination Truck	Short-haul Combination Long-haul Combination

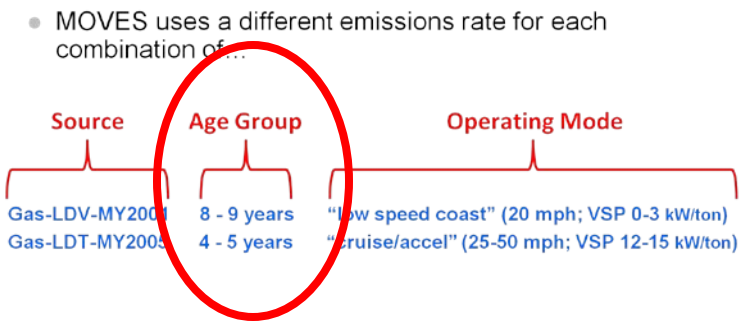


Guidance Reference:

Section 4.4.5

Emissions by Age

- Emission rates can vary by age as well as model year; activity also varies by age



- Vehicles 0-29 & 30+ years old are modeled

- Age groups used by MOVES to account for deterioration:
  - 0 to 3 years old
  - 4 or 5 years old
  - 6 or 7 years old
  - 8 or 9 years old
  - 10 to 14 years old
  - 15 to 19 years old
  - 20 or more years old

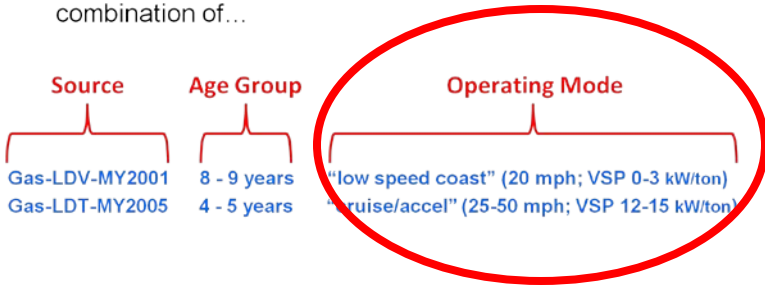
Guidance Reference:

Section 4.5.2

Emissions by Operating Mode

VSP Class (kW/tonne)	Speed Class (mph) 1-25	25-50	50 +
30 +	16	30	40
27-30			
24-27		29	39
21-24		28	38
18-21			
15-18			37
12-15		27	
9-12	15	25	
6-9	14	24	35
3-6	13	23	
0-3	12	22	33
< 0	11	21	

- MOVES uses a different emissions rate for each combination of…



Vehicle Specific Power (VSP)

A measure of the energy the moving vehicle is using at a moment in time

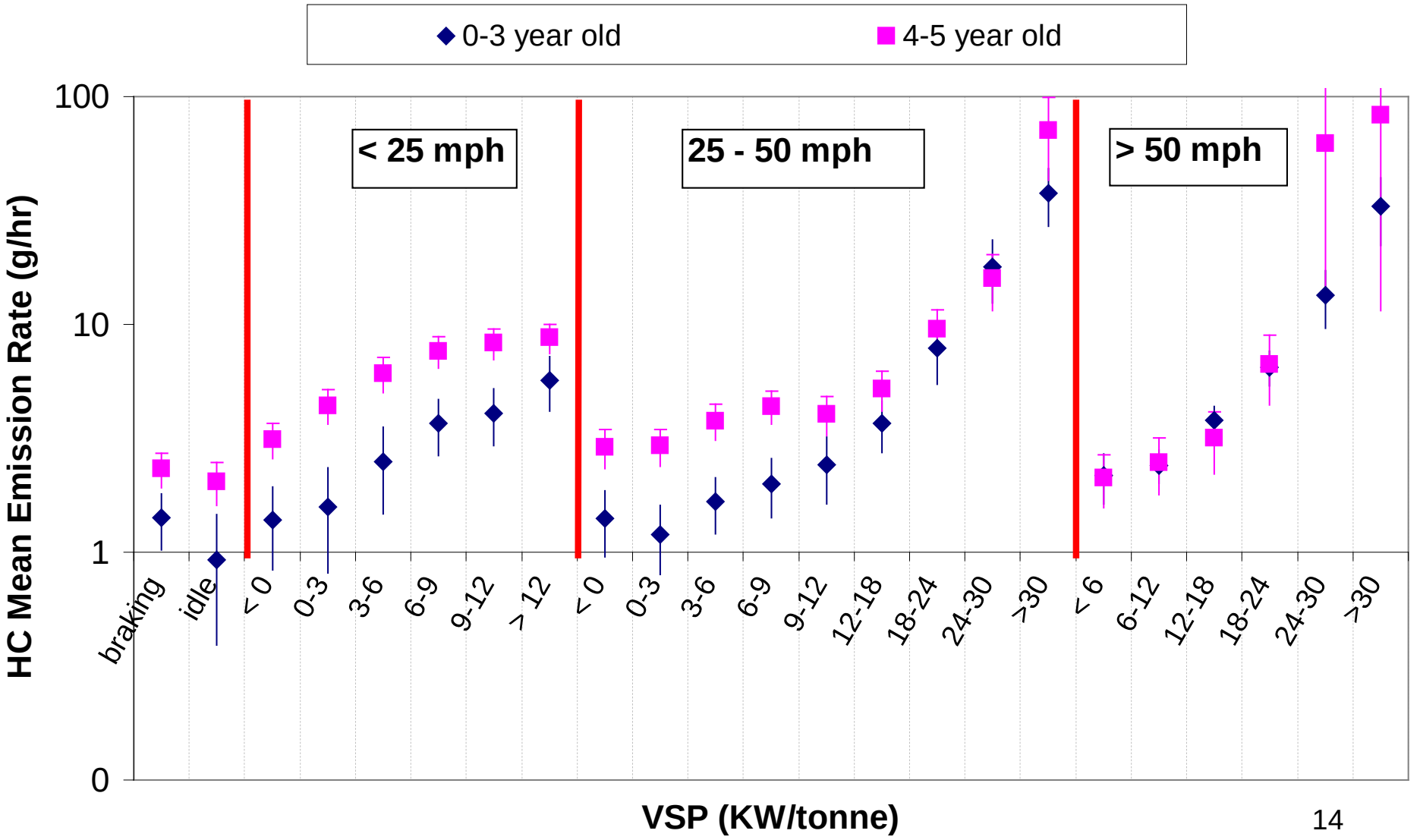
MOVES Operating Mode Bins

- Running activity bins
  - » Division of total activity into categories that differentiate emissions
  - » Defined by **speed** and **VSP** for running emissions (from previous slide)

- Start and extended idle activity bins
  - » Used to define soak-time distribution and/or extended idling for “off-network” emissions
    - – Off-network refers to an area of activity not occurring on a roadway (e.g., involves starts or extended idling)

HC Emission Rates By Bin

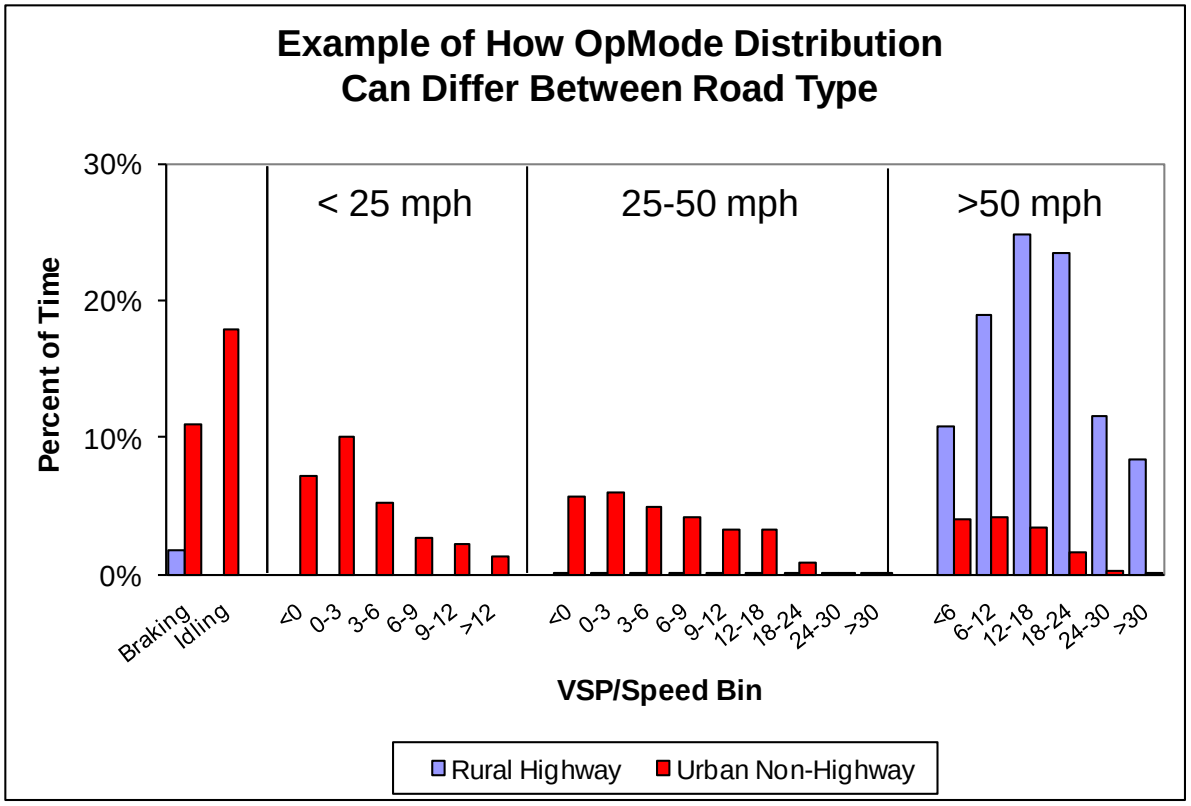
Source Bin: LDV Gasoline / 1996 MY



Defining Vehicle Activity in MOVES

All Running Links have an OpMode distribution (i.e., fraction of time spent in each operating mode)

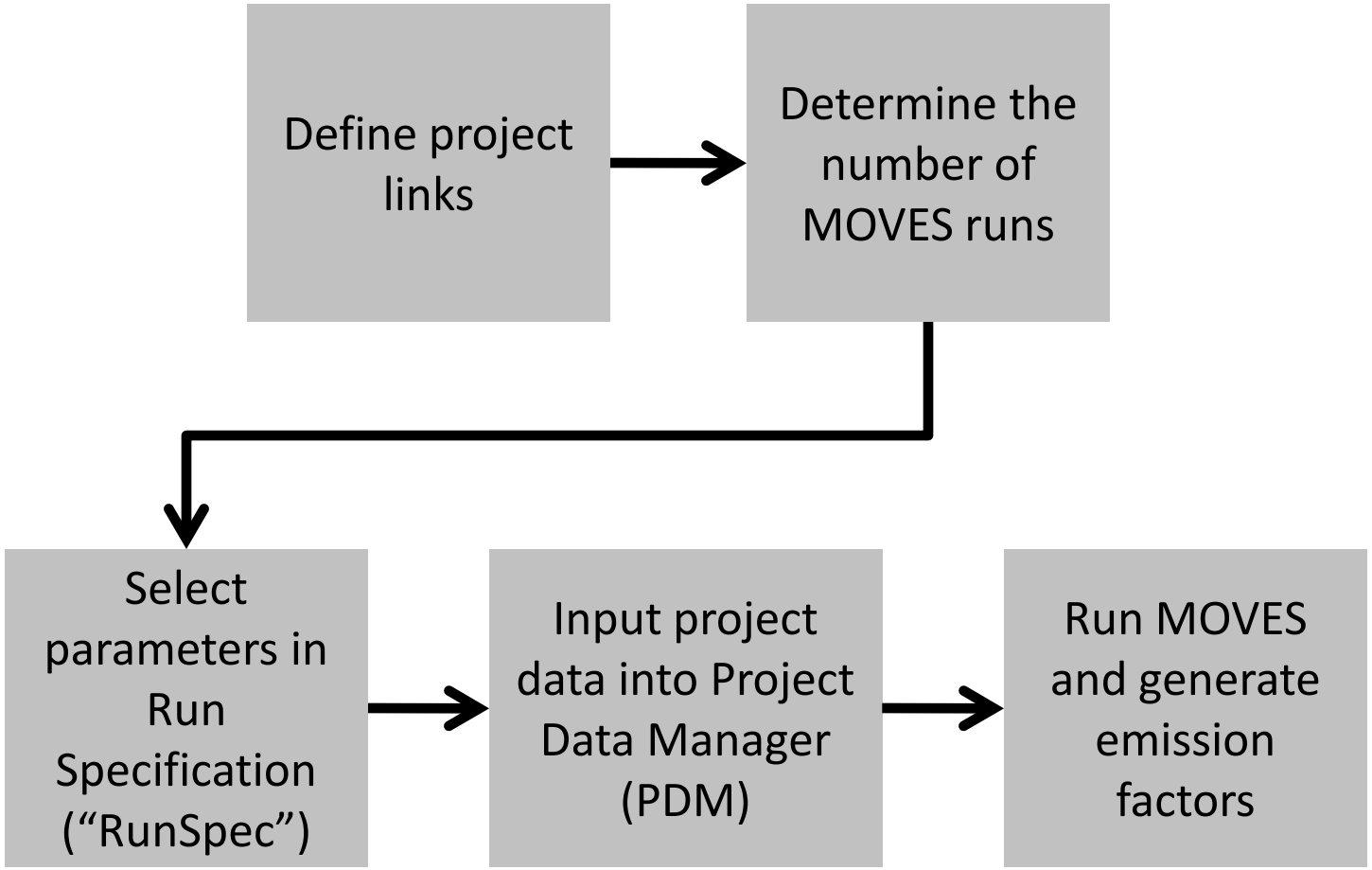
- This can be explicitly defined by the user or…
- MOVES can calculate an OpMode distribution based on either an average speed or vehicle trajectory provided by the user
- More later on specific options



Guidance Reference:

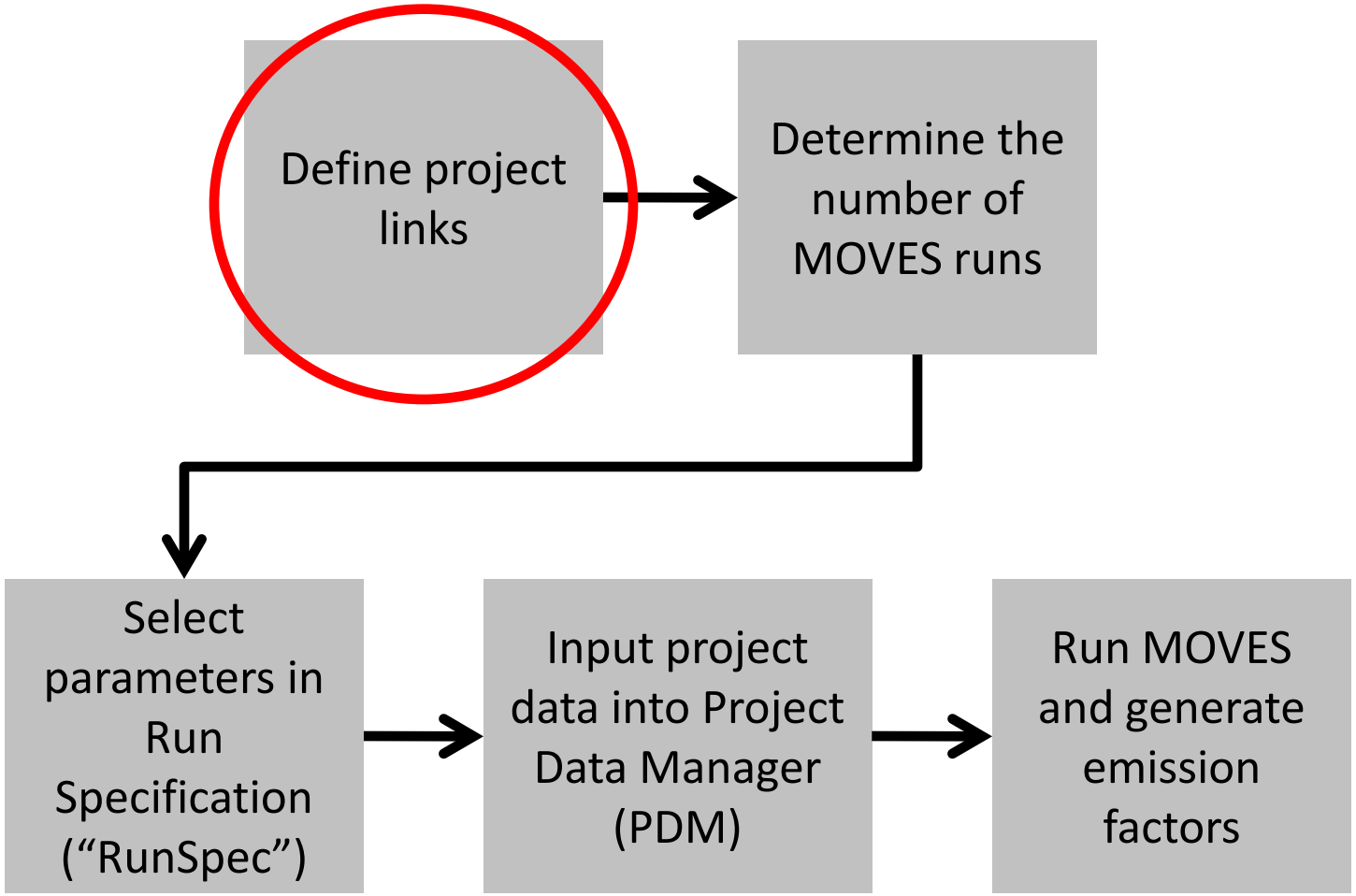
Section 4.5.7

Running MOVES at the Project Scale



Adapted from Guidance Exhibit 4-1

Running MOVES at the Project Scale



Adapted from Guidance Exhibit 4-1

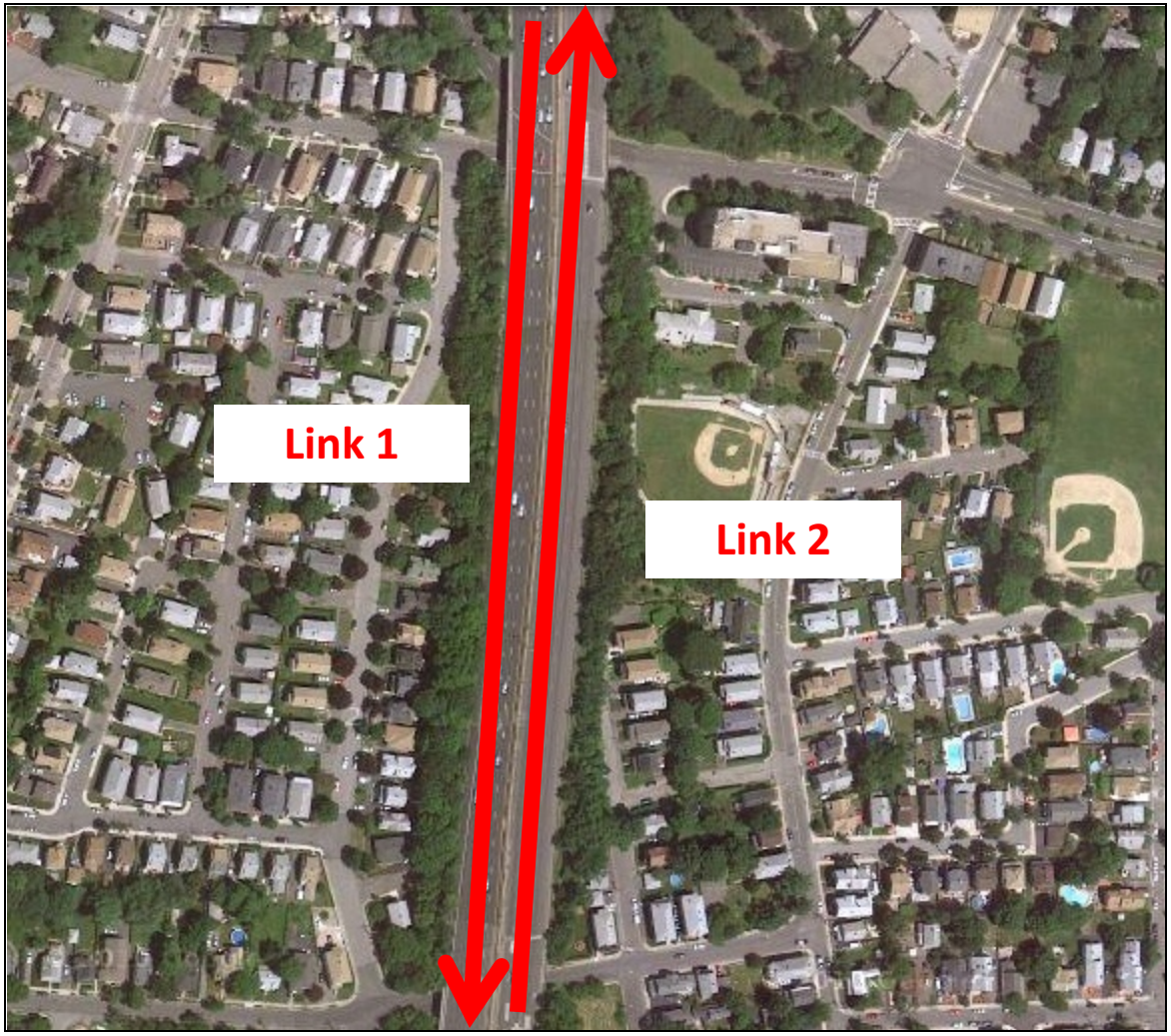
What Is a MOVES Link?

- A segment of road or an “off-network” location where a similar type of vehicle activity occurs
- Types of links include:
  - Running Links
    - Free-flow highway and ramps
    - Intersection (cruise, deceleration, idle, and acceleration)
  - Off-Network Links
    - Start and extended idling
- Remainder of module refers to a MOVES link as a “MOVES link” or a “link”

Guidance Reference:

Section 4.2

What Is a MOVES Link?



More on MOVES Links

- From link-specific activity and other inputs, MOVES calculates emissions from every link of a project for a specific hour
- No limit to number of links that can be defined in MOVES
- Output from MOVES for each link will be used to characterize sources in air quality model (which are geographically oriented using a coordinate system)

Guidance Reference:

Section 4.2

Types of Projects and MOVES Inputs

- Highway and intersection projects
  - » Running links (includes idling at traffic signals)
    - – Defined through "**Links**" Importer (at PDM step -- more later)
    - – Running exhaust, crankcase, brake/tire wear emissions are the focus
- Transit or other terminal projects
  - » Off-network links
    - – Defined through "**Off-network**" Importer (also at PDM step)
    - – Used to calculate start and extended idle emissions
- Some projects involve multiple types of links

Guidance Reference:

Section 4.2

General Guidance for All Projects

- Goal of defining a project's links in MOVES is to accurately capture emissions where they occur
- Should include segments with similar traffic/activity conditions and characteristics
- In general, the definition of a link will depend on how much the vehicle activity (accel, decel, cruise, or idle) changes over the length of roadway, data availability, and the modeling approach used

Guidance Reference:

Section 4.2

General Guidance for All Projects

- EPA encourages the development of sufficient travel activity data to capture expected ranges of traffic conditions for build and no-build scenarios

- PM hot-spot analyses must be based on latest planning assumptions or data available when the analysis begins (40 CFR 93.110)

- Use interagency consultation process to select models, methods, and assumptions as described in local procedures (40 CFR 93.105(c)(1)(i))

Guidance Reference:

Section 4.3

Modeling Highways and Intersections in MOVES

General Guidance for Highway and Intersection Links

- Divide project into separate MOVES links to allow sufficient resolution at different traffic and activity patterns
  - » Local traffic data should be used to characterize each link sufficiently
- In general, density of links depends on project type:
  - » Less links for free-flow highways
  - » More links expected for intersections

Guidance Reference:

Section 4.2

Highway Links

- For free-flow highway links (e.g., freeways) where vehicle behavior is fairly constant, the length of the MOVES link could be longer
  - » In such cases, detailed activity data will have a smaller impact on results
- Free-flow highway links are assumed at steady-state flow
  - » Relatively constant speed and minimal acceleration or deceleration
  - » Expect free-flow speed if volumes are below 1500 vehicles per hour per lane
- For highway ramps, multiple links may be needed to describe variation in vehicle activity
  - » More details later

Guidance Reference:

Section 4.2.1

Intersection Links

- Intersections need to be treated separately from free-flow MOVES links that connect to those intersections
  - » Approaches and departures from intersections will likely involve acceleration, deceleration, and idling activity not present on free-flow link

- Definition of link length will depend on:
  - » Geometry of intersection
  - » How that geometry affects vehicle activity
  - » The level of detail of available activity information
  - » See Appendix D of PM Hot-spot Guidance for more details

Guidance Reference:

Section 4.2.1

Examples

- New links could be defined when…
  - » Speeds change (e.g., changes in activity over a highway ramp or intersection)
  - » Volumes change (e.g., changes in volumes when vehicles use freeway exit ramps or turn at an intersection)
  - » Fleets change (e.g., truck-only lane vs. all-purpose lane)
  - » Facility purpose changes (e.g., a turn lane vs. a through lane of an intersection)

- Details provided later on some of these examples

Defining Highway/Intersection Vehicle Activity in MOVES

For each link, the user can choose one of the following options:*

1. Define a **link average speed** through the "Links" table
   - » MOVES has default OpMode distributions based on typical driving cycles
   - » Different road types have different default OpMode distributions
2. Enter a **link specific drive cycle**
   - » MOVES calculates OpMode distribution from second-by-second speed/grade profile
3. Directly enter a link specific **OpMode distribution** (not covered in this course)
   - » Describes fraction of time spent in each OpMode bin on a link
   - » Not a direct output from current traffic models – but may be derived

Choice of approach used for defining activity will affect the way links are defined.

** E.g., a drive cycle may be developed for a ramp link, while average speeds are used for all other links*

Guidance Reference:

Section 4.5.7

Activity Option 1: Using Average Speed Input

- Defining a lower average speed will most likely result in higher emissions in MOVES. *However…*
- MOVES will use a default drive cycles consistent with the average speed and vehicle type defined
- Note that “Queue”, “Acceleration”, and “Cruise” links will include idle, cruise, acceleration, and deceleration activity in different proportions based on the link average speed
- **Other vehicle activity options may be preferred to more precisely define intersection activity (if data are available)**

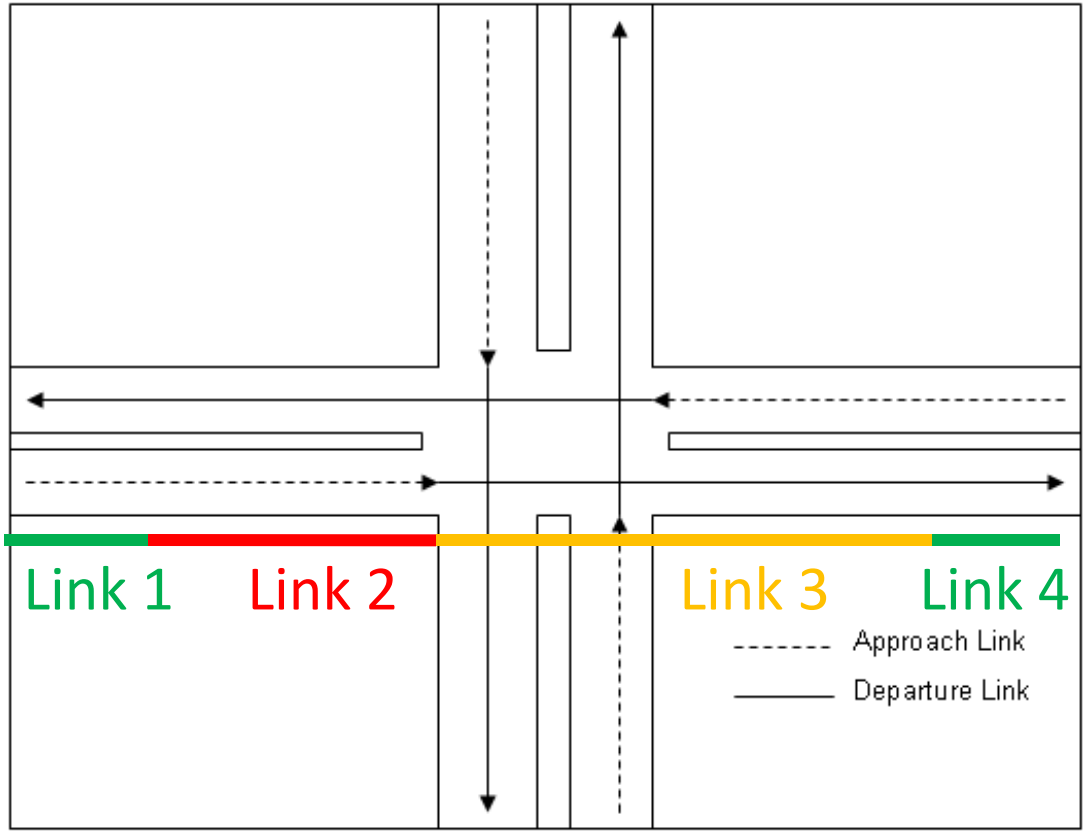
Guidance Reference:

Section 4.5.7 & App D

Activity Option 1: Using Average Speed Input

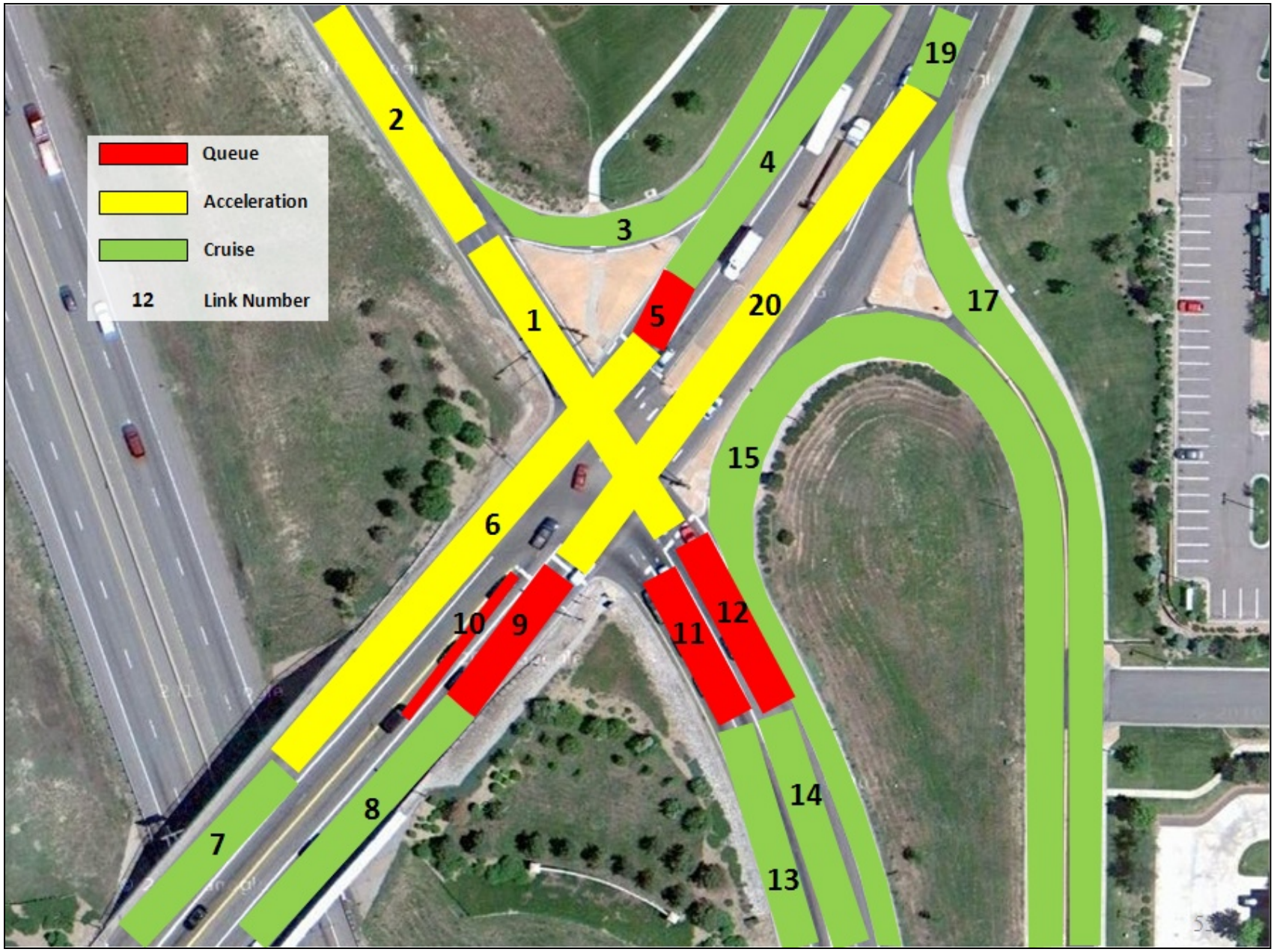
In this example, links are defined to capture four unique areas of activity:

- **Link 1** – Cruise
- **Link 2** – "Queue" - Deceleration, Idle, and Acceleration (red light) also Cruise (green light)
- **Link 3** – Acceleration (red light) also Cruise (green light)
- **Link 4** - Cruise

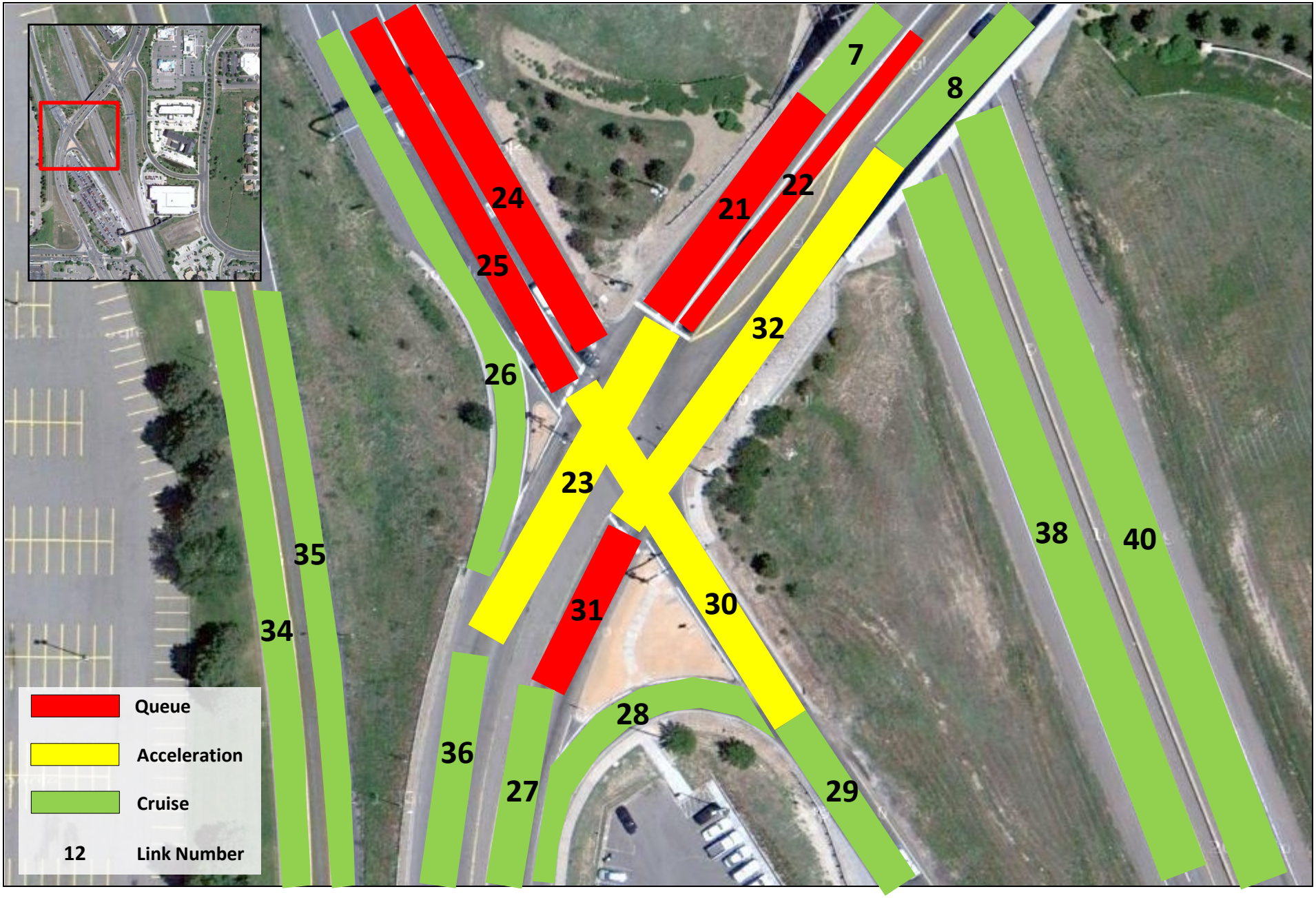


Defining Project Links (Using Average Speed Approach)

Defining Project Links (Using Average Speed Approach)

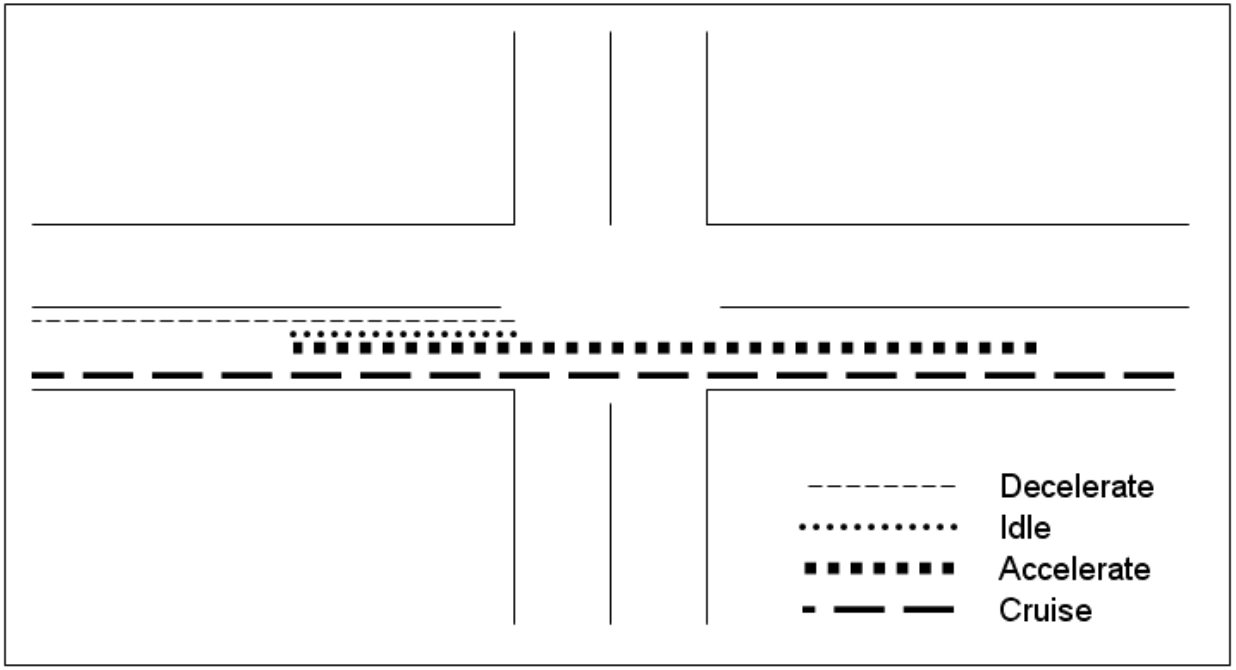


Links Exercise Handout


7
8
24
25
21
22
26
32
23
35
34
31
30
38
40
28
36
27
29
Queue
Acceleration
Cruise
12
Link Number

Activity Option 2: Using Link Drive Schedules

- Each explicit type of activity can be considered a separate link (overlapping)
- Volumes defined on each type of link depend on signal timing
- Results can be modeled as individual (overlapping) links in air quality models



Note: Modeling activity using over-lapping drive schedules requires some additional considerations not covered in this course

Guidance Reference:

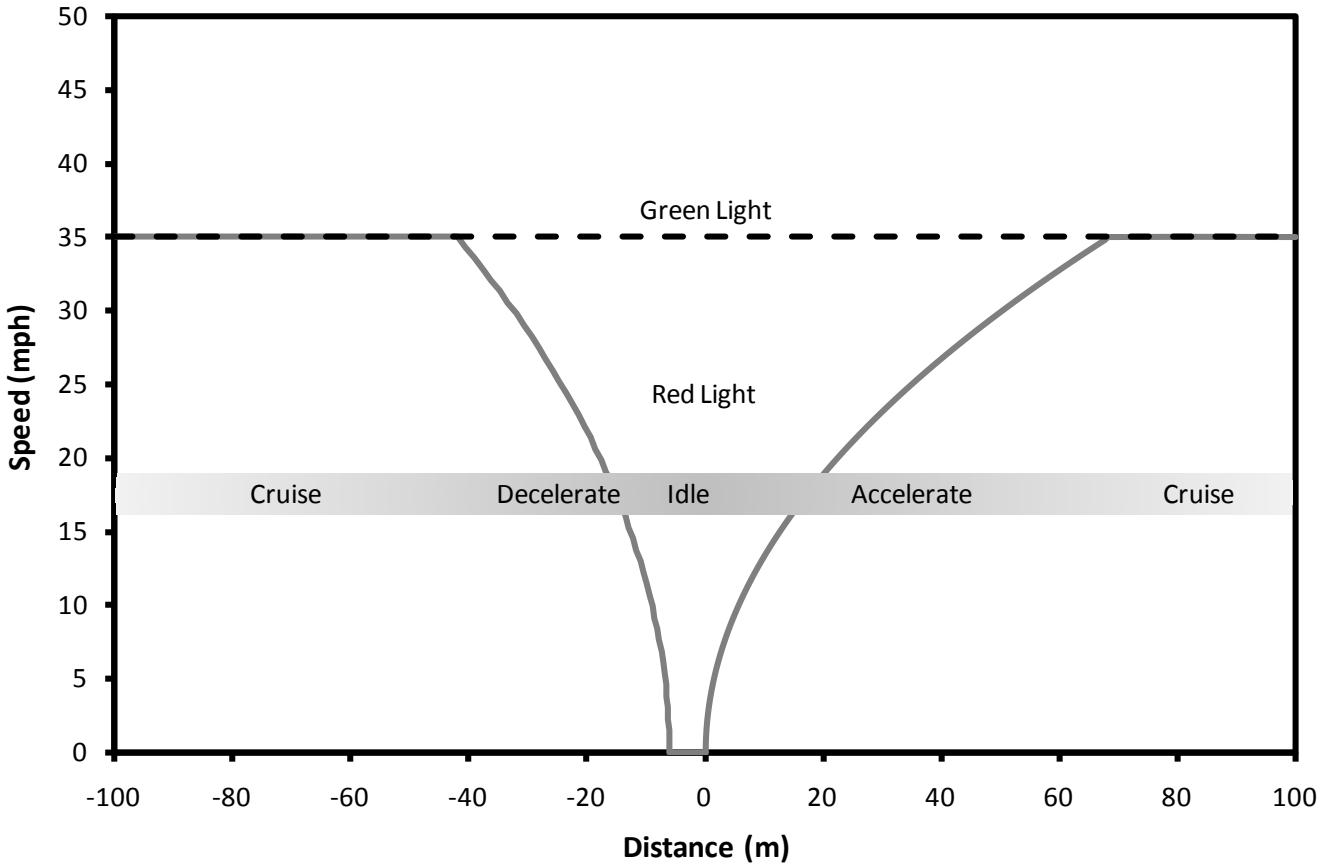
Section 4.5.7 & App D

Activity Option 2: Using Link Drive Schedules

In an under-capacity situation, vehicles passing through intersections will use one of the following paths:

1. **Green light** cruise

2. **Red light** cruise → decelerate → idle → accelerate → cruise



Guidance Reference: Section 4.5.7 & App D

Activity Option 3: Using OpMode Distributions

- Users may define vehicle activity as the proportion of time spent in different modes of activity

- Determining the appropriate OpMode bin for a given vehicle and type of activity is difficult
  - » Requires additional VSP calculation
  - » Not a direct output from current traffic models – but can be derived
  - » This method is not covered in this course

Guidance Reference:

Section 4.5.7 & App D

Typical Traffic Data

- What traffic data might be available for a project?
  - » Network schematics with segment data:
    - – Annual average daily traffic (AADT)
    - – Peak-hour traffic volume (% of AADT)(k)
    - – Directional split in peak-hour (D)
    - – Truck percentage, daily or peak-hour (T)
    - – Average speed (most likely for peak-hour)
- What additional traffic data might be needed?
  - » Volumes, fleet mix, and speeds for additional time periods
  - » Operational details (cruise, queue, deceleration, acceleration)
- **Tips for applying traffic data covered later in this module**

Guidance Reference:

Section 4.2 & 4.3

Modeling
Terminals and Parking Lots

Defining Links for Terminals and Parking Lots

- Example projects include a bus terminal, intermodal freight terminal, or a parking lot
- User should divide such a project into separate links to appropriately characterize variability in emission density
  - » Each link describes an area with a certain number of vehicle starts per hour, or a certain number of vehicles idling each hour
  - » Running links also possible (see next slide)
- May exclude sources that are determined to be insignificant to project emissions (e.g., separate service drive, small employee parking lot)

Guidance Reference:

Section 4.2.2

Defining Links for Terminals and Parking Lots

- Most terminal and parking lot activity will be captured on an "off-network" link
  - » **Only one off-network link allowed per MOVES run**

- However, some terminal projects may have significant running emissions similar to highway and/or intersection projects
  - » E.g., trucks arriving and leaving the loading area of freight terminal
  - » Follow guidance for running links, as appropriate
  - » See Section 4.2.1 and Appendix D of PM Hot-spot Guidance

Guidance Reference:

Section 4.2.2

Handling Start and Idle Emissions

- MOVES can estimate start emissions for all sources types

- MOVES defines two types of idling emissions:
  - » "Extended Idling"
    - – **Applies only to long-haul combination trucks**
    - – Gives emission rates based on long-duration idling while trucks are hoteling
    - – Treated in MOVES as an off-network input
  - » All other idling (e.g., from idling buses at a terminal)
    - – Treated in MOVES as a running link with a speed of "0" mph
    - – Not included as an off-network input

Guidance Reference:

Section 4.2.2

Off-Network Data for Terminals and Parking Lots

Emission Type	Applies to…	Off-Network Data Required
Starts	All source types	• Vehicle population • Start fraction • Soak time distribution
Extended Idling	Long-haul combination trucks in hoteling operation only	• Vehicle population • Extended idling fraction
All other Idling	All source types	None – not handled in MOVES as an off-network link. Treat as a running link with a speed of "0" mph

Note: How and where to enter the off-network data into MOVES is covered later in this module

Guidance Reference:

Section 4.2.2

Typical Terminal Data

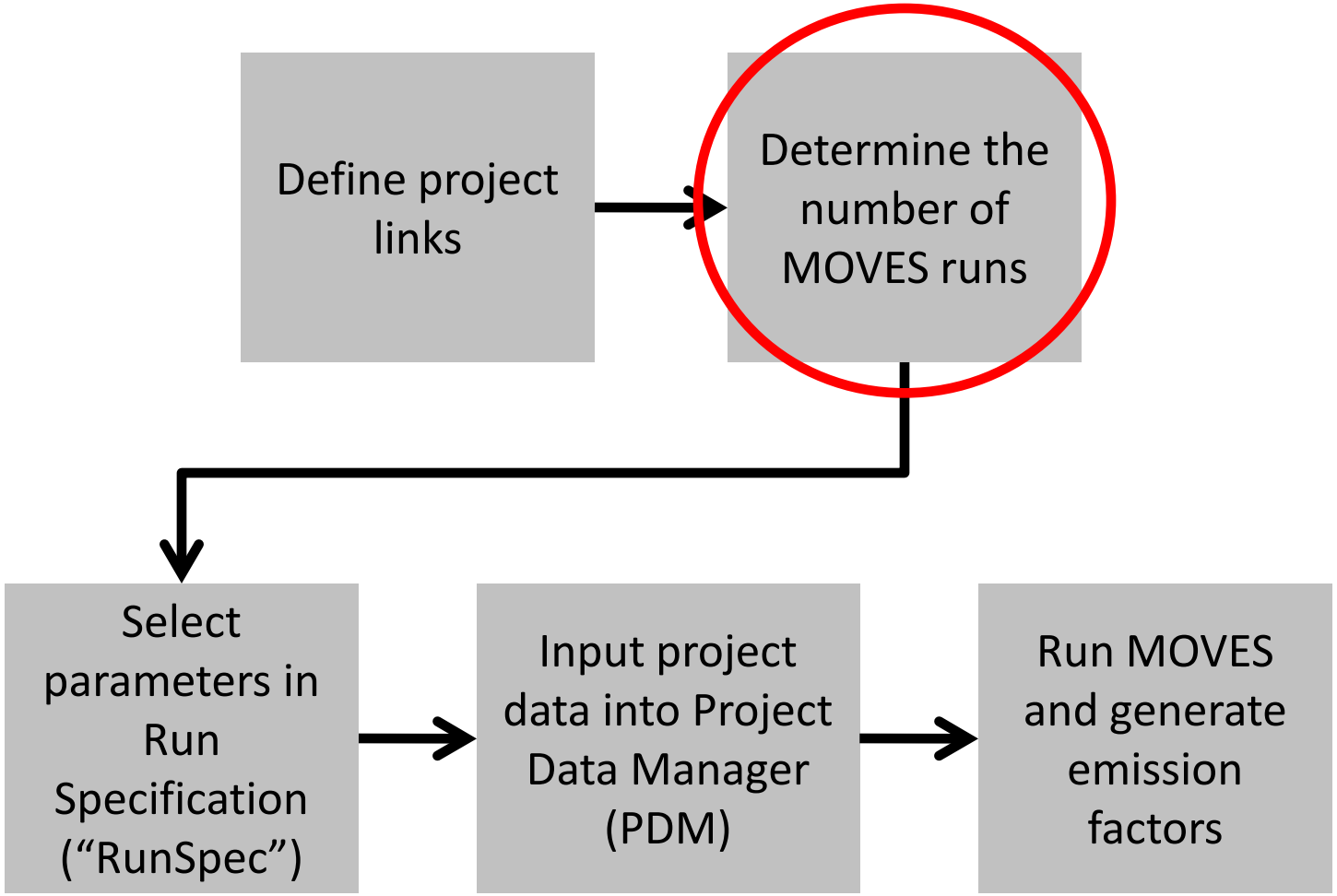
- What data might be available for a project?
  - » Fleet mix
  - » Hourly estimates for starts and number of vehicles
    - – Regular idling (e.g., bus idle) – idle dwell time
    - – Extended idling (long-haul combination trucks only)
  - » Running emissions in some cases

- What additional data might be needed?
  - » Soak-time distribution (when vehicles are parked before starting)
  - » Operational details for running links (cruise, queue, deceleration, acceleration)

Guidance Reference:

Section 4.2.2

Running MOVES at the Project Scale



Guidance on Number of Runs

Applicable NAAQS	Build Scenario	No-build Scenario
Annual $PM_{2.5}$ NAAQS only	16	16
24-hour $PM_{2.5}$ NAAQS only	16 (4 in certain cases)	16 (4 in certain cases)
24-hour PM_{10} NAAQS only	16 (4 in certain cases)	16 (4 in certain cases)
Annual and 24-hour PM NAAQS	16	16

- 4 hours of a weekday x 4 quarters = 16 runs per scenario
- "Certain cases" where only four runs may be necessary include analyses in areas where the PM violations only occur in one quarter
- The decision to model less than 16 runs should be decided upon through the interagency consultation process

Guidance Reference:

Section 4.3.1

Why Number of Runs Matters

- Recommendations on the number of runs reflect the need to capture emissions variability across the day and year

- Emissions based on:
  - Temperature
  - Vehicle Volumes
  - Vehicle Speeds
  - Fleet Mix

- Air quality also affected by the timing of emissions across the day and year

Guidance Reference:

Section 4.3.1

Guidance for Highway/Intersection Projects

- Typical travel activity data involves annual average daily traffic (AADT) volumes, with an allocation factor for a daily peak-hour volume

- The most reasonable methods in accordance with good practice should be used to obtain the peak-hour allocation factors and diurnal distribution of traffic
  - » In accordance with interagency consultation procedures (40 CFR 93.105(c)(1)(i))

Guidance Reference:

Section 4.3.2

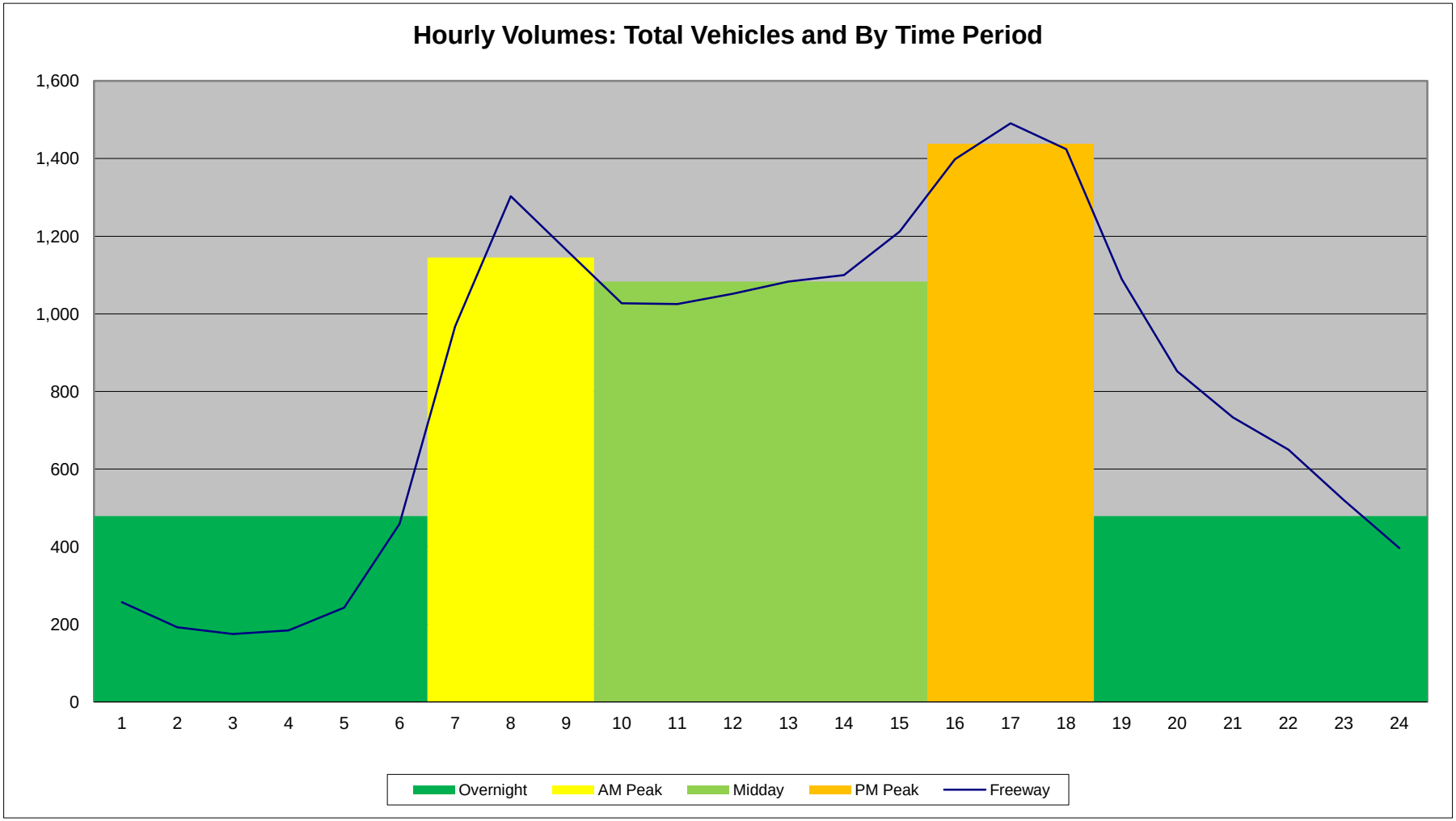
Guidance for Highway/Intersection Projects

- 16 runs will capture emissions for:
  - » Four quarters (January, April, July, and October)
  - » Four weekday time periods:
    - – Morning peak (AM) - Evening peak (PM)
    - – Midday (MD) - Overnight (ON)
- AM and PM peak periods should be run with peak-hour traffic activity
- MD and ON periods should be run with average-hour (or off-peak) activity
- Results for each of the 4 hours can be extrapolated to cover entire day

Guidance Reference:

Section 4.3.2

Traffic Volumes



Determining Representative Time Periods

A suggested approach for an analysis employing the average-hour/peak-hour traffic scenario:

- Morning peak (AM) emissions based on traffic data and meteorology occurring between 6 a.m. and 9 a.m. (emissions from one hour/one MOVES run represent all three hours)
- Midday (MD) emissions based on data from 9 a.m. to 4 p.m.
- Evening peak (PM) emissions based on data from 4 p.m. to 7 p.m.
- Overnight (ON) emissions based on data from 7 p.m. to 6 a.m.

Note: Longer or shorter periods of time can be used if local or project-specific data supports; information should be documented in PM hot-spot analysis

Guidance Reference:

Section 4.3.2

Determining Representative Time Periods

MOVES Run Scenario	Representative Period
January	January, February, March
April	April, May, June
July	July, August, September
October	October, November, December

Guidance Reference:

Section 4.3.2

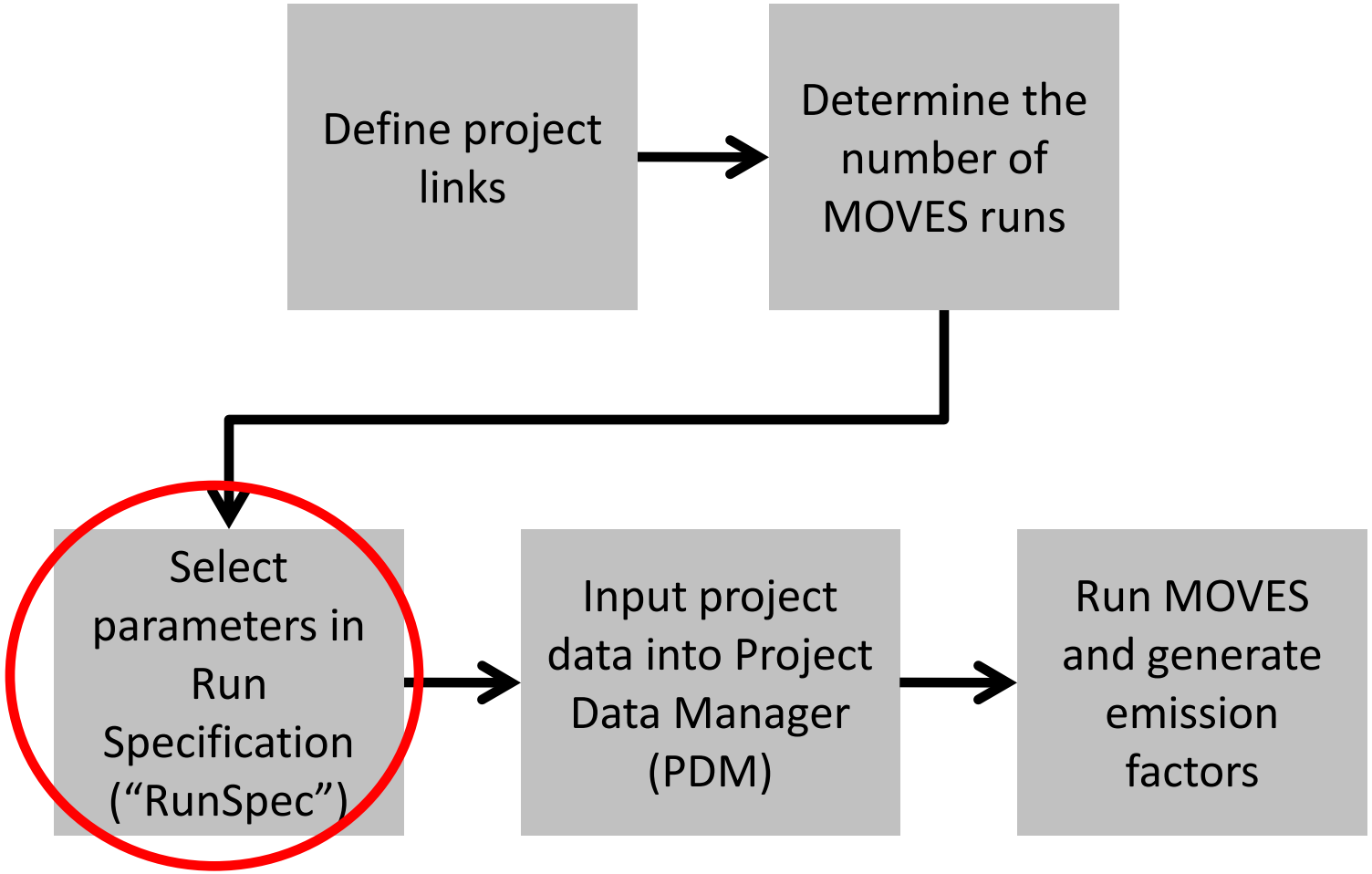
Guidance for Terminals

- For transit or other terminal projects, it is likely that project sponsors will have more comprehensive activity data; possibly covering each hour of the day
- In these cases it may be appropriate to develop additional MOVES runs (beyond the recommended 16)
- The decision to model additional time periods should be decided on through interagency consultation and will depend on available data and whether using additional data would significantly impact emissions modeling results

Guidance Reference:

Section 4.3.3

Running MOVES at the Project Scale



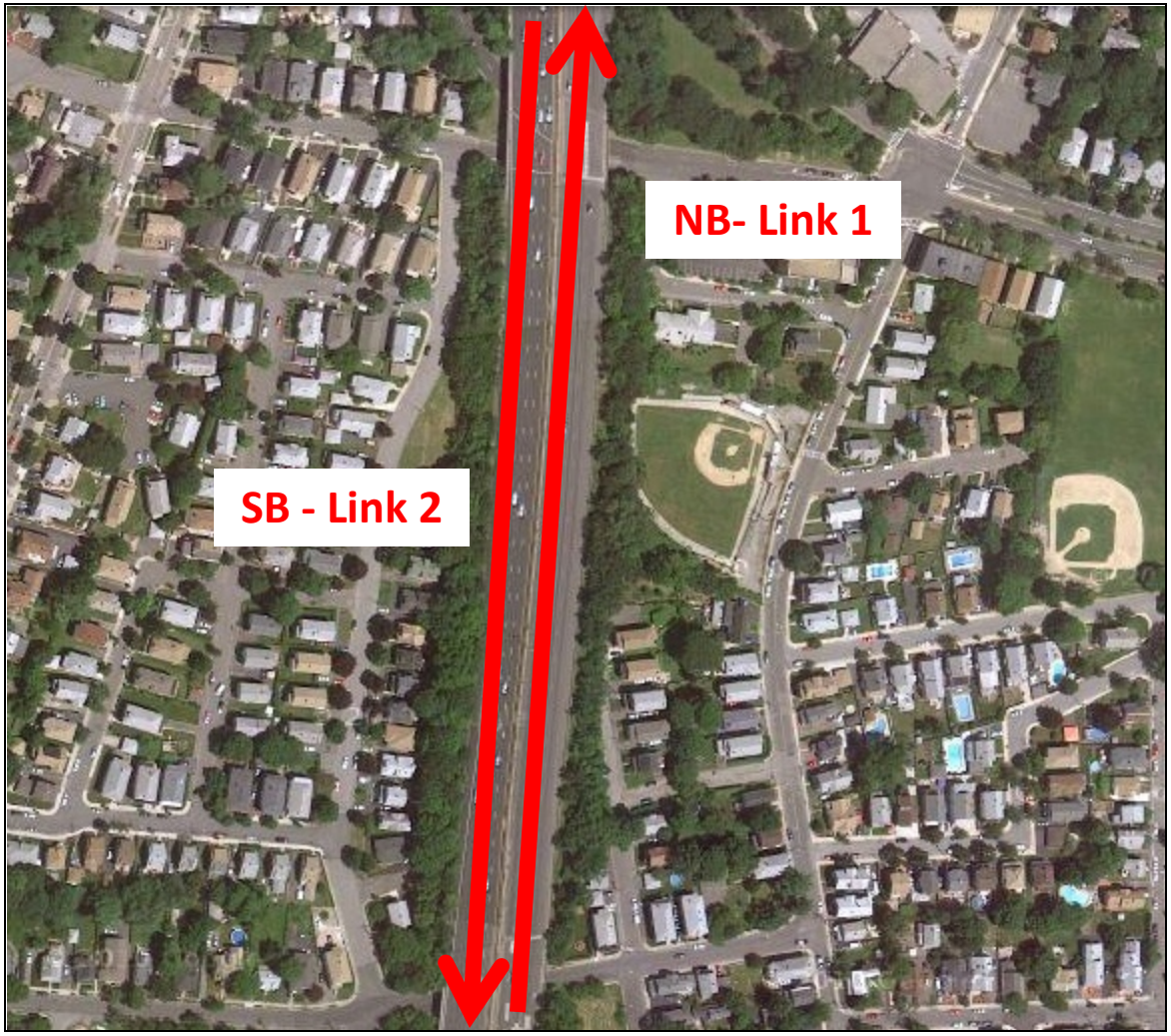
MOVES RunSpec Panels

- Description
- Scale
- Time Spans
- Geographic Bounds
- Vehicles/Equipment
- Road Type
- Pollutants and Processes
- Manage Input Data Sets
- Strategies
- Output
- Advanced Performance Features

Mini-MOVES Run

- Guidance will be explained as class walks through a very simple, hypothetical PM_{10} MOVES highway-only analysis
- Project consists of a two-lane highway in Washtenaw County, Michigan
- Analysis period is July 2011
  - » Example scenario covers one hour (12 a.m.- 1 a.m.)

Mini-MOVES Run

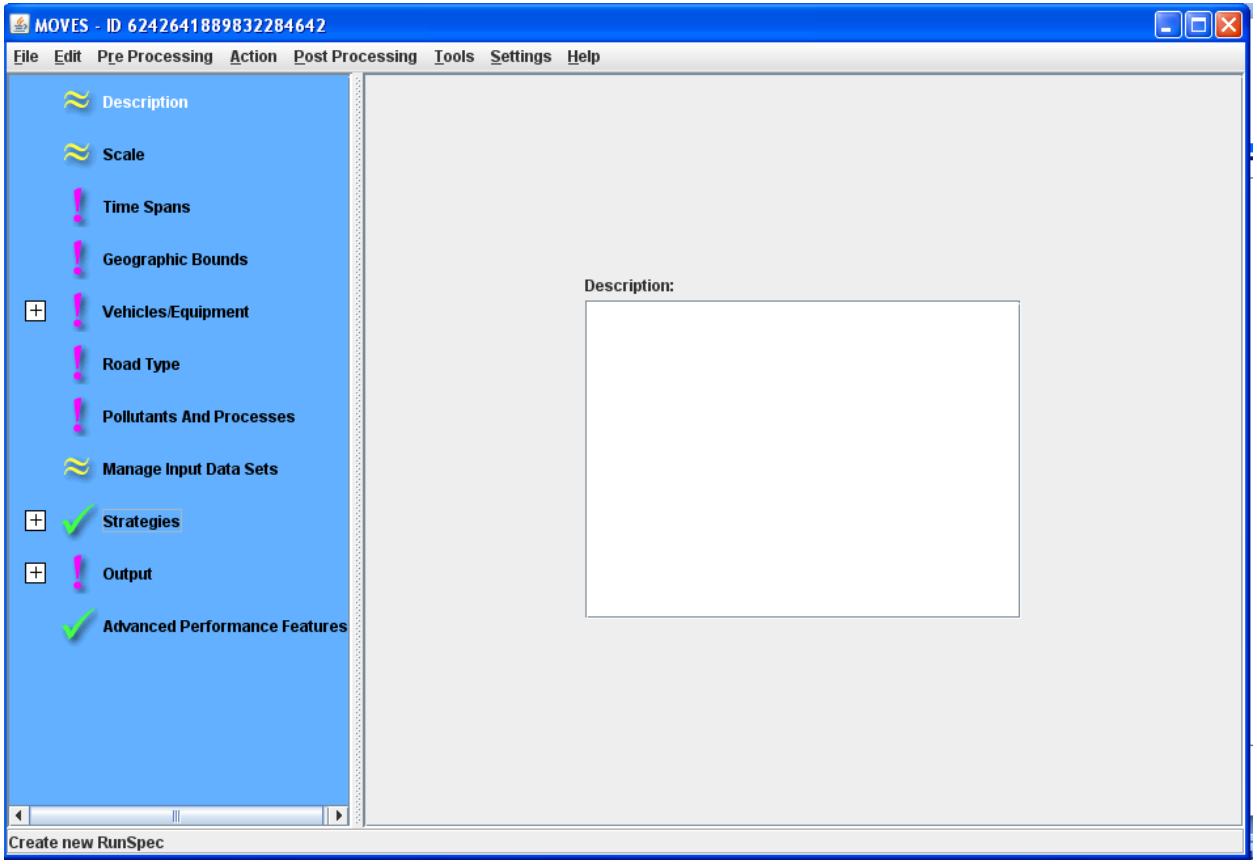


Mini-MOVES Run

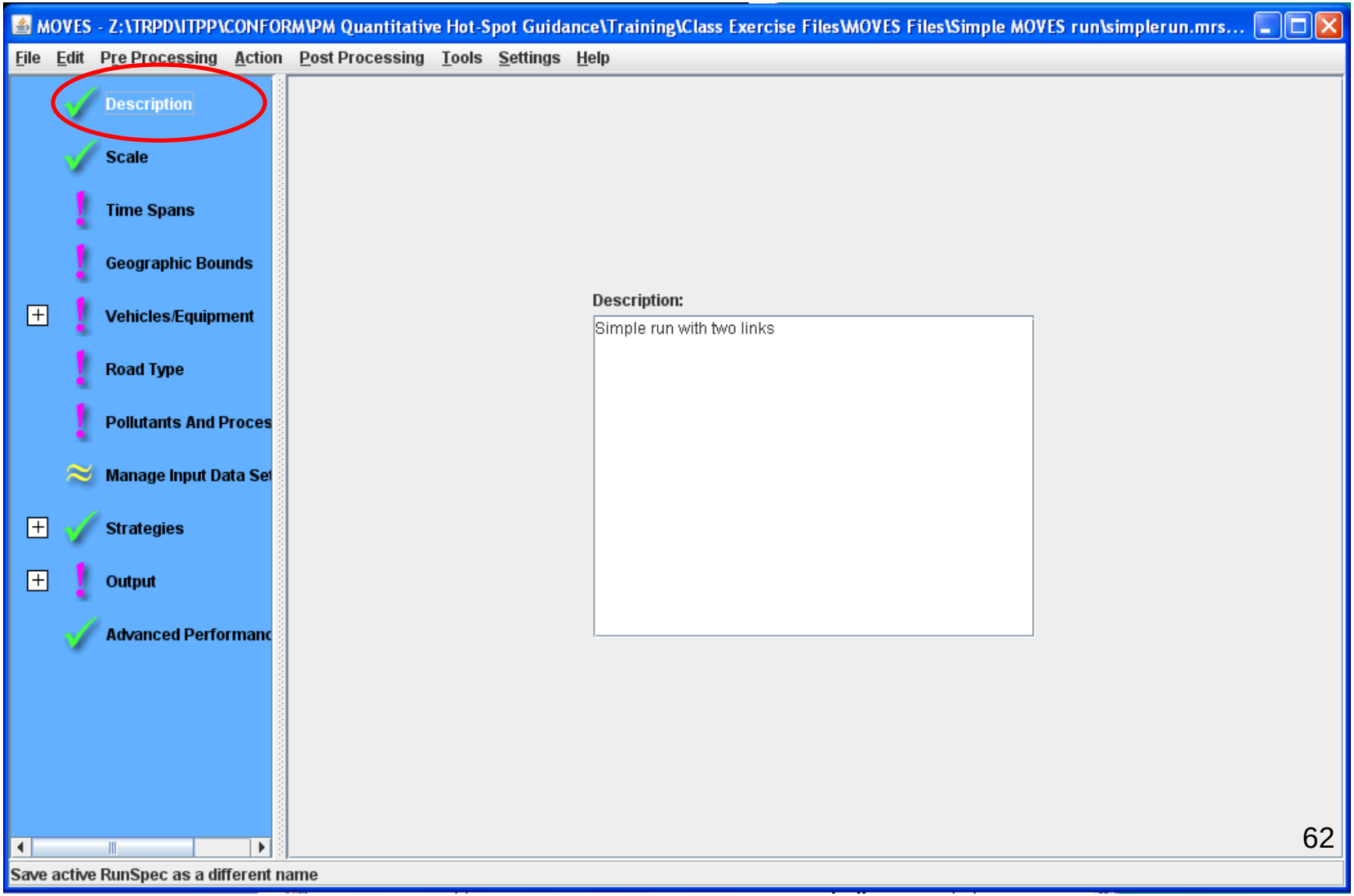
- Two links:
  - Northbound
    - 1.25 miles in length
    - 765 vehicles in analysis hour
    - 62.5 mph average speed
    - 95% gasoline passenger cars, 5% diesel combination long-haul diesel trucks
  - Southbound
    - 1.25 miles in length
    - 690 vehicles in analysis hour
    - 61.0 mph average speed
    - 95% gasoline passenger cars, 5% diesel combination long-haul diesel trucks

Opening MOVES

- Double-click on “MOVES Master” Icon
- GUI will open



Description Panel



Scale and Calculation Type

- Scale should always be set to “Project” for hot-spot analyses

- Calculation Type can be specified as “Inventory” or “Emission Rates”
  - “Inventory” will produce aggregate emissions (e.g., grams, lbs, or tons per link)
  - “Emission Rates” will produce link specific emission factors:
    - grams/vehicle-mile
    - grams/vehicle-hour
    - grams/vehicle-start

Guidance Reference:

Section 4.4.2

Guidance on Calculation Type

- Either “Inventory” or “Emission Rates” can be selected as output, depending on the air quality model being used

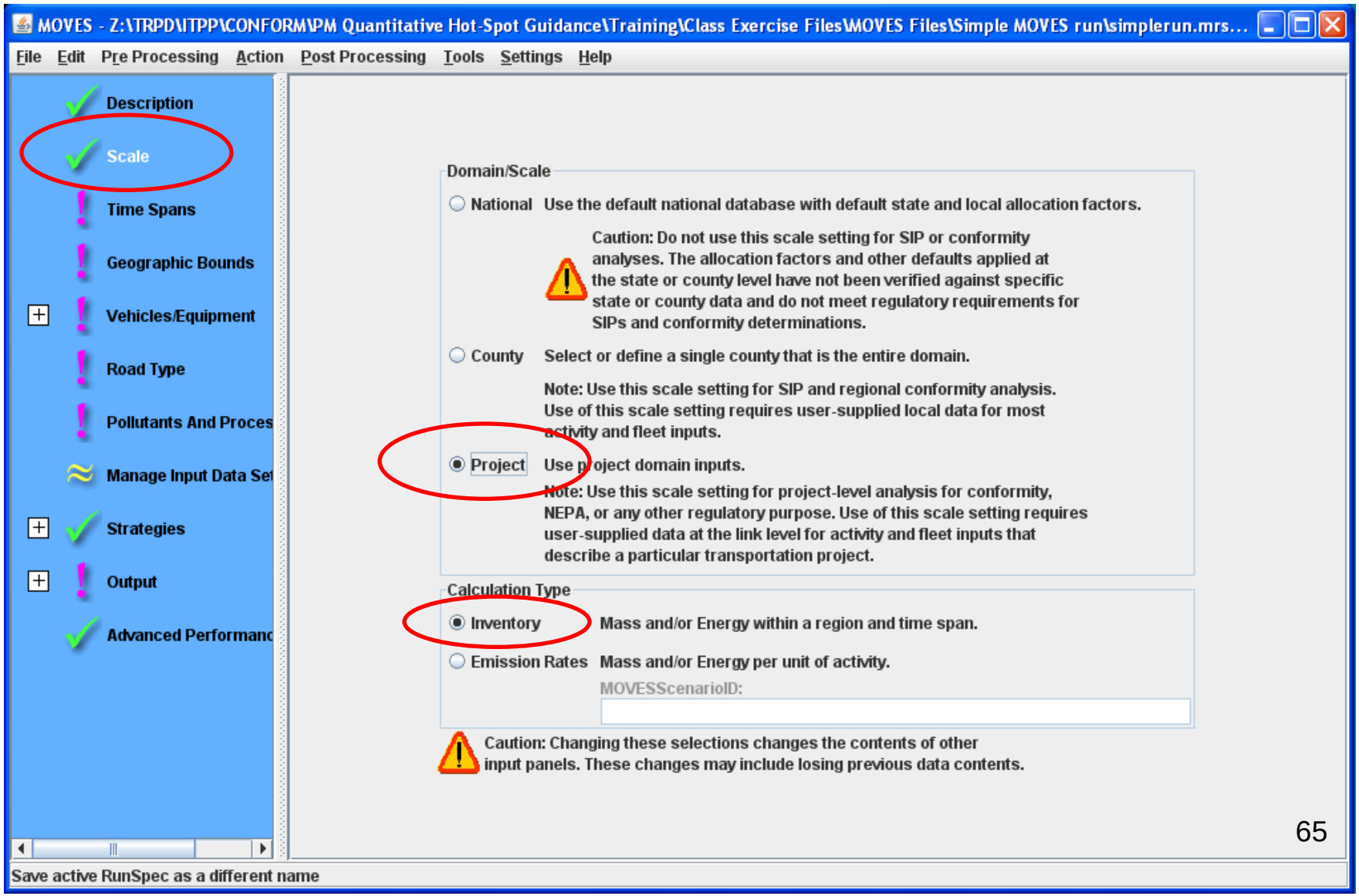
- When using AERMOD, select “Inventory”
  - » This will produce results for total emissions on each link, and since running MOVES at the project-level produces results for only one hour, this is equivalent to a grams/hour emission factor needed by AERMOD

- When using CAL3QHCR, select “Emission Rates”
  - » This will produce link-specific grams/vehicle-mile emission factors needed by CAL3QHCR

Guidance Reference:

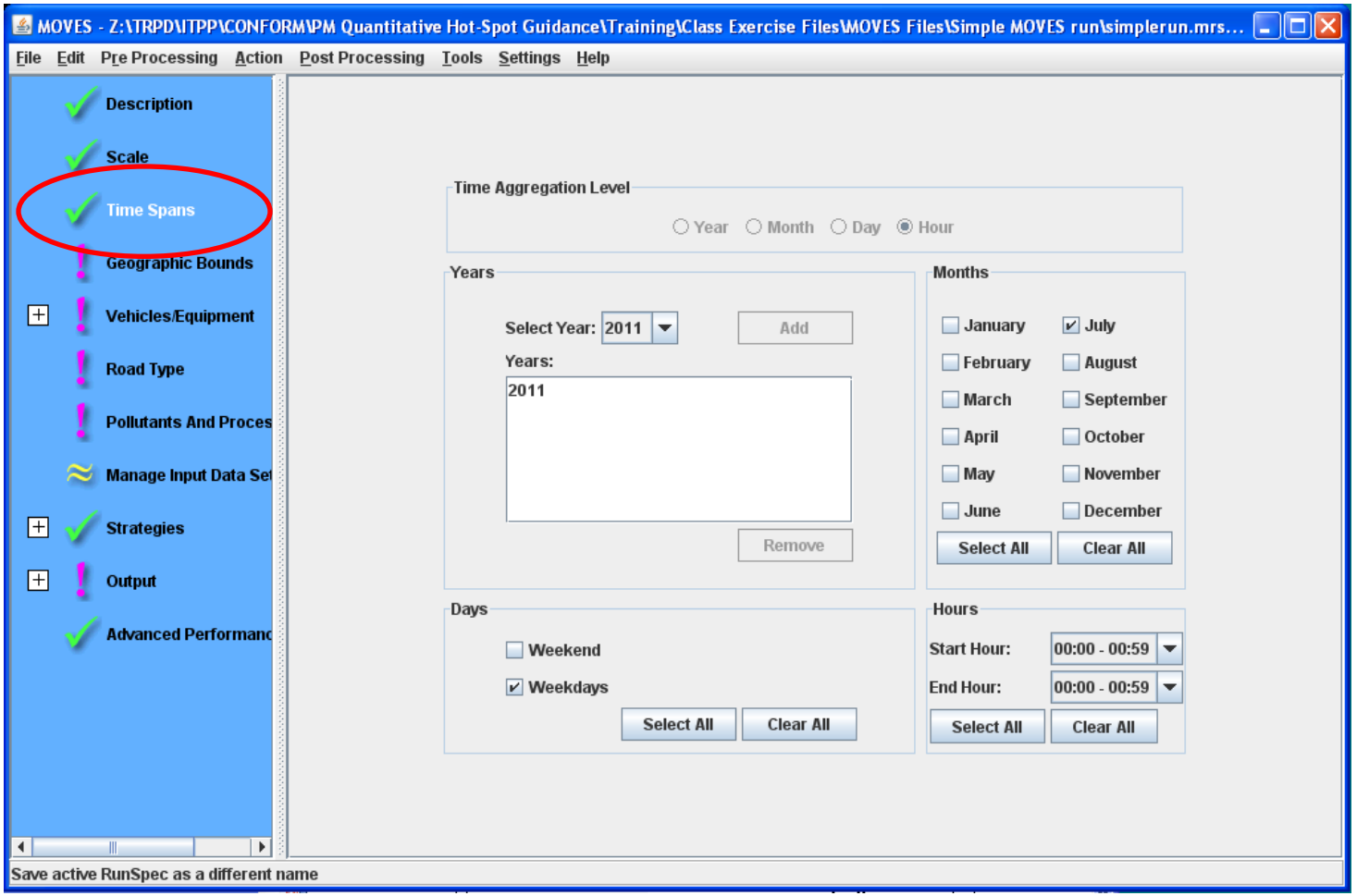
Section 4.4.2

Scale and Calculation Type



Time Spans Panel

- Time Aggregation Level is set to “Hour” by default
- Only one calendar year, month, day, and hour can be selected



Guidance Reference:

Section 4.4.3

Geographic Bounds Panel

- Once you have selected the Project scale, you may only choose a single county from the list (or custom domain)
- Choosing a single county selects the available default data stored for that county
- “Custom Domain” can be selected to represent a project spanning multiple counties: no defaults are available
- You must create/select an input database to store the project data (after filling out RunSpec)

Guidance Reference:

Section 4.4.4

Guidance on Selecting County or Custom Domain

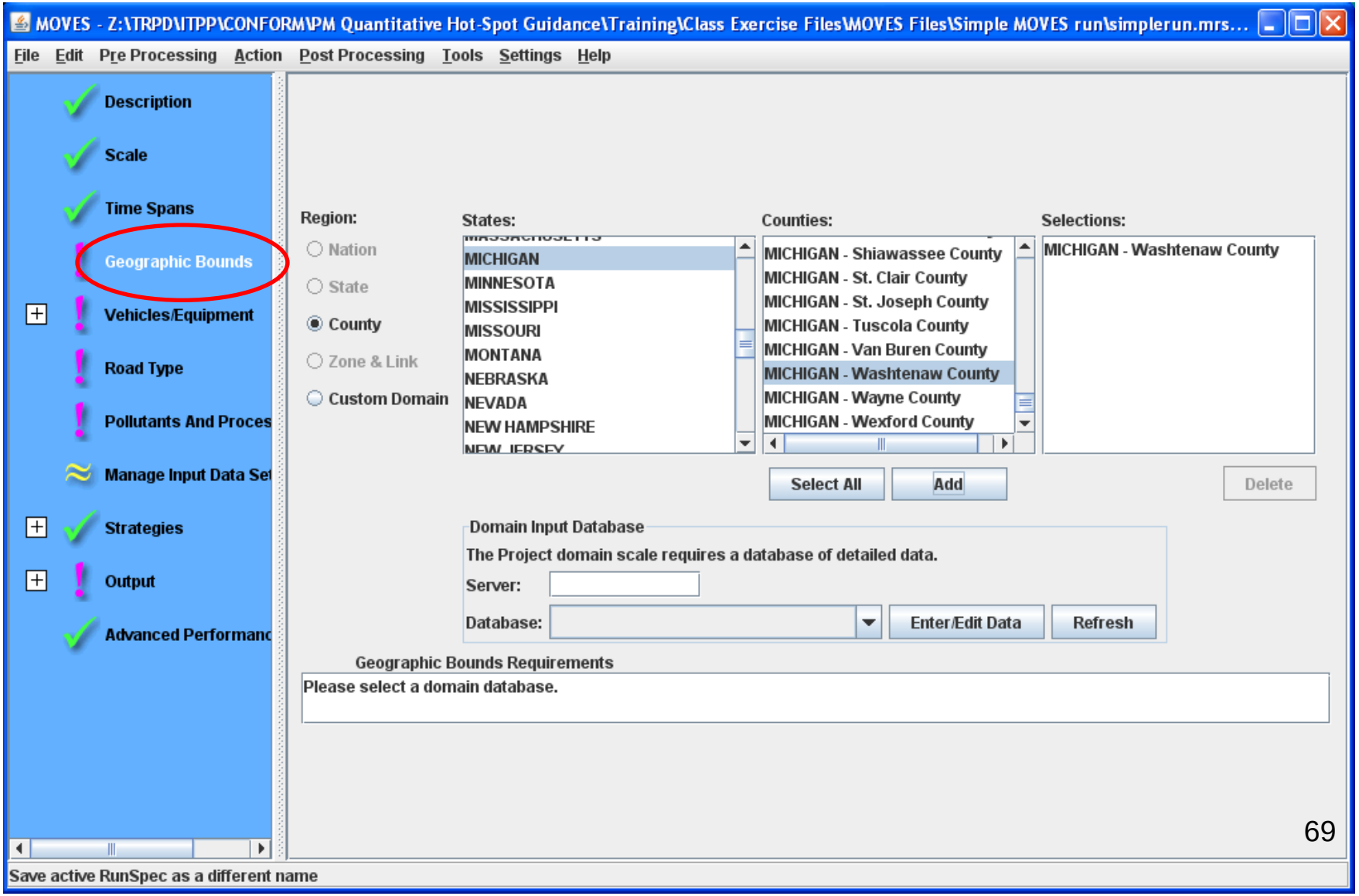
- Users should select the specific county where the project is located

- If a project spans multiple counties, users have three options:
  1. If the fuel supply and age distribution of vehicles in the fleet are the same for all of the counties, select the county in which the majority of the project area is located;
  2. If not, separate the project into multiple parts (each of which is in a separate county) and do a separate MOVES run for each part; *or*
  3. Use the custom domain option to model multiple unique areas that share the same fuel and age distribution, but may have different meteorological data

Guidance Reference:

Section 4.4.4

Geographic Bounds Panel



Guidance on Selecting Vehicle Types

- For most analyses, select all vehicle and fuel types:
  - Diesel
  - Compressed Natural Gas (CNG)
  - Gasoline

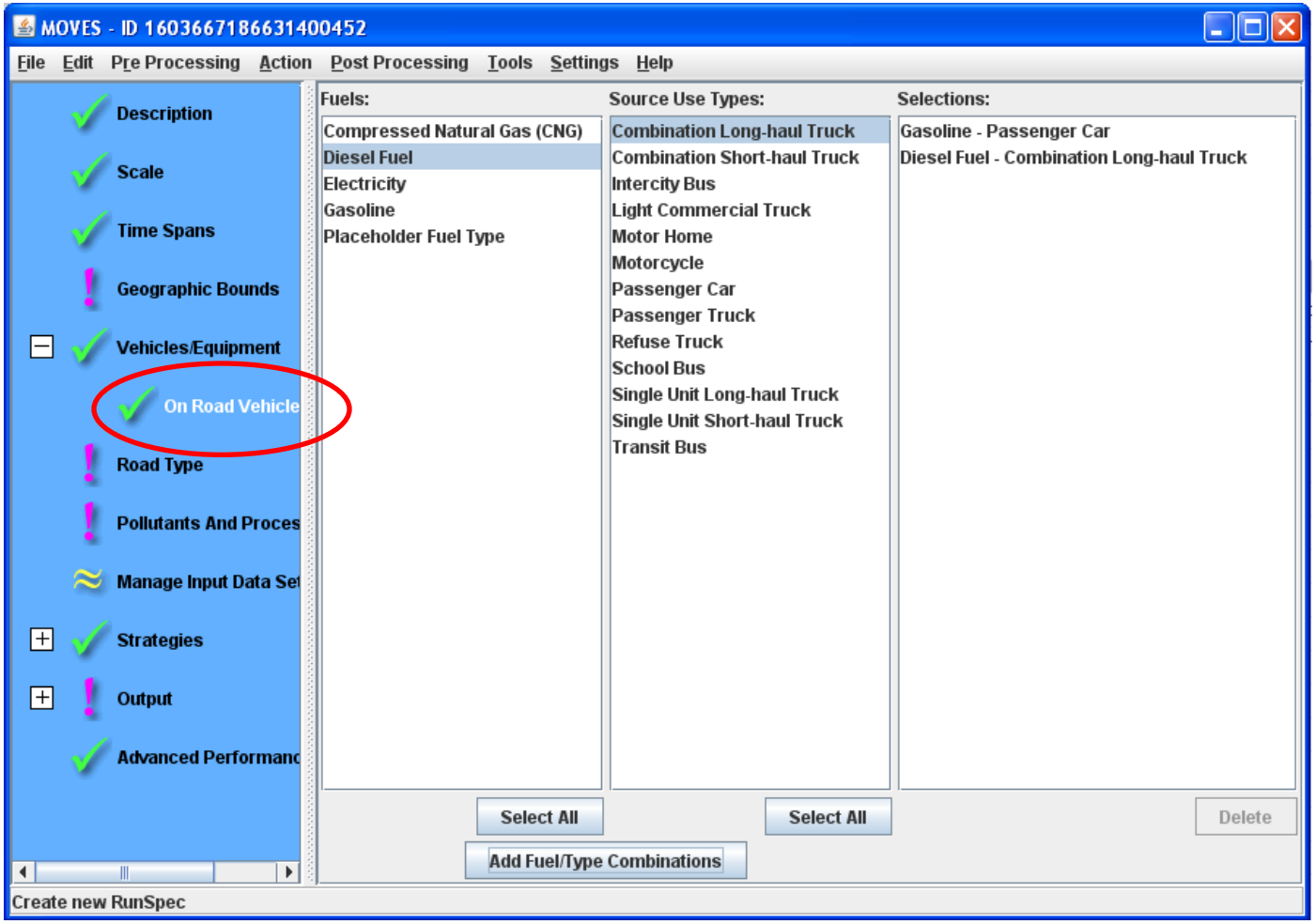
- Note that some projects may only have one or more vehicle types (e.g., a bus fleet running entirely on CNG)
  - Diesel fractions may still need to be adjusted through the "FuelType and Technology" input, regardless of what is selected here
  - Discussed later in example analysis

Guidance Reference:

Section 4.4.5

On Road Vehicle and Equipment Panel

- Users should select all on-road vehicles present on project
- Invalid combinations:
  - » Diesel motorcycle
  - » Gasoline long-haul combination truck
  - » Gasoline intercity bus



Guidance Reference:

Section 4.4.5

Road Types in MOVES

- **Rural Restricted Access** – A rural highway that can be accessed only by an on-ramp (road type ID = 2)
- **Rural Unrestricted Access** – All other rural roads, i.e., arterials, connectors, and local streets (road type ID = 3)
- **Urban Restricted Access** – An urban highway that can be accessed only by an on-ramp (road type ID = 4)
- **Urban Unrestricted Access** – All other urban roads, i.e., arterials, connectors, and local streets (road type ID = 5)
- **Off-Network** – Any location where the predominant activity is vehicle starts and extended-idling, i.e., parking lots, truck stops, rest areas, freight or bus terminals (road type ID = 1)

Guidance Reference:

Section 4.4.6

HPMS Road Type Mapping

HPMS ROAD TYPE CODE	HPMS AREA TYPE	HPMS ROAD TYPE DESCRIPTION	MOVES ROAD TYPE ID	MOVES ROAD TYPE DESCRIPTION
11	Rural	Interstate	2	Rural restricted access
13	Rural	Other Principal Arterial	3	Rural unrestricted access
15	Rural	Minor Arterial	3	Rural unrestricted access
17	Rural	Major Collector	3	Rural unrestricted access
19	Rural	Minor Collector	3	Rural unrestricted access
21	Rural	Local	3	Rural unrestricted access
23	Urban	Interstate	4	Urban restricted access
25	Urban	Other Freeways and Expressways	4	Urban restricted access
27	Urban	Other Principal Arterial	5	Urban unrestricted access
29	Urban	Minor Arterial	5	Urban unrestricted access
31	Urban	Collector	5	Urban unrestricted access
33	Urban	Local	5	Urban unrestricted access

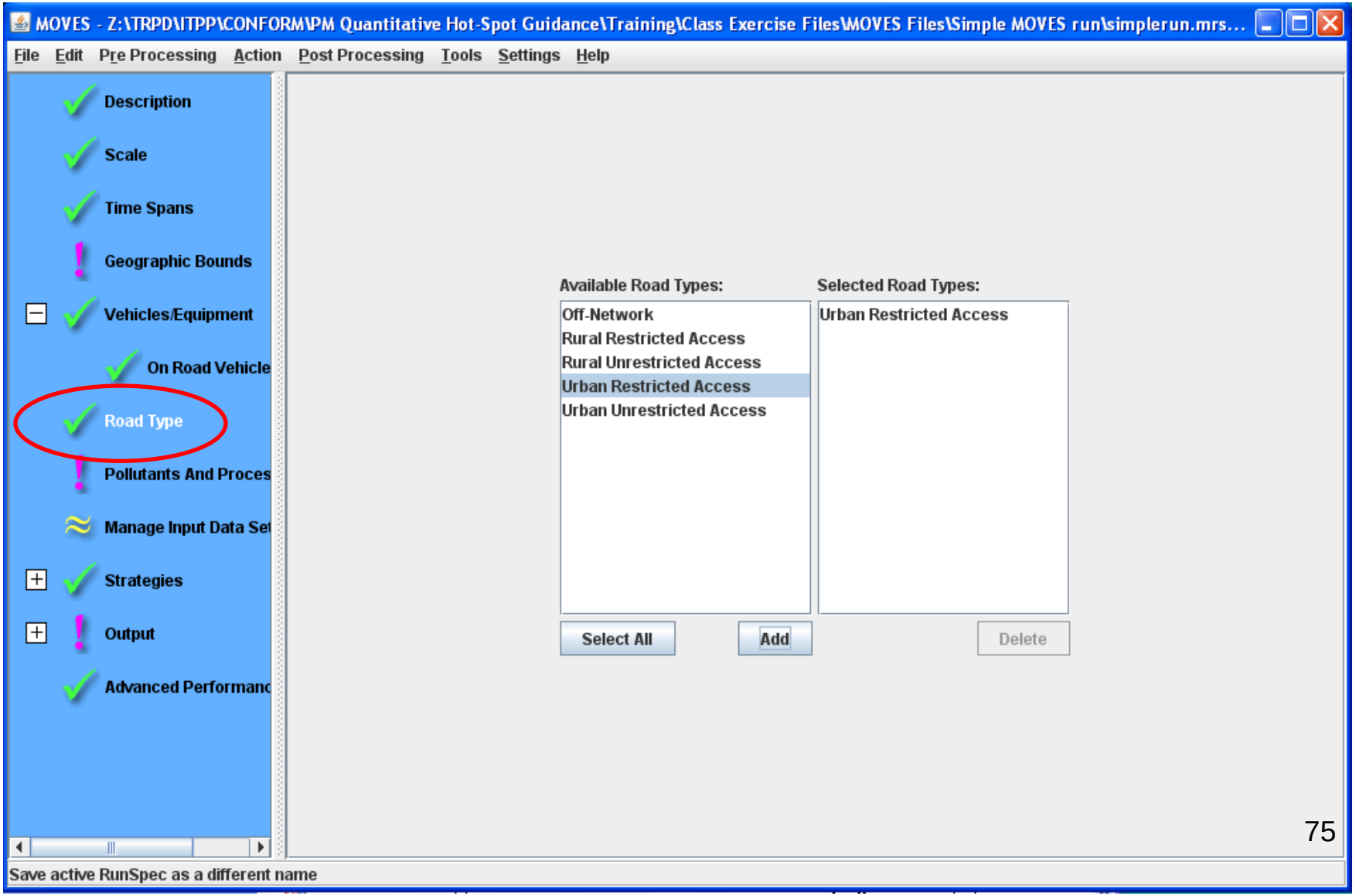
Guidance on Selecting Road Types

- Select all road types present in project
  - » Do not select road types that do not exist in project
  - » Road type can be determined by HPMS classification
- Off-network road type should only be selected if an Off-Network link exists (starts and extended idle)
  - » Used for parking lots, intermodal facilities, bus terminals, etc.
- Some pollutant-process selections automatically select certain road types
  - » Example: Selecting start emissions or extended idle emissions in the Pollutants and Processes panel will automatically select the "Off-network" road type
  - » Will discuss next

Guidance Reference:

Section 4.4.6

Road Type Panel



Guidance on Selecting Pollutants

- Primary Exhaust PM – Total (PM_{10} or $PM_{2.5}$)
  - » Organic Carbon (OC)
  - » Elemental Carbon (EC)
  - » Sulfate Particulate
- Brake Wear Particulate (running links only)
- Tire Wear Particulate (running links only)

Guidance Reference:

Section 4.4.7

Guidance on Selecting Processes

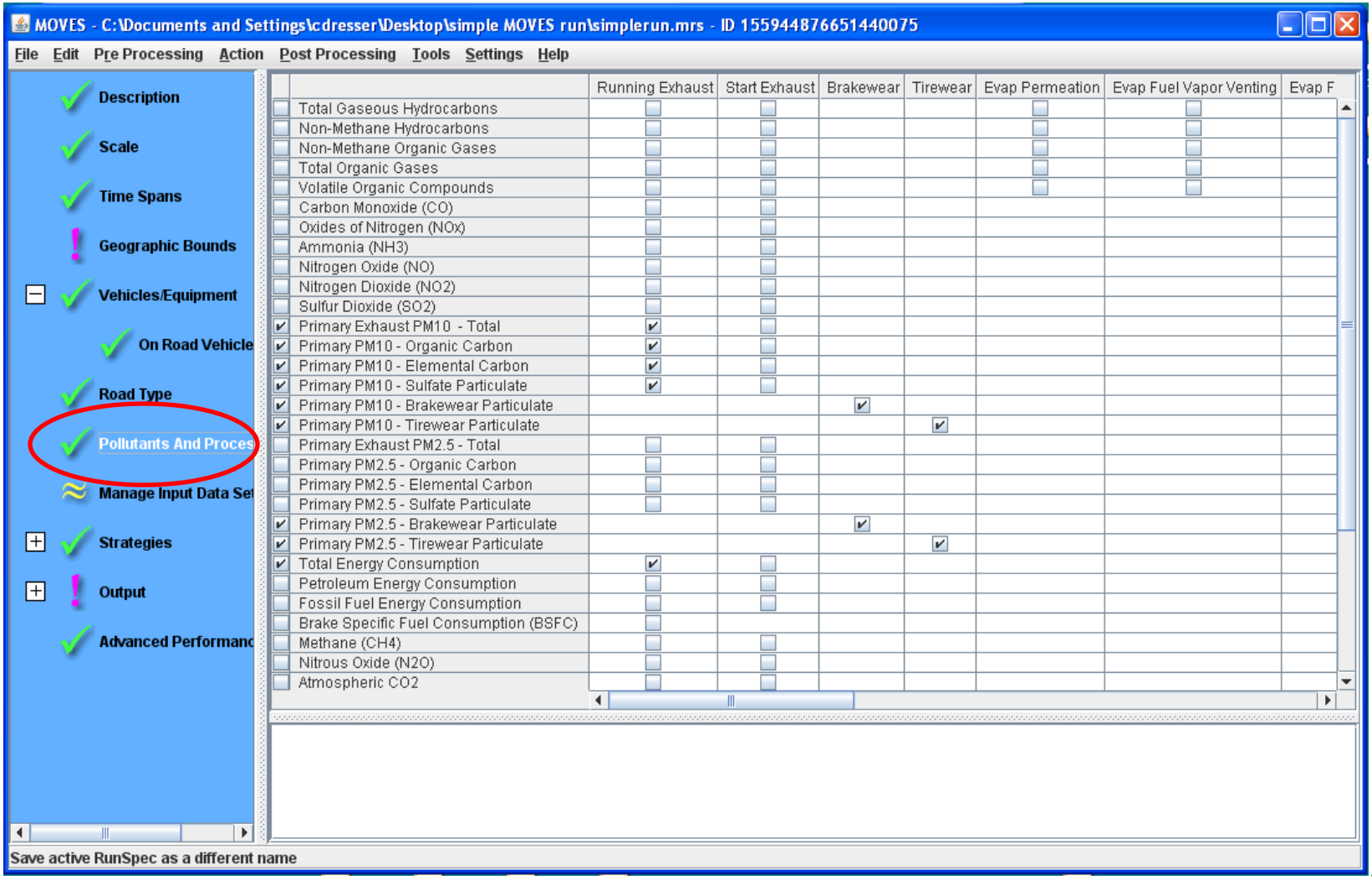
- For highway and intersection links:
  - » Running Exhaust
  - » Crankcase Running Exhaust
  - » Brake Wear
  - » Tire Wear

- For off-network links:
  - » Start Exhaust
  - » Extended Idle Exhaust
  - » Crankcase Start Exhaust
  - » Crankcase Extended Idle Exhaust

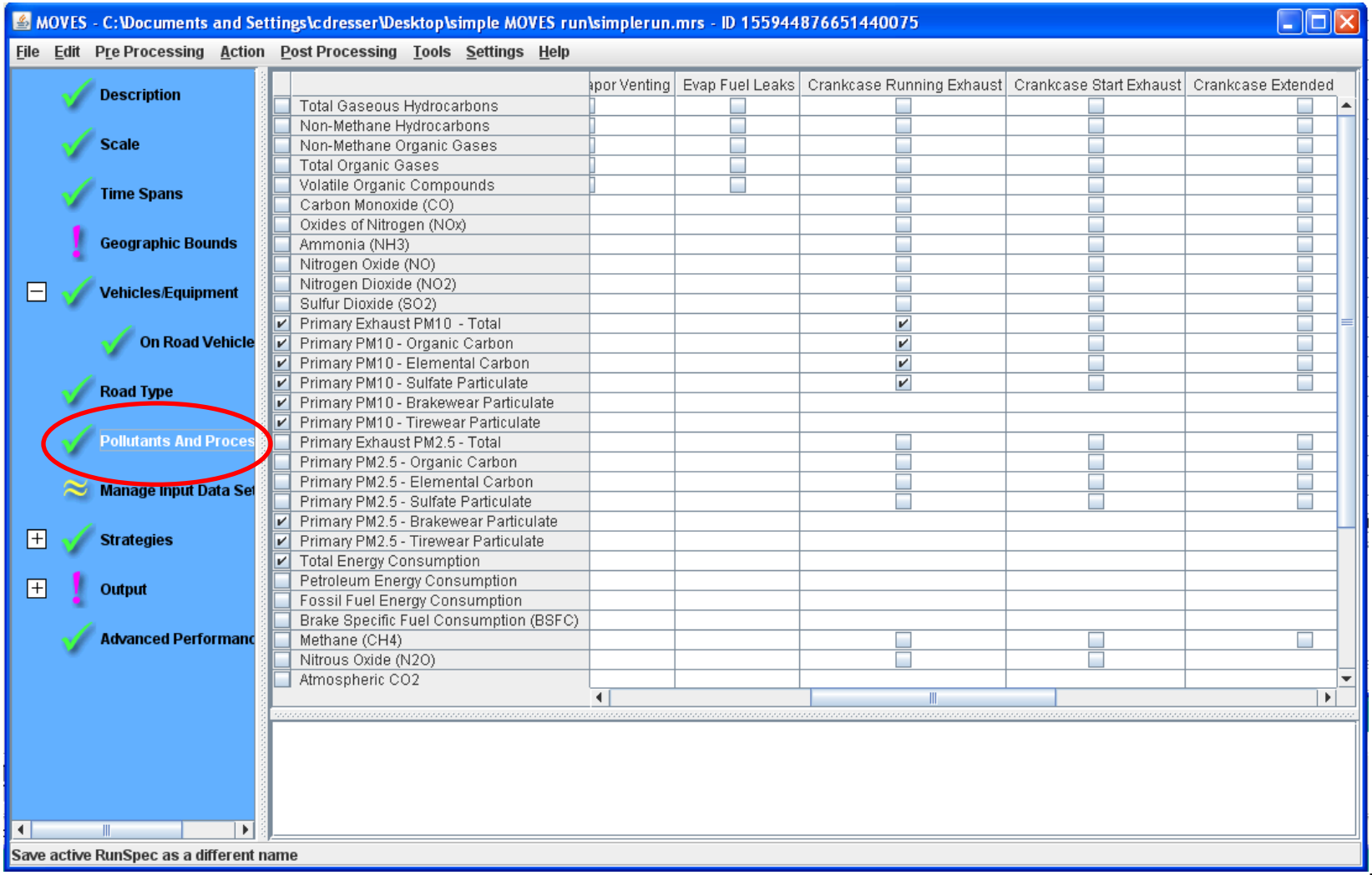
Guidance Reference:

Section 4.4.7

Pollutants and Processes Panel



Pollutants and Processes Panel



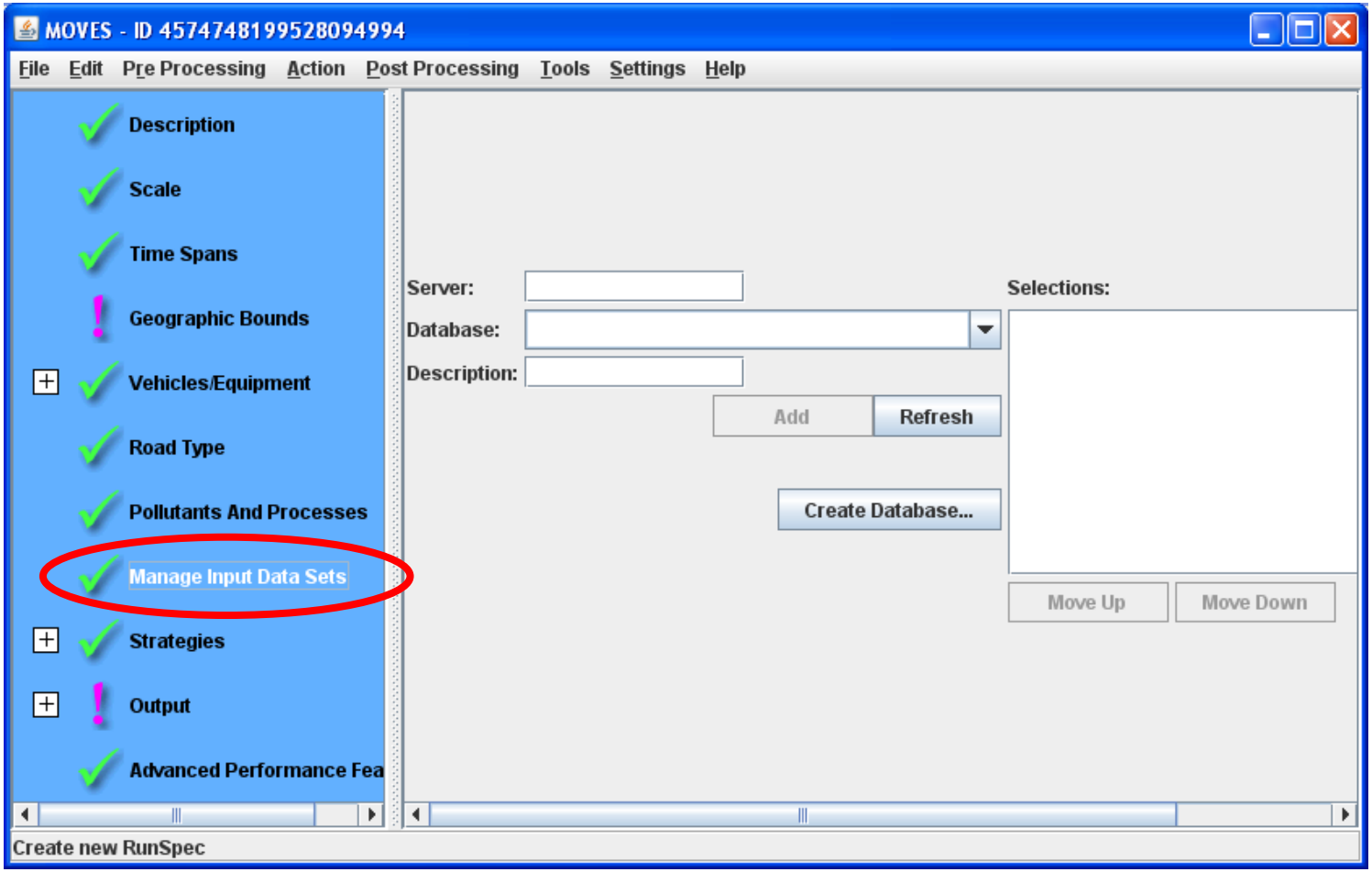
Guidance on Manage Input Data Sets Panel

- Most PM hot-spot analyses will not use this panel
- Instead, the PDM will be used to input project-specific data

Guidance Reference:

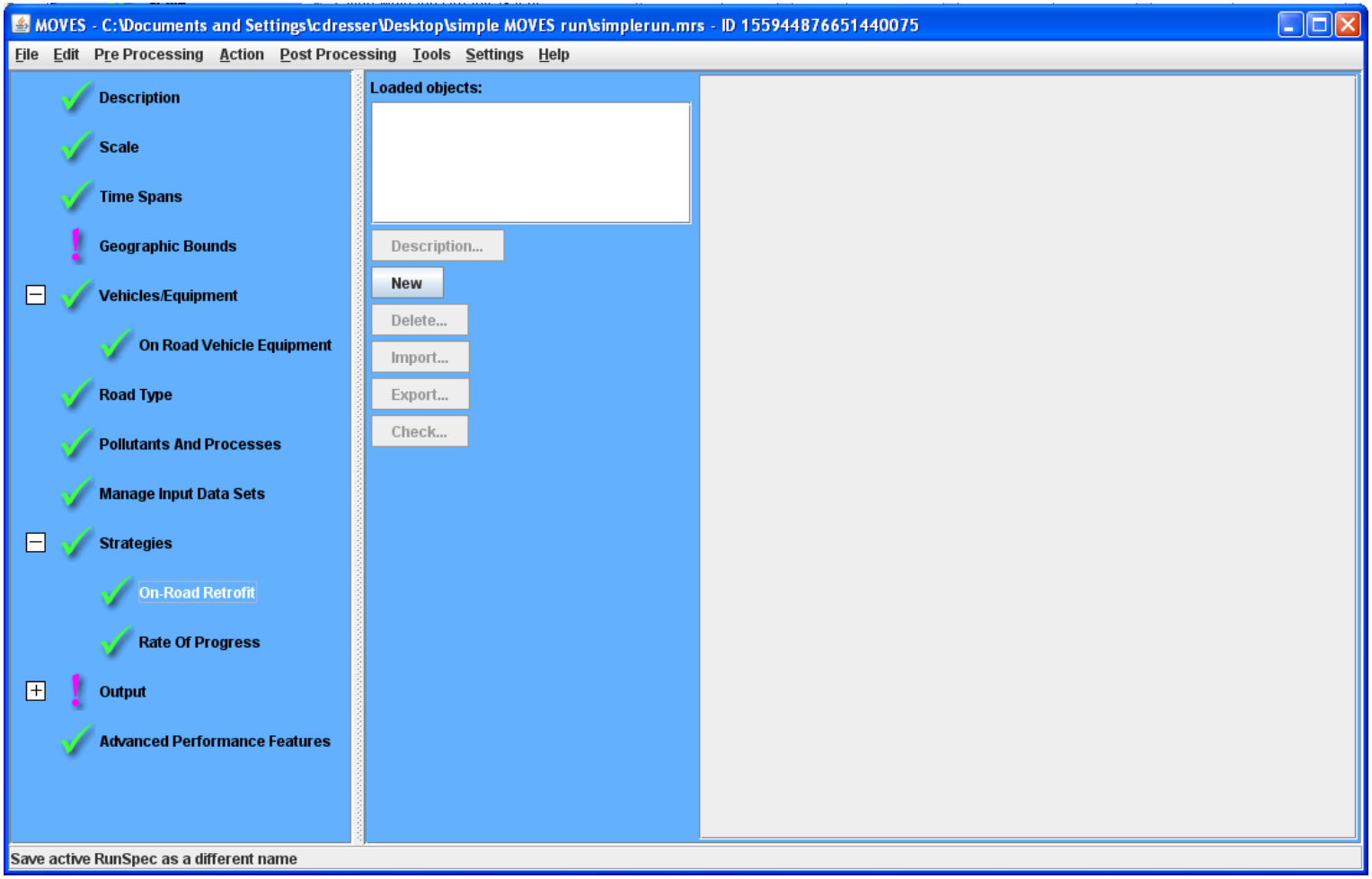
Section 4.4.8

Manage Input Data Sets Panel



Note: Only need to click on panel in left column to get green check

Strategies Panels



Note: Do not use "Rate of Progress" strategy – not relevant for project level

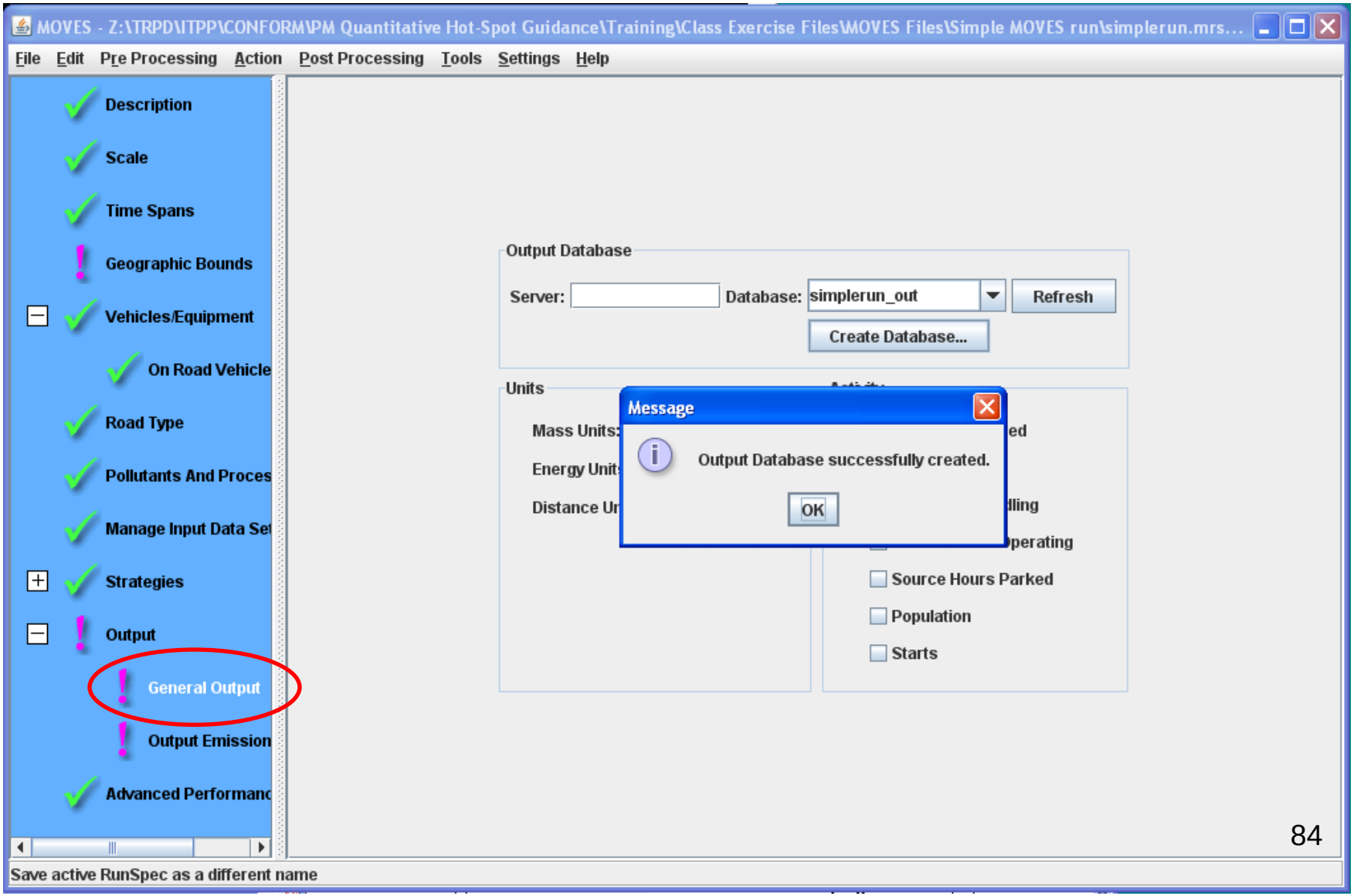
On-Road Retrofit Panel

- The On-Road Retrofit panel allows users to define emission reductions/increases that are provided by retrofit programs
  - » In MOVES, retrofits are only applied to heavy-duty diesel vehicles
  - » EPA's Retrofit Guidance and PM Hot-Spot Guidance should be consulted to determine the appropriate inputs
- Retrofit programs should be defined only for the year being modeled
  - » Modeling Year = Final Calendar Year
- Fraction/Year should be calculated in terms of the fraction of vehicles to which the retrofit was applied as of the year being modeled

Guidance Reference:

Section 4.4.9

General Output Panel



Database Naming Recommendations

- Name all the files you use for a specific run using the same name, but with different extensions
  - » Examples:

    Input database: **Simplerun_in**

    Output database: **Simplerun_out**

    RunSpec: **Simplerun.mrs**

  - » Identifies each part of the run file
  - » Helps organize information

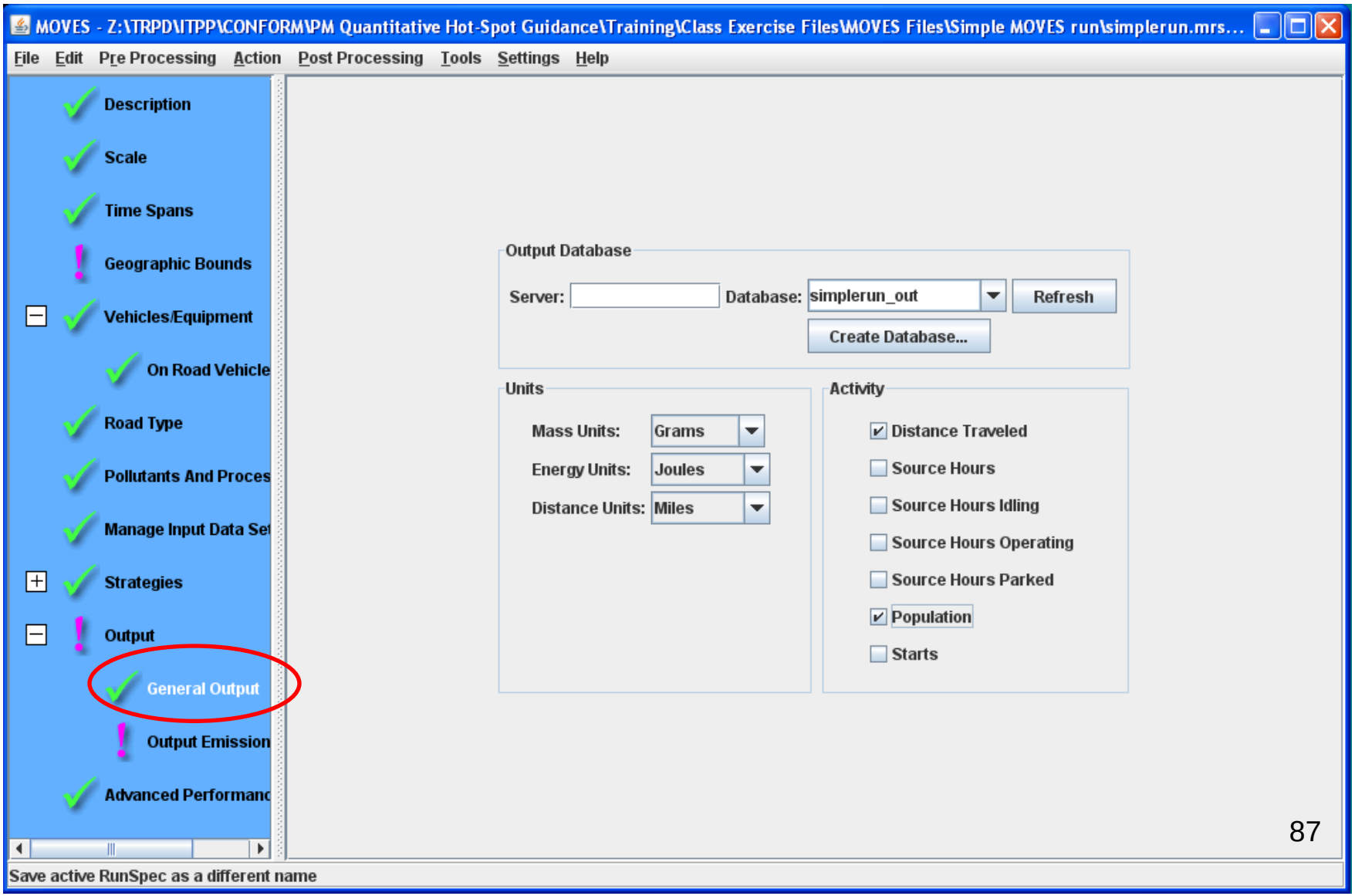
General Output Panel

- Selecting Activity output is useful for diagnostic purposes
  - » Will report what was input for different activity parameters
- "Distance Traveled" and "Population" should be selected
  - » Selecting "Rates" calculation in the Scale panel will automatically select "Distance Traveled" and "Population"
  - » Population will reflect vehicle population
- Selecting "Starts" and "Source Hours Idling" may also be helpful

Guidance Reference:

Section 4.4.10

General Output Panel



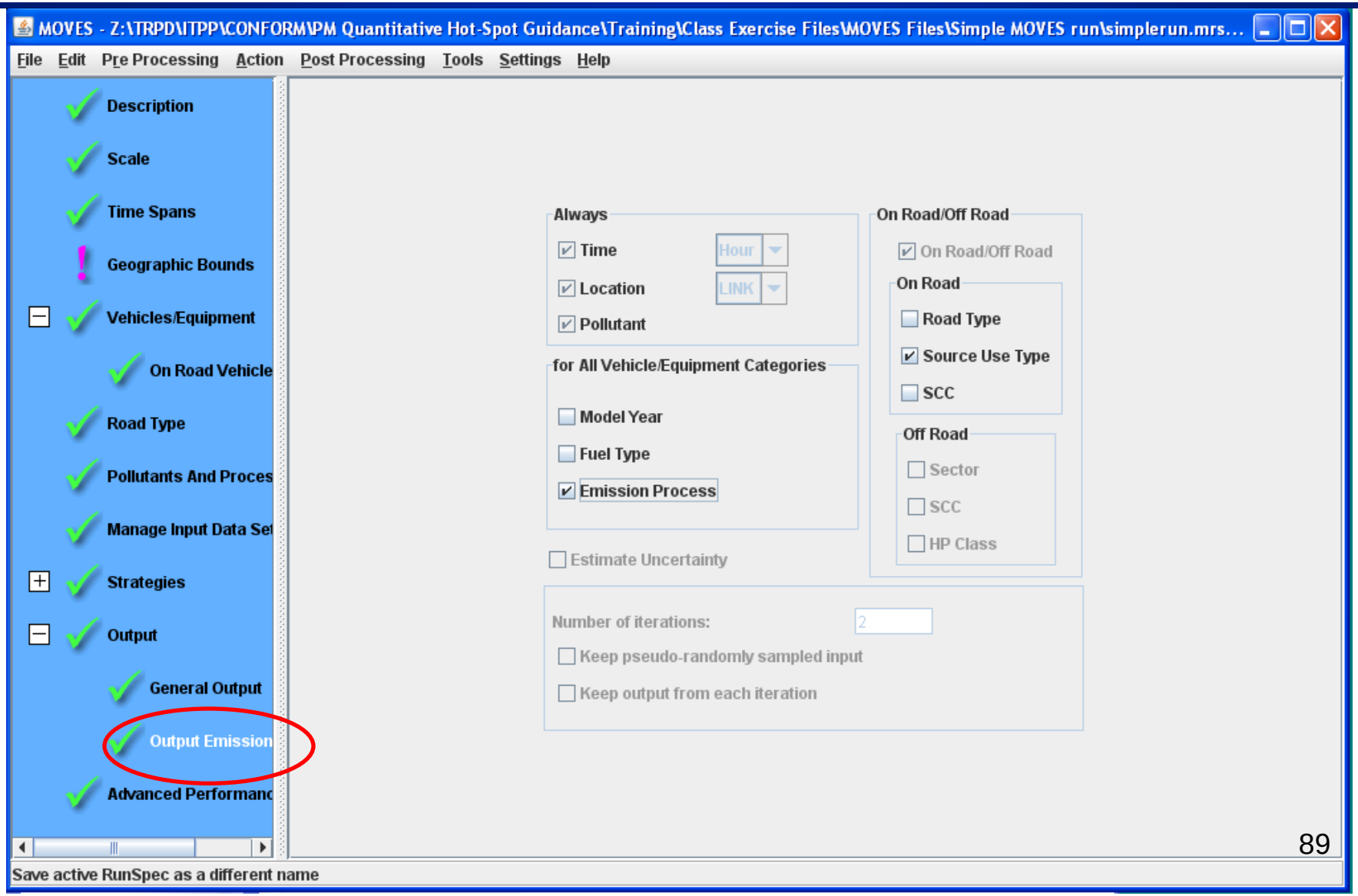
Guidance on Output Emission Detail Panel

- The aggregation of the Time level is set to “Hour” and “Link” by default
- The “for All Vehicle/Equipment Categories” and “On Road” selections depend on the detail desired by the user
  - » More selections means more detail
  - » Differentiation by Emission Process and Source Type is likely most useful
- **However, output by Source Type, Model Year, or Fuel Type should not be selected if “Rates” was selected in the Scale panel**

Guidance Reference:

Section 4.4.10

Output Emission Detail Panel



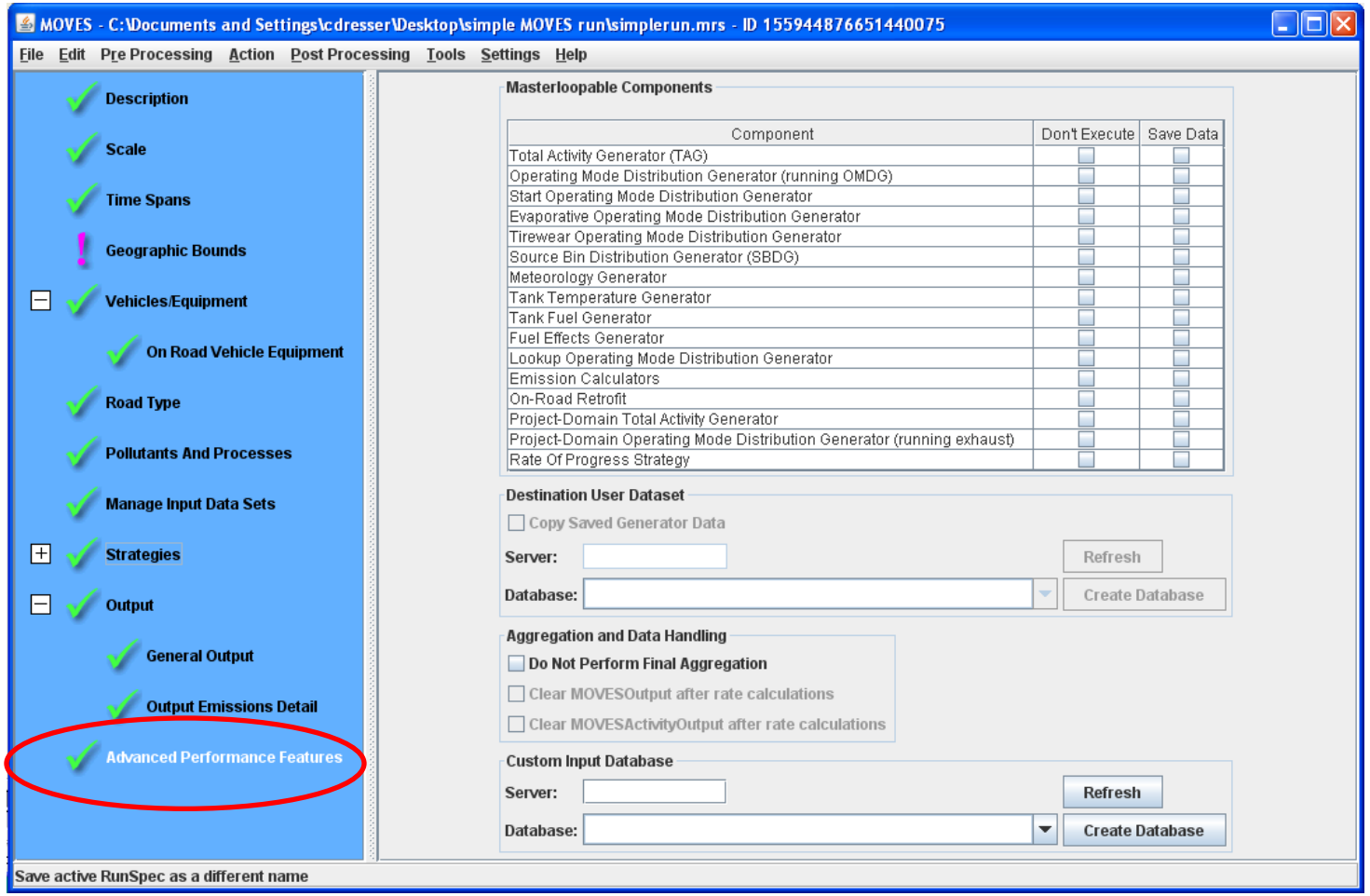
Guidance on Advanced Performance Features Panel

- Not relevant for MOVES project-level analyses for most cases
  - » See Appendix F of PM Hot-spot Guidance for transit project example where used

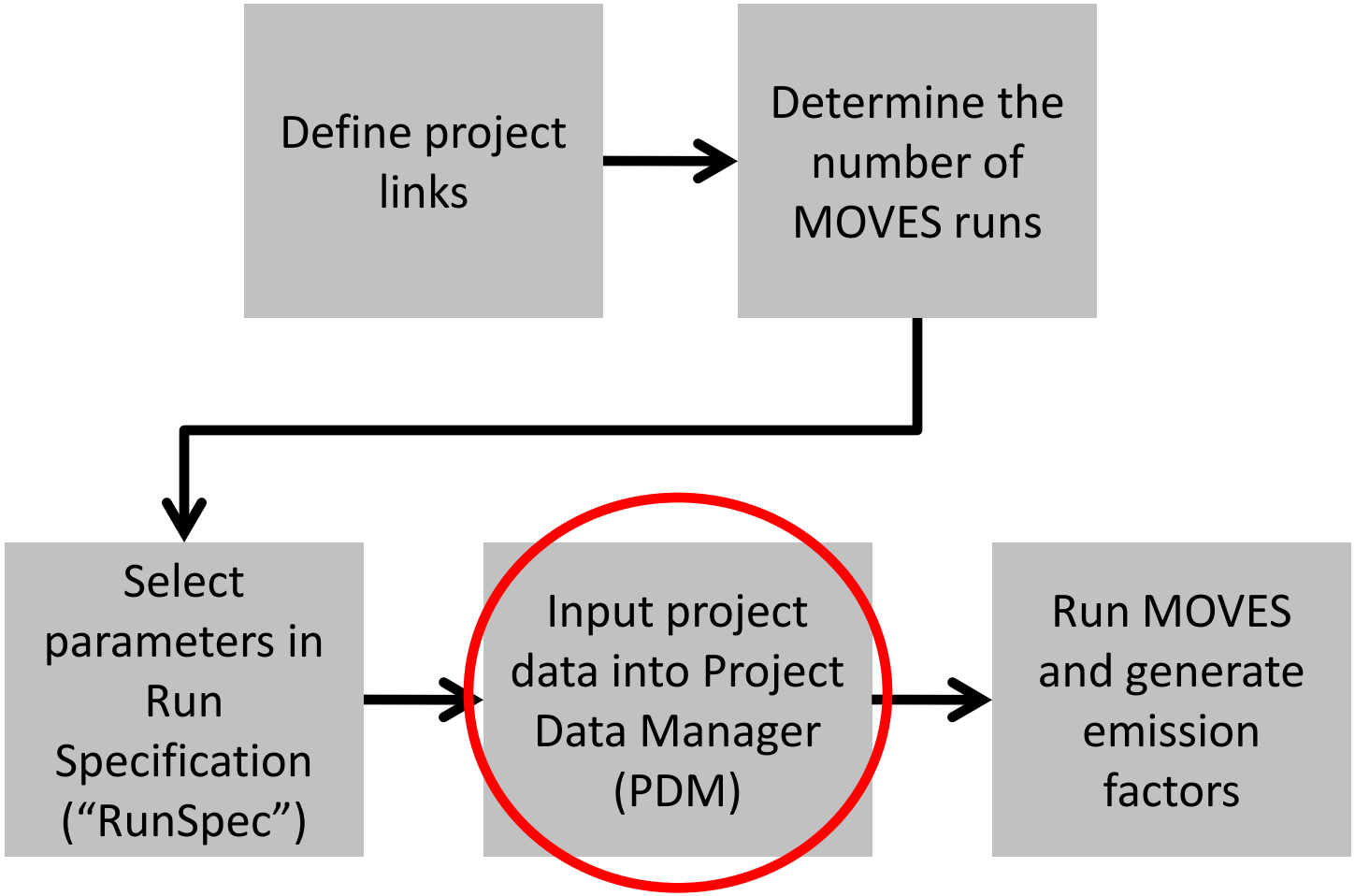
Guidance Reference:

Section 4.4.11

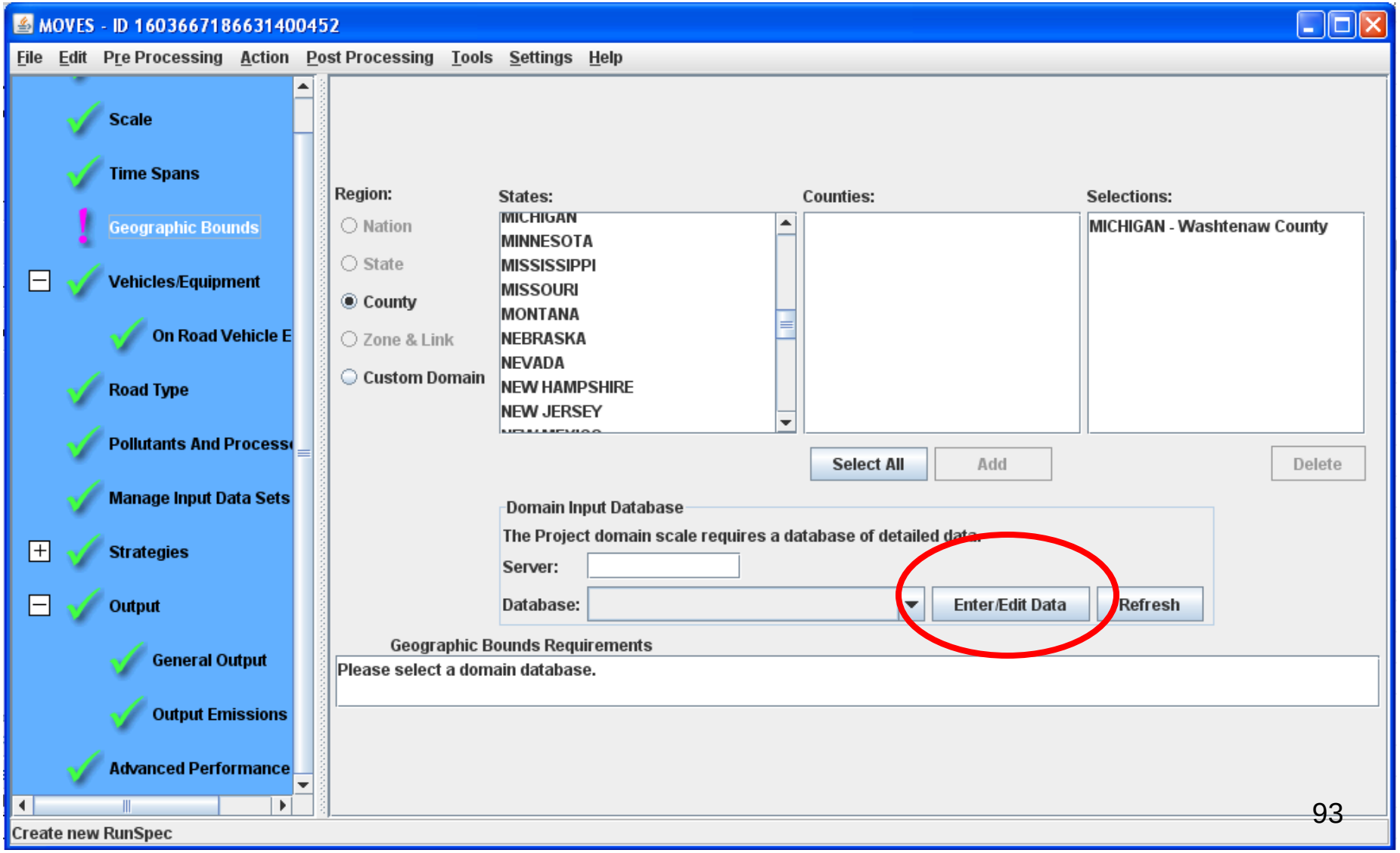
Advanced Performance Features Panel



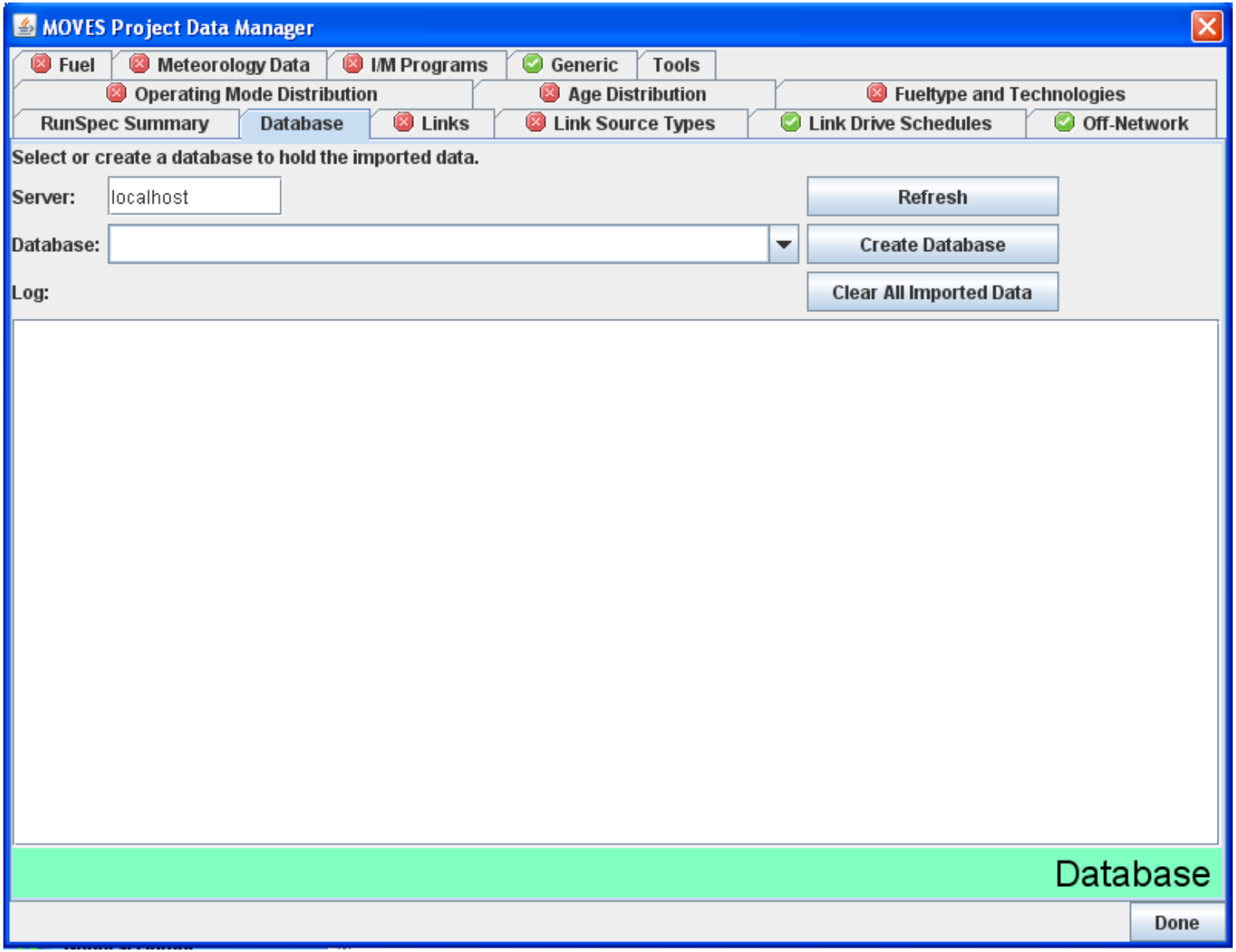
Running MOVES at the Project Scale



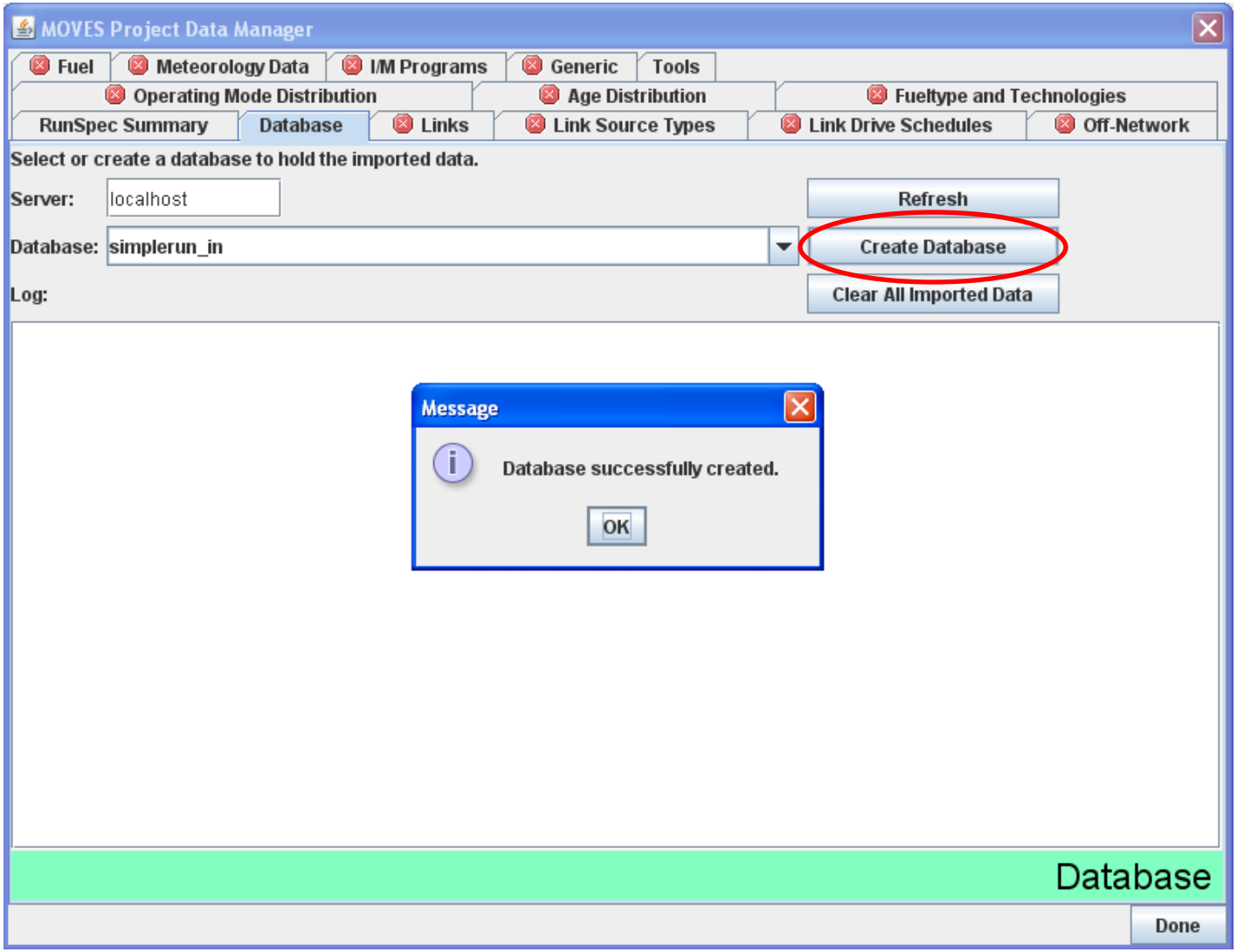
Accessing the Project Data Manager



Accessing the Project Data Manager



Creating an Input Database



Project-Level Inputs

- Links
- Meteorology Data
- Age Distribution
- Fuel
- Inspection/Maintenance (I/M)
- Link Source Types
- Fueltype and Technologies
- Link Drive Schedules
- Operating Mode Distribution
- Off-Network

Links Table Input

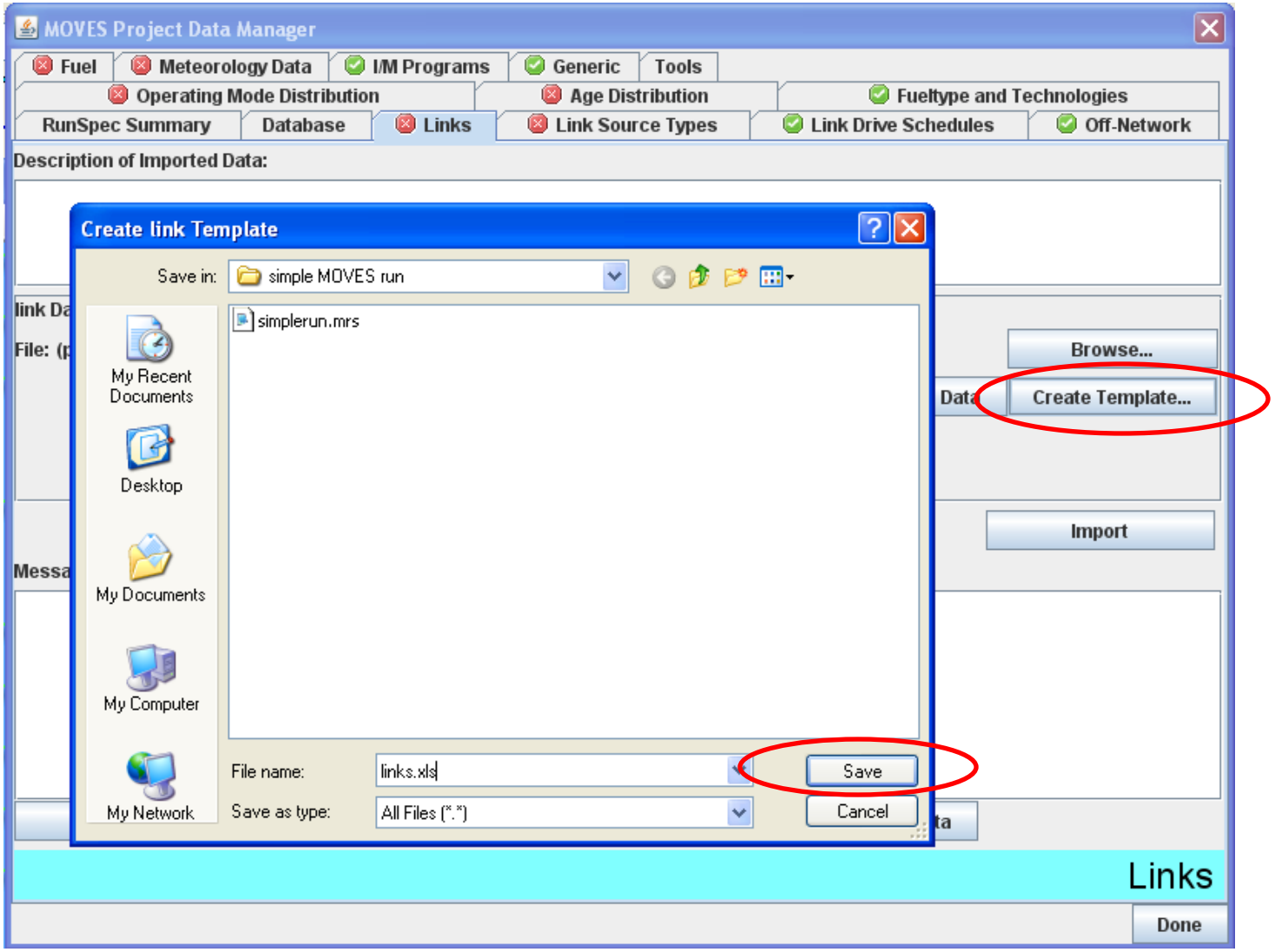
- Should reflect link information from traffic data
  - No defaults available

- MOVES requires following data for each link:
  - LinkID (LinkIDs are used for defining MOVES links as well as basis for defining sources in air quality model)
  - ZoneID (usually the countyID + 0, unless multiple zones are being modeled in a custom domain)
  - Road Type (e.g., 5 for “off-network” road type)
  - Length (Miles)
  - Traffic Volume (VPH)
  - Average Speed (mph)
  - Grade (% grade)

Guidance Reference:

Section 4.5.6

Creating the “Links” Template



Completing the Links Template

links.xls [Compatibility Mode]

	A	B	C	D	E	F	G	H	I	J
1	linkID	countyID	zoneID	roadTypeID	linkLength	linkVolume	linkAvgSpeed	linkDescription	linkAvgGrade	
2		26161	261610	4						
3										
4										
5										
6										
7										

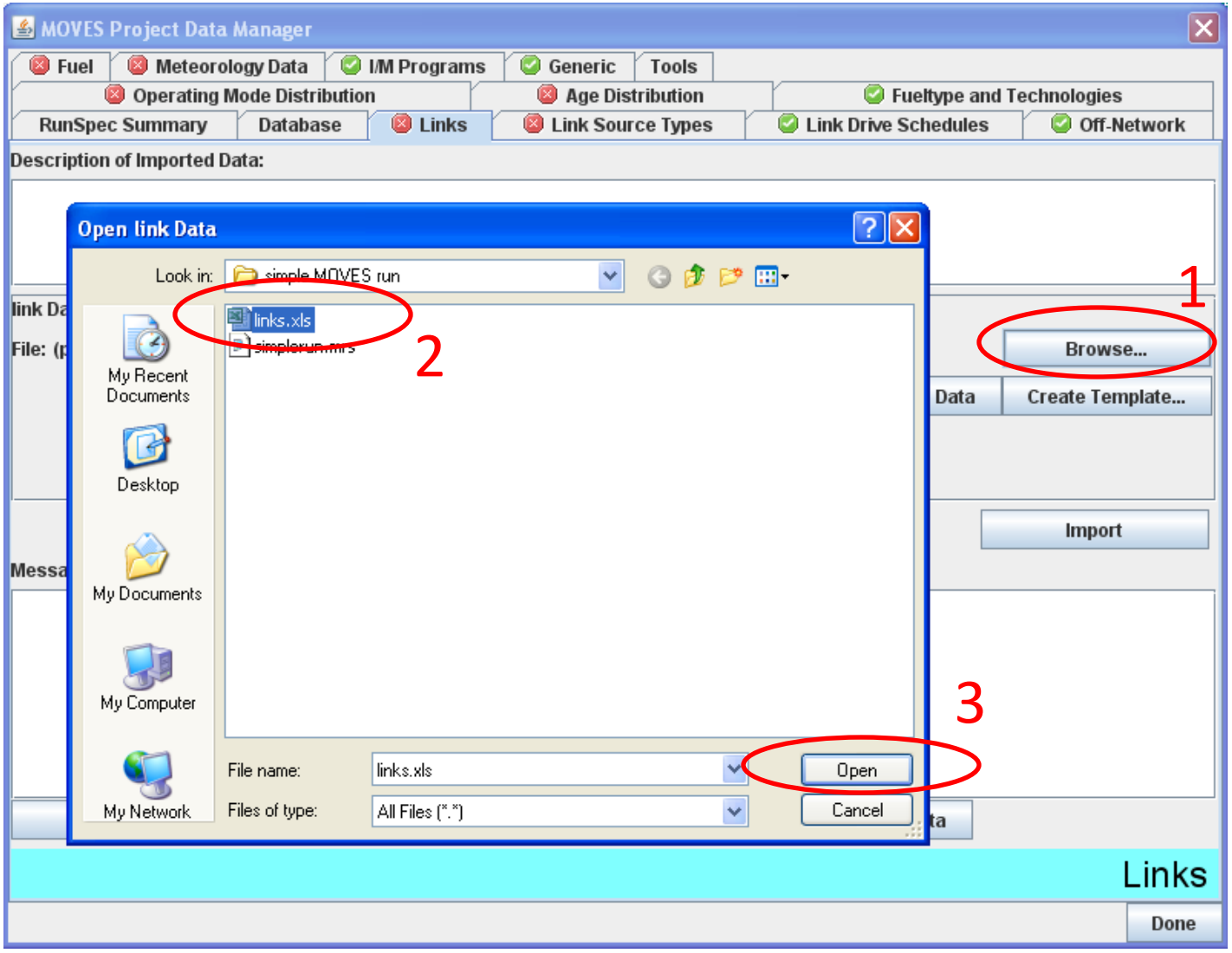
link | County | RoadType | Zone

links.xls [Compatibility Mode]

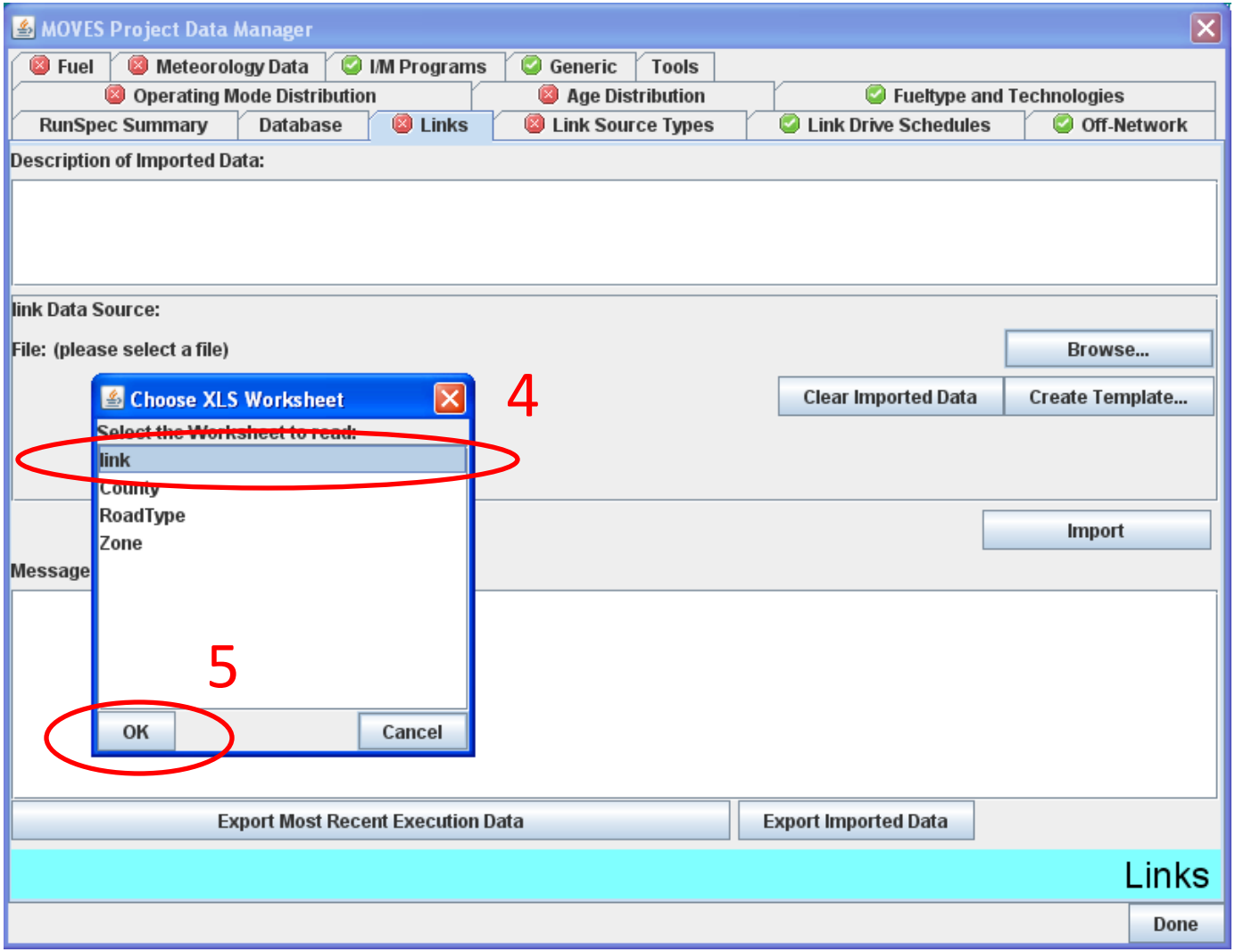
	A	B	C	D	E	F	G	H	I	J	K	L
1	linkID	countyID	zoneID	roadTypeID	linkLength	linkVolume	linkAvgSpeed	linkDescription	linkAvgGrade			
2	1	26161	261610	4	1.25	765	62.5	NB Highway	0			
3	2	26161	261610	4	1.25	690	61	SB Highway	0			
4												
5												
6												
7												

link | County | RoadType | Zone

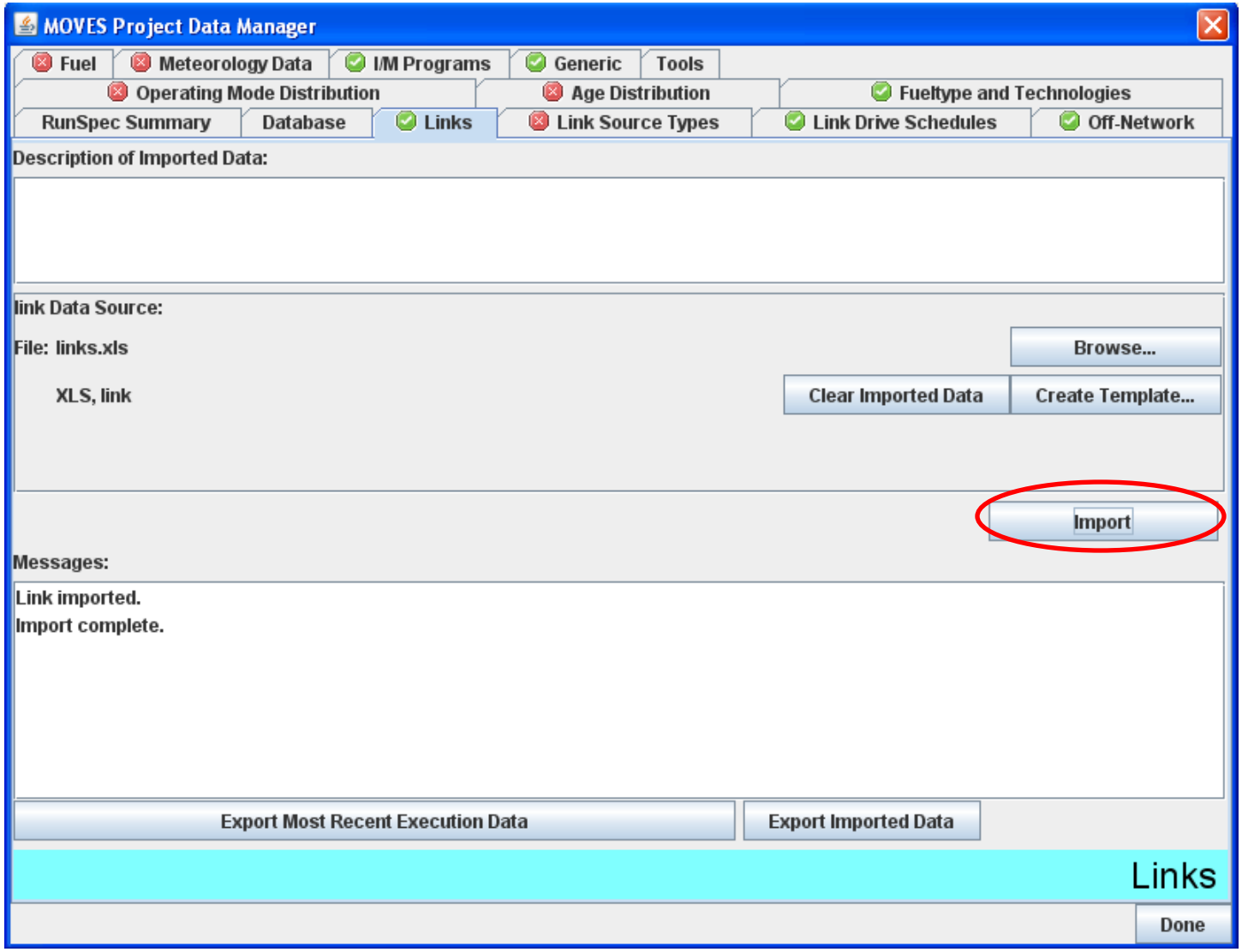
Importing the Completed Links Table



Importing the Completed Links Table

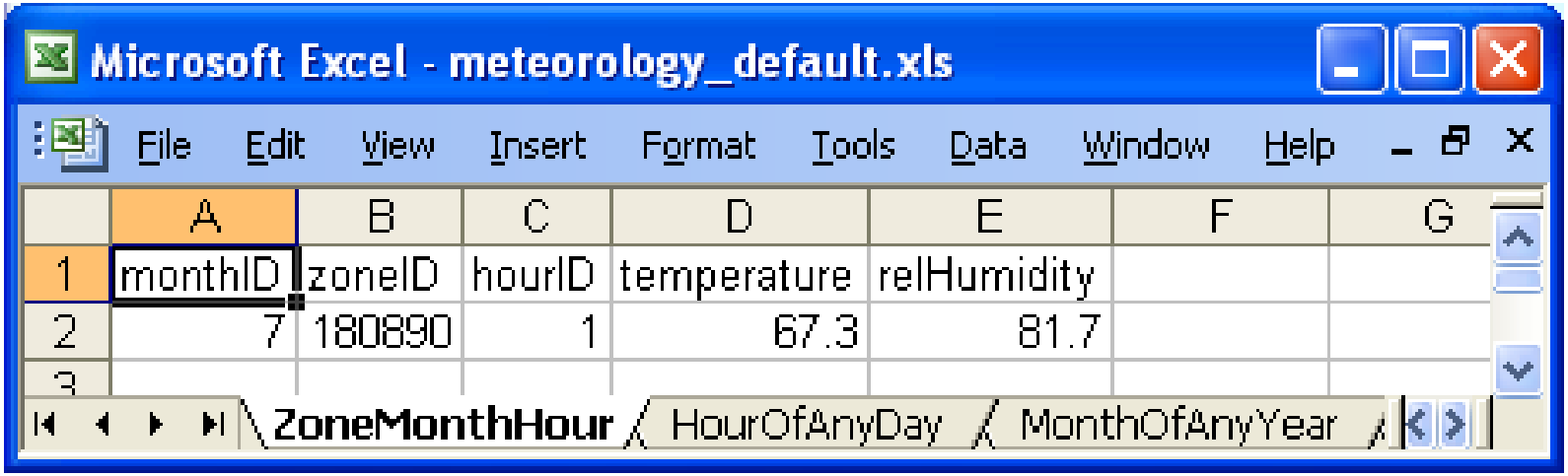


Importing the Completed Links Table



6

Developing Inputs: Meteorology (ZoneMonthHour)



- Meteorology data should be entered with the specific month and hour selected in the RunSpec
- ZoneID is simply the countyID + zero
- Temperatures are in degrees Fahrenheit
- Relative humidity (% humidity) must be between 0 and 100

Guidance on Meteorology

- Should enter data specific to the project's location and time period modeled
  - » Default temperature and humidity values are available in MOVES, but are not recommended for use in a PM hot-spot analysis
- Use temperatures from the representative meteorological data selected for air quality modeling
  - » Temperatures must be consistent with those used for the project's county in the regional emissions analysis (Section 93.123(c)(3))
- The temperature and humidity data should be the same for both the build and no-build scenarios
- We will discuss more about obtaining representative met data in **Module 3**

Guidance Reference:

Section 4.5.1

Guidance on Meteorology

- Use a minimum of four hours per quarter (corresponding to AM peak traffic/PM peak traffic/MD traffic/ON traffic)…
  - » For one day (weekday)
  - » For January, April, July, and October.

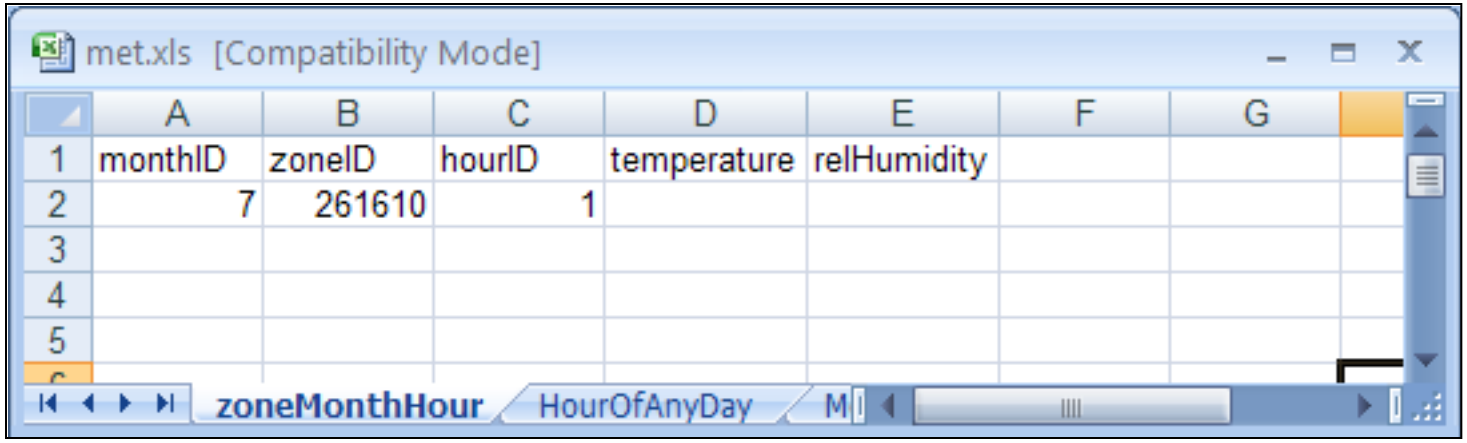
- Within each period of day in each quarter, use average temperature within that time period

- For example, for January AM peak periods corresponding to 6 a.m. to 9 a.m., use average January temperature based on the meteorological record for those hours

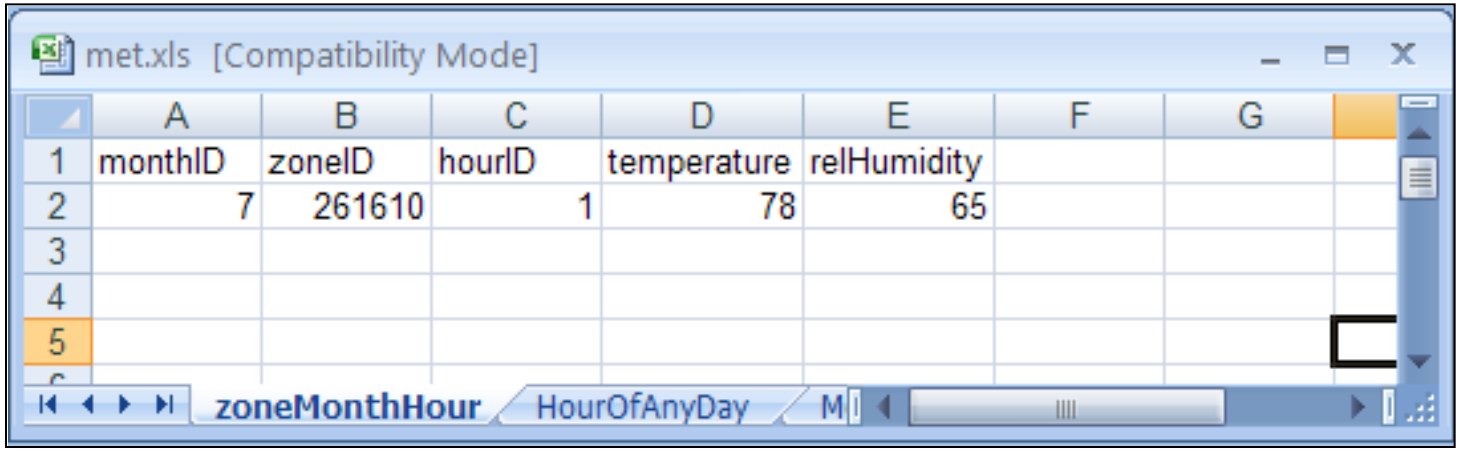
Guidance Reference:

Section 4.5.1

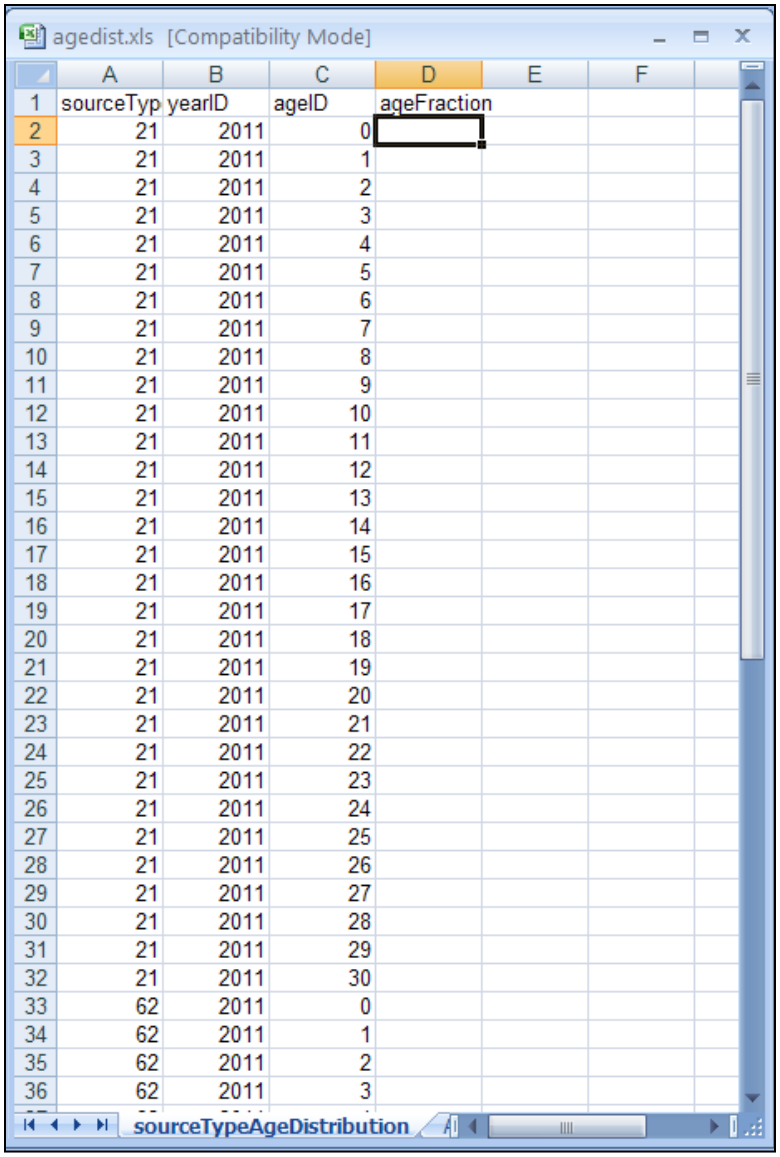
Completing the Meteorology Template



Create template, complete, then import **met.xls** file through MOVES PDM



Developing Inputs: Age Distribution (SourceTypeAgeDistribution)



agedist.xls [Compatibility Mode]

	A	B	C	D	E	F
1	sourceTyp	yearID	ageID	ageFraction		
2	21	2011	0			
3	21	2011	1			
4	21	2011	2			
5	21	2011	3			
6	21	2011	4			
7	21	2011	5			
8	21	2011	6			
9	21	2011	7			
10	21	2011	8			
11	21	2011	9			
12	21	2011	10			
13	21	2011	11			
14	21	2011	12			
15	21	2011	13			
16	21	2011	14			
17	21	2011	15			
18	21	2011	16			
19	21	2011	17			
20	21	2011	18			
21	21	2011	19			
22	21	2011	20			
23	21	2011	21			
24	21	2011	22			
25	21	2011	23			
26	21	2011	24			
27	21	2011	25			
28	21	2011	26			
29	21	2011	27			
30	21	2011	28			
31	21	2011	29			
32	21	2011	30			
33	62	2011	0			
34	62	2011	1			
35	62	2011	2			
36	62	2011	3			

sourceTypeAgeDistribution

- Age Distribution is entered according to MOVES source types (vehicle types) and calendar year
  - » AgeFraction must sum to 1 within these fields
- Age Distribution covers new (0) to 30+ year old vehicles
- MOVES does not vary age distribution by month
- See decoder tab or handout for source type ID
  - » 21 = passenger cars
  - » 62 = combination long-haul truck

Guidance on Age Distribution

There are 3 options for using age distribution data:

Option 1: Use the latest state or local age distribution assumptions from the SIP or transportation conformity regional emissions analysis

- Often available from local Metropolitan Planning Organization (MPO), state DOT, or state air agency
- For cases where some but not all age distributions are available, we'll cover in Option 3

Guidance Reference: Section 4.5.2

Guidance on Age Distribution

Option 2: If the project is designed to serve a fleet that operates only locally, the user should provide project-specific fleet age distribution data

- Example: a drayage yard or bus terminal
- For most captive fleets, an exact age distribution should be readily available or obtainable

Guidance Reference:

Section 4.5.2

Guidance on Age Distribution

Option 3: If no state or local age distribution is available, the MOVES default age distribution should be used

- Also relevant option where user has registration distributions only for one or more vehicle classes (e.g., LDVs) and has relied on MOBILE6.2 defaults in its SIP or regional conformity analysis for the remaining vehicle classes
- MOVES default distributions available on the EPA's website: www.epa.gov/otaq/models/moves/tools.htm

Guidance Reference:

Section 4.5.2

Completing the Age Distribution Template

agedist.xls [Compatibility Mode]

	A	B	C	D	E	F
1	sourceTyp	yearID	ageID	ageFraction		
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3	21	2011	1			
4	21	2011	2			
5	21	2011	3			
6	21	2011	4			
7	21	2011	5			
8	21	2011	6			
9	21	2011	7			
10	21	2011	8			
11	21	2011	9			
12	21	2011	10			
13	21	2011	11			
14	21	2011	12			
15	21	2011	13			
16	21	2011	14			
17	21	2011	15			
18	21	2011	16			
19	21	2011	17			
20	21	2011	18			
21	21	2011	19			
22	21	2011	20			
23	21	2011	21			
24	21	2011	22			
25	21	2011	23			
26	21	2011	24			
27	21	2011	25			
28	21	2011	26			
29	21	2011	27			
30	21	2011	28			
31	21	2011	29			
32	21	2011	30			
33	62	2011	0			
34	62	2011	1			
35	62	2011	2			
36	62	2011	3			

sourceTypeAgeDistribution

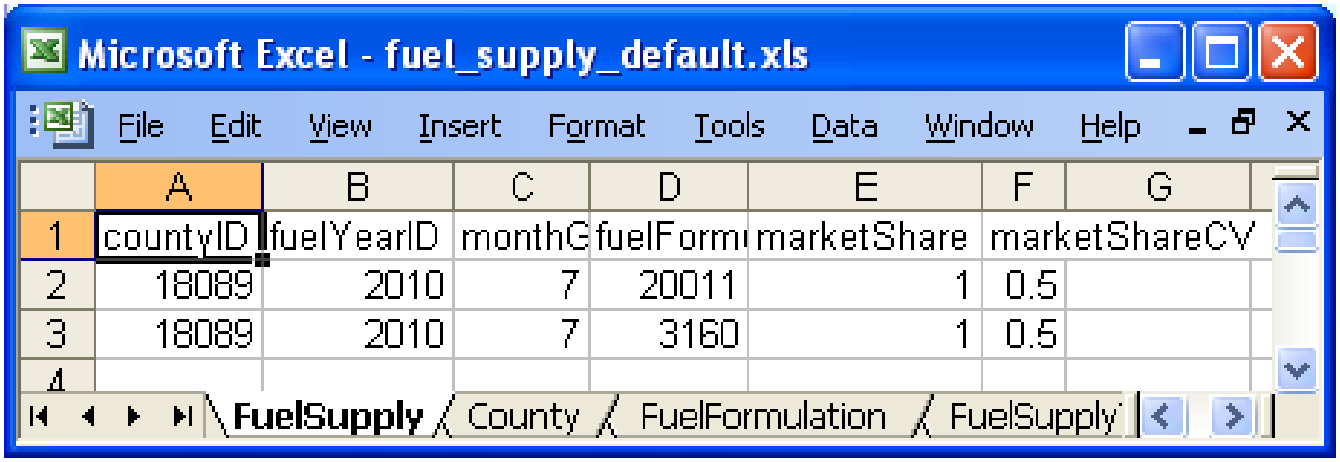
Create template, complete, then import **agedist.xls** file through MOVES PDM

agedist.xls [Compatibility Mode]

	A	B	C	D	E	F
1	sourceTyp	yearID	ageID	ageFraction		
2	21	2011	0	0.5		
3	21	2011	1	0.5		
4	21	2011	2	0		
5	21	2011	3	0		
6	21	2011	4	0		
7	21	2011	5	0		
8	21	2011	6	0		
9	21	2011	7	0		
10	21	2011	8	0		
11	21	2011	9	0		
12	21	2011	10	0		
13	21	2011	11	0		
14	21	2011	12	0		
15	21	2011	13	0		
16	21	2011	14	0		
17	21	2011	15	0		
18	21	2011	16	0		
19	21	2011	17	0		
20	21	2011	18	0		
21	21	2011	19	0		
22	21	2011	20	0		
23	21	2011	21	0		
24	21	2011	22	0		
25	21	2011	23	0		
26	21	2011	24	0		
27	21	2011	25	0		
28	21	2011	26	0		
29	21	2011	27	0		
30	21	2011	28	0		
31	21	2011	29	0		
32	21	2011	30	0		
33	62	2011	0	0.5		
34	62	2011	1	0.5		
35	62	2011	2	0		
36	62	2011	3	0		

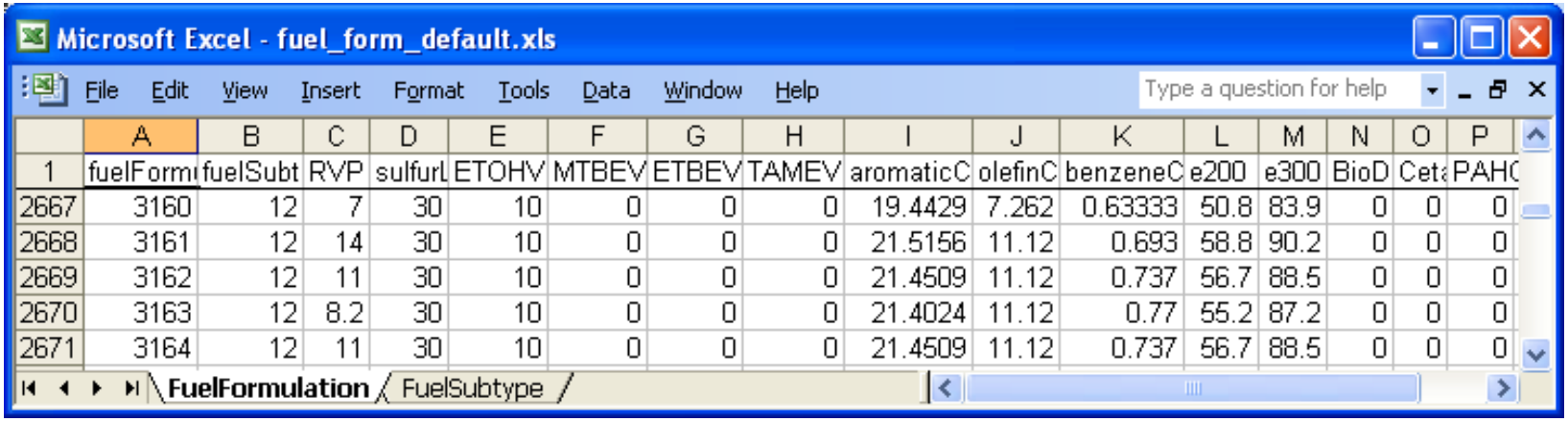
sourceTypeAgeDistribution

Developing Inputs: Fuel Supply (FuelSupply)



- Fuel Supply is entered according to county, year, month, fuel type
  - » MarketShare should sum to 1 within these fields for each fuel type
- If defaults are exported, they will contain only gasoline and diesel formulations
  - » If CNG is selected in RunSpec, add an entry for CNG (fuelFormulationID = 30)

Developing Inputs: Fuel Formulation (FuelFormulation)



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	fuelForm	fuelSubt	RVP	sulfurL	ETOHV	MTBEV	ETBEV	TAMEV	aromaticC	olefinC	benzeneC	e200	e300	BioD	Cet	PAHC
2667	3160	12	7	30	10	0	0	0	19.4429	7.262	0.63333	50.8	83.9	0	0	0
2668	3161	12	14	30	10	0	0	0	21.5156	11.12	0.693	58.8	90.2	0	0	0
2669	3162	12	11	30	10	0	0	0	21.4509	11.12	0.737	56.7	88.5	0	0	0
2670	3163	12	8.2	30	10	0	0	0	21.4024	11.12	0.77	55.2	87.2	0	0	0
2671	3164	12	11	30	10	0	0	0	21.4509	11.12	0.737	56.7	88.5	0	0	0

- Use only existing fuelFormulationID's with the appropriate fuelSubTypeID for the fuel properties being entered
- Properties can be changed for existing formulations
  - » Gasoline fuelformulationID's are 500-9419
  - » Diesel: 20011-20491
  - » CNG: 30

Guidance on Fuels

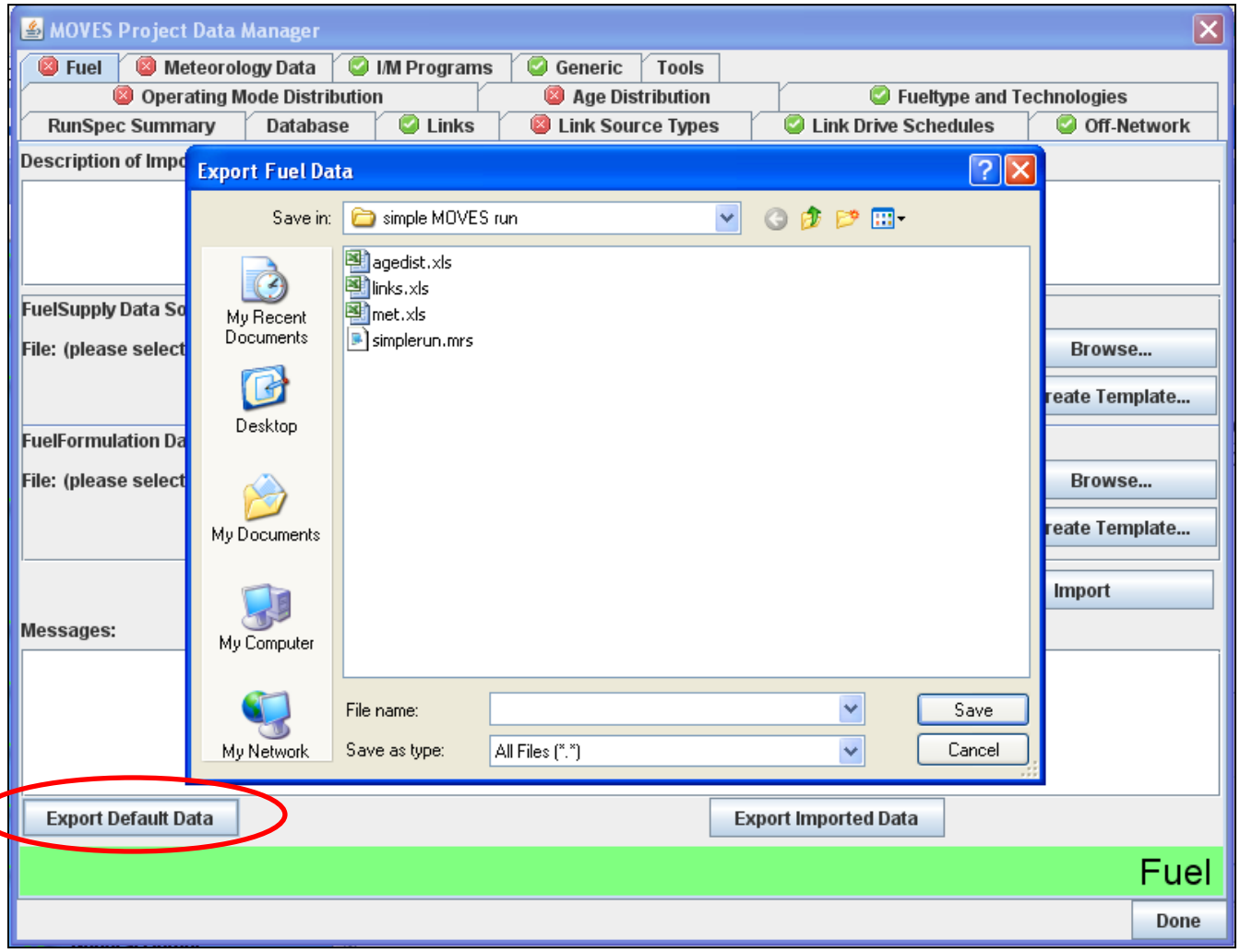
- Users should review default fuels for the project area and make changes only when volumetric fuel data is available
  - » Exception: Reid Vapor Pressure (RVP) should be changed in fuel formulation table to reflect ethanol blend requirements (e.g., Renewable Fuel Standards (RFS))

- Generally fuels should be the same for both build and no-build
  - » Exception: if project will include addition of alternatively-fueled vehicles and infrastructure

Guidance Reference:

Section 4.5.3

Exporting Default Fuels



After exporting default fuels (**fuels.xls**), browse and import default fuel supply and fuel formulation through MOVES PDM

Guidance on I/M Programs

- MOVES does not provide a PM emission benefit from any I/M program

- If the user includes an I/M program in the run specification, the selection will have no impact on PM emissions

Guidance Reference:

Section 4.5.4

Link Source Type Input

linksource.xls [Compatibility Mode]

	A	B	C	D	E
1	linkID	sourceTypeID	sourceTypeHourFraction		
2		21			
3		62			
4					
5					
6					
7					

linkSourceTypeHour | SourceU

- LinkID
  - » Must include all LinkIDs defined in Links Input
- SourceTypeID
  - » Must include all source types selected in On Road Vehicle/Equipment panel
- SourceTypeHourFraction
  - » Specify vehicle mix (fraction of Vehicle Hours Traveled (VHT)) on each link
  - » Fractions should sum to “1” for each linkID

Guidance Reference: Section 4.5.5

Link Source Type Input

- Enter the fraction of the link traffic volume that is represented by each vehicle type (source type)
  - » No defaults available

- This is not necessary for off-network links

Guidance Reference:

Section 4.5.5

Guidance on Link Source Type Input

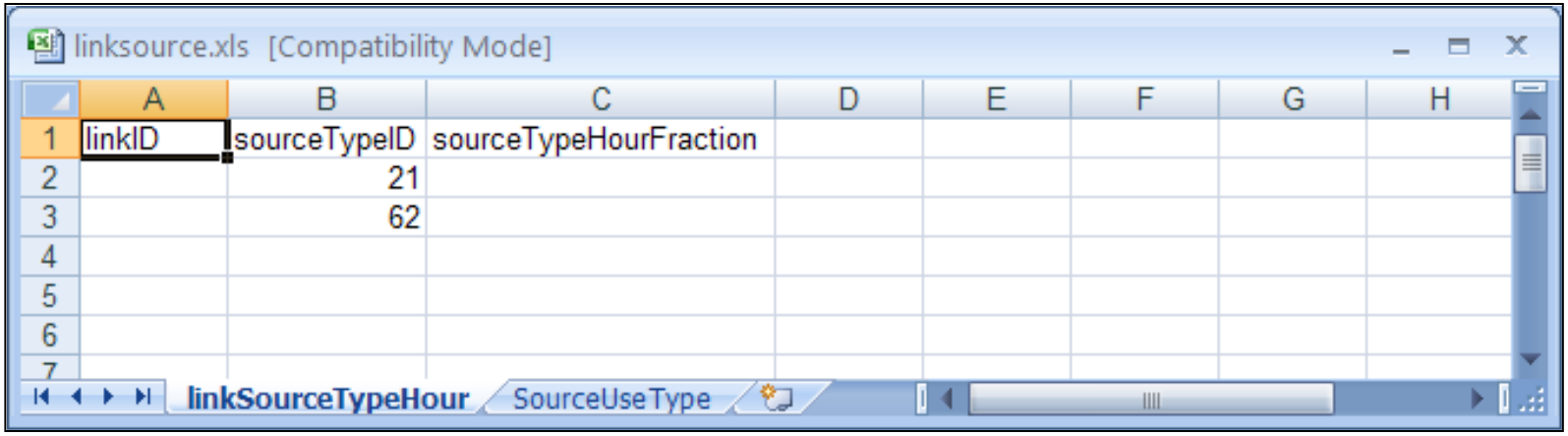
- **Option 1:** Collect project-specific data
  - » Example: projects such as bus or freight terminals or maintenance facilities
  - » This could be based on analysis of similar existing projects

- **Option 2:** Use regional fleet information
  - » Use the same source type distribution used in the latest regional emissions analysis for each road type in the project
    - » Data often available from state DOT, state air agency, or local MPO
  - » May be adjusted if data are available for light-duty vs. heavy-duty mix

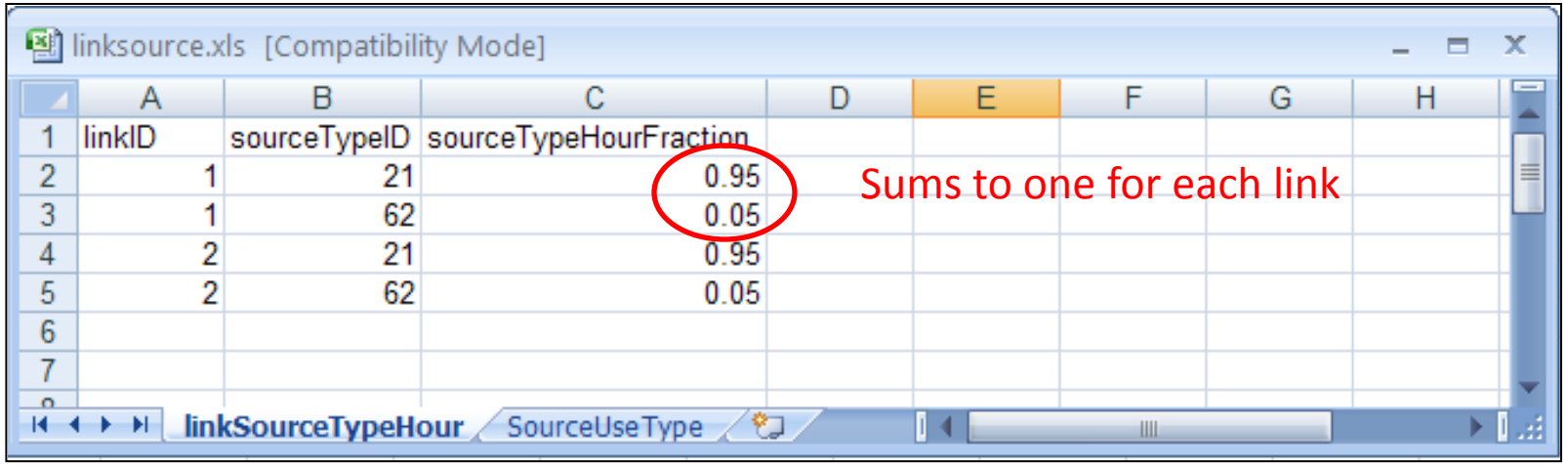
Guidance Reference:

Section 4.5.5

Completing the Link Source Template



Create template, complete, then import **linksource.xls** file through MOVES PDM



Sums to one for each link

Fueltype and Technologies Input

- Optional input used to change fuel/technology mix among vehicles and model years
  - » Defaults should be used in most cases, when more detailed fuel mix data are not available
  - » Most often used to change diesel fractions

- Common example: When modeling a captive fleet of entirely diesel transit buses, the Fueltype and Technologies input would be used to specify that the fleet is 100% diesel
  - » Why? Based on national data, MOVES assumes that transit buses use a mix of gasoline, diesel, and CNG – even if only the diesel fuel type was specified in the On Road Vehicle and Equipment Type Panel
  - » Some vehicles will not be captured if fractions are not changed to reflect 100% diesel

Guidance Reference:

Section 4.4.9

Importing Project Activity Data

- For this example, we will complete two simple MOVES runs:
  - The first using the average speed activity approach
  - A second using a link-drive schedule (vehicle trajectory) activity approach

Options for Defining Activity: Option 1 – Average Speed

Defining the Average Speed Function Through the Links Table

- If no Op-Mode distribution or Link Drive Schedule is defined, MOVES uses average speed combined with road type and road grade to calculate Op-Mode distribution
  - » Based on default drive cycles
  - » As defined in the Links Input
- Provides least resolution when analyzing project emissions
- Note: We have already imported the Links table (with link average speeds) and no further action is needed

Guidance Reference:

Section 4.5.7

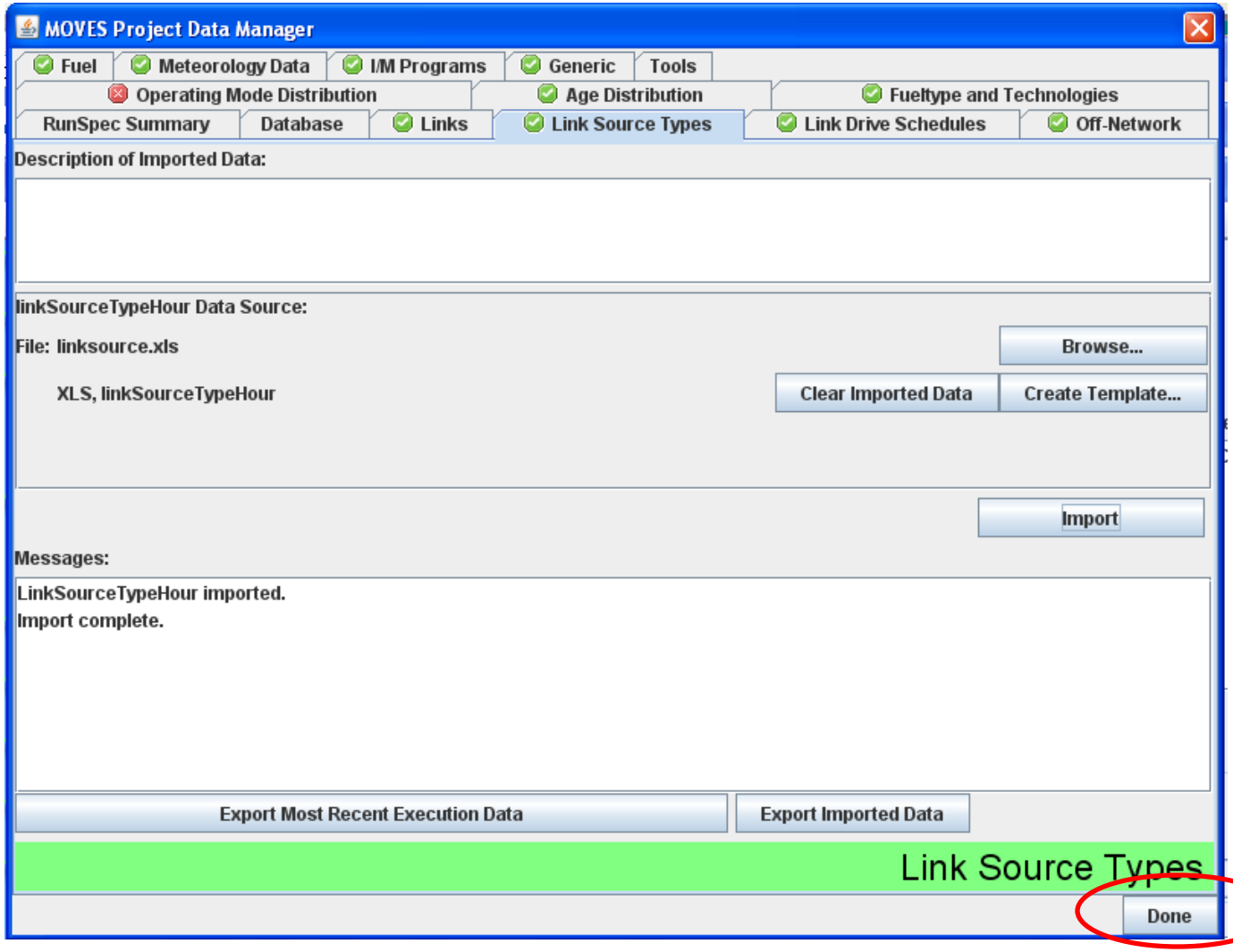
Allowable Average Speed Ranges

Allowable Average Speed Input Range for Project Level Input By Source Type			
sourcetypeid	**sourcetypename**	**Minimum Speed (mph)**	**Maximum Speed (mph)**
11	Motorcycle	2.5	73.8
21	Passenger Car	2.5	73.8
31	Passenger Truck	2.5	73.8
32	Light Commercial Truck	2.5	73.8
41	Intercity Bus	4.6	72.8
42	Transit Bus	15.0	72.8
43	School Bus	15.0	72.8
51	Refuse Truck	2.2	71.7
52	Single Unit Short-haul Truck	4.6	72.8
53	Single Unit Long-haul Truck	4.6	72.8
54	Motor Home	4.6	72.8
61	Combination Short-haul Truck	5.8	71.7
62	Combination Long-haul Truck	5.8	71.7

Table 2.3.3.4.12 Allowable Average Speed

Note: Average speeds outside the allowable range will be assigned the closest available drive cycle. Also, speeds of "0" are allowed for all source types, indicating idle operation.

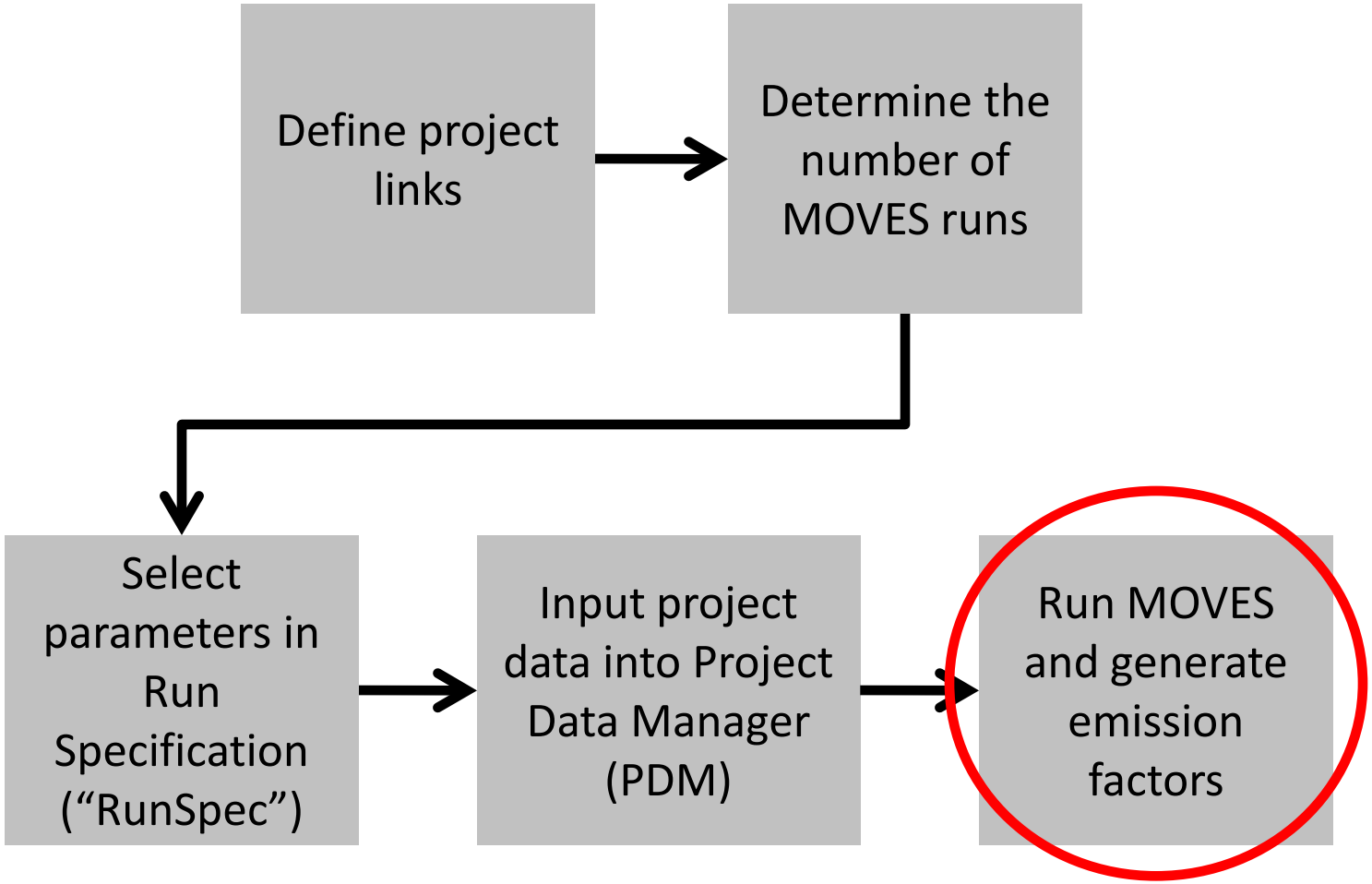
Completed Input Database



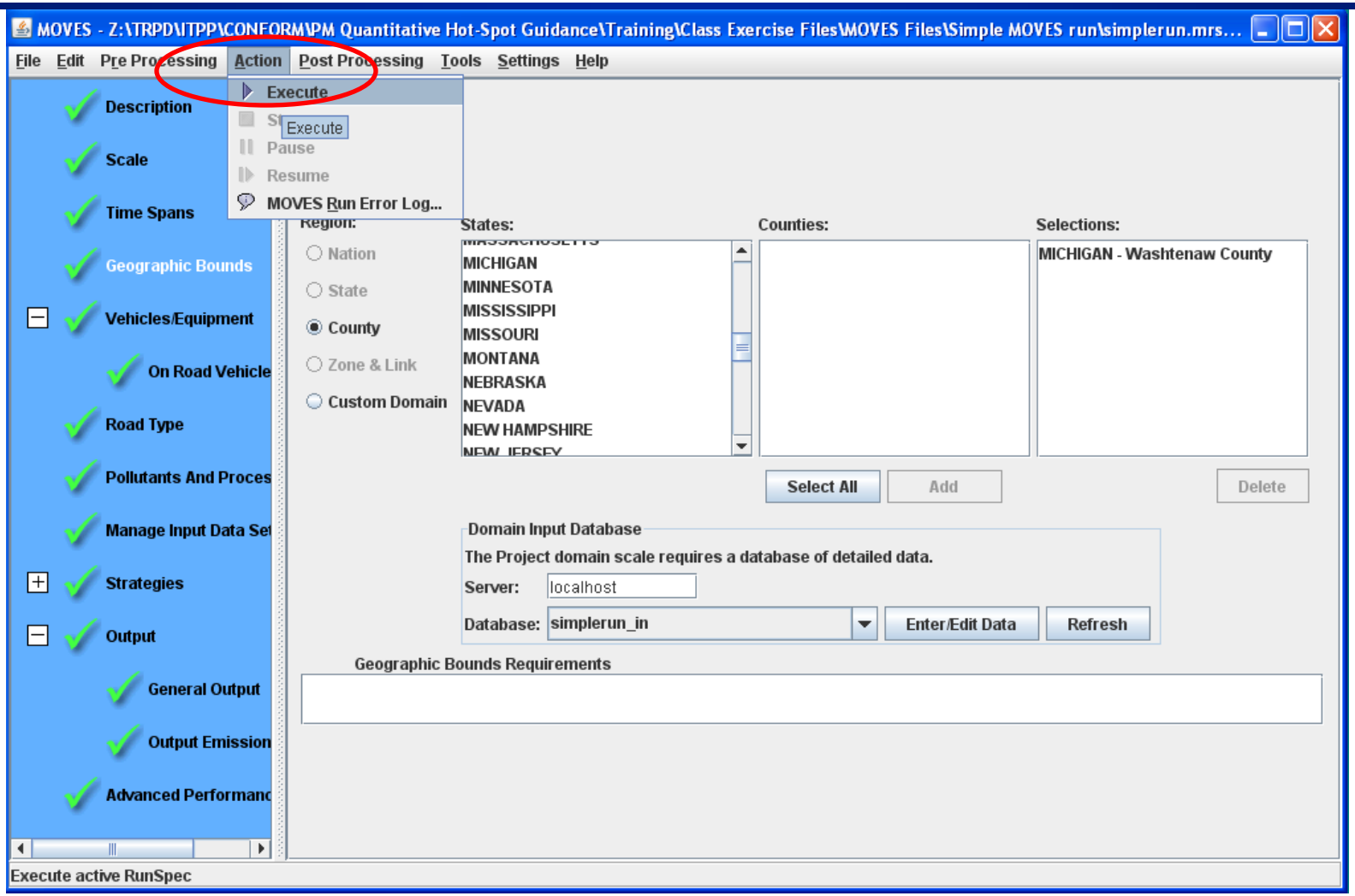
Green checks for all tabs (except OpMode Distribution)

Note – This run will not use any inputs into the Off-Network, Operating Mode Distribution, I/M Programs, Link Drive Schedule or Generic database tables

Running MOVES at the Project Scale

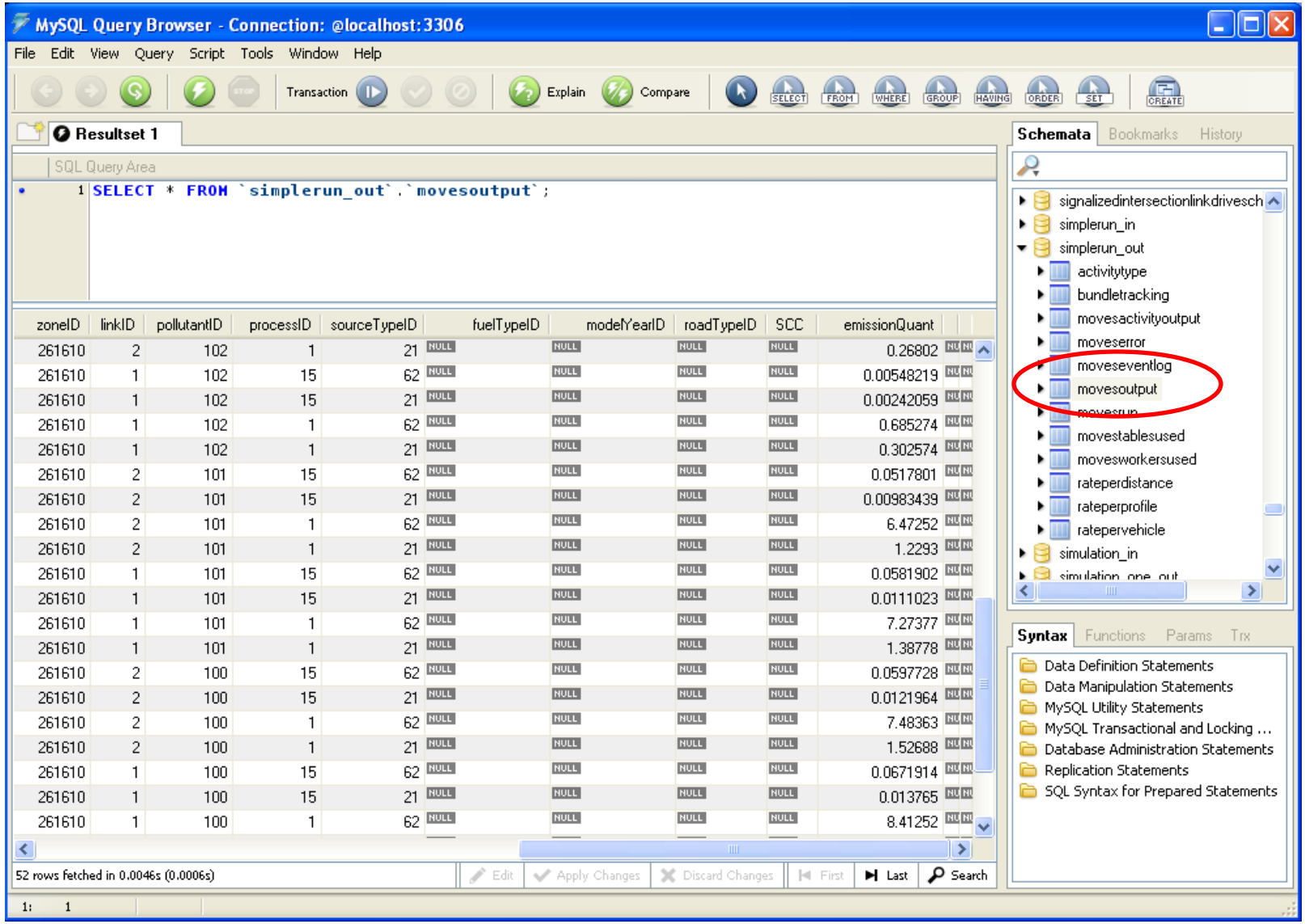


Save RunSpec and Execute the MOVES run



Note: It may be necessary to refresh the screen to get a green check for the Geographic Bounds Panel. To do this, simply click on another panel (e.g., Time Spans), and then click back to the Geographic Bounds Panel.

Viewing MOVES Output in MySQL

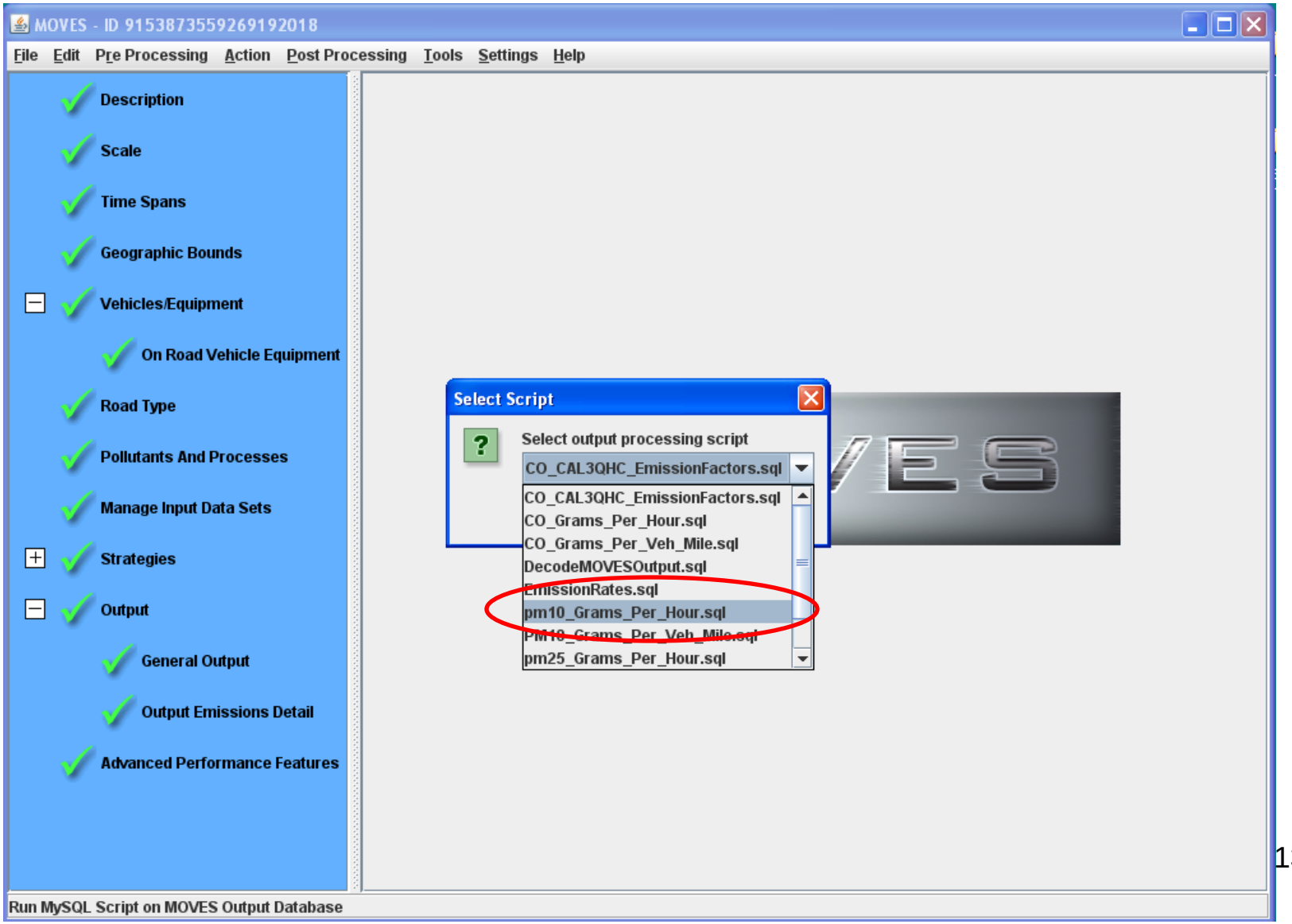


Available Post-Processing Scripts for Calculating Emission Factors (EF)

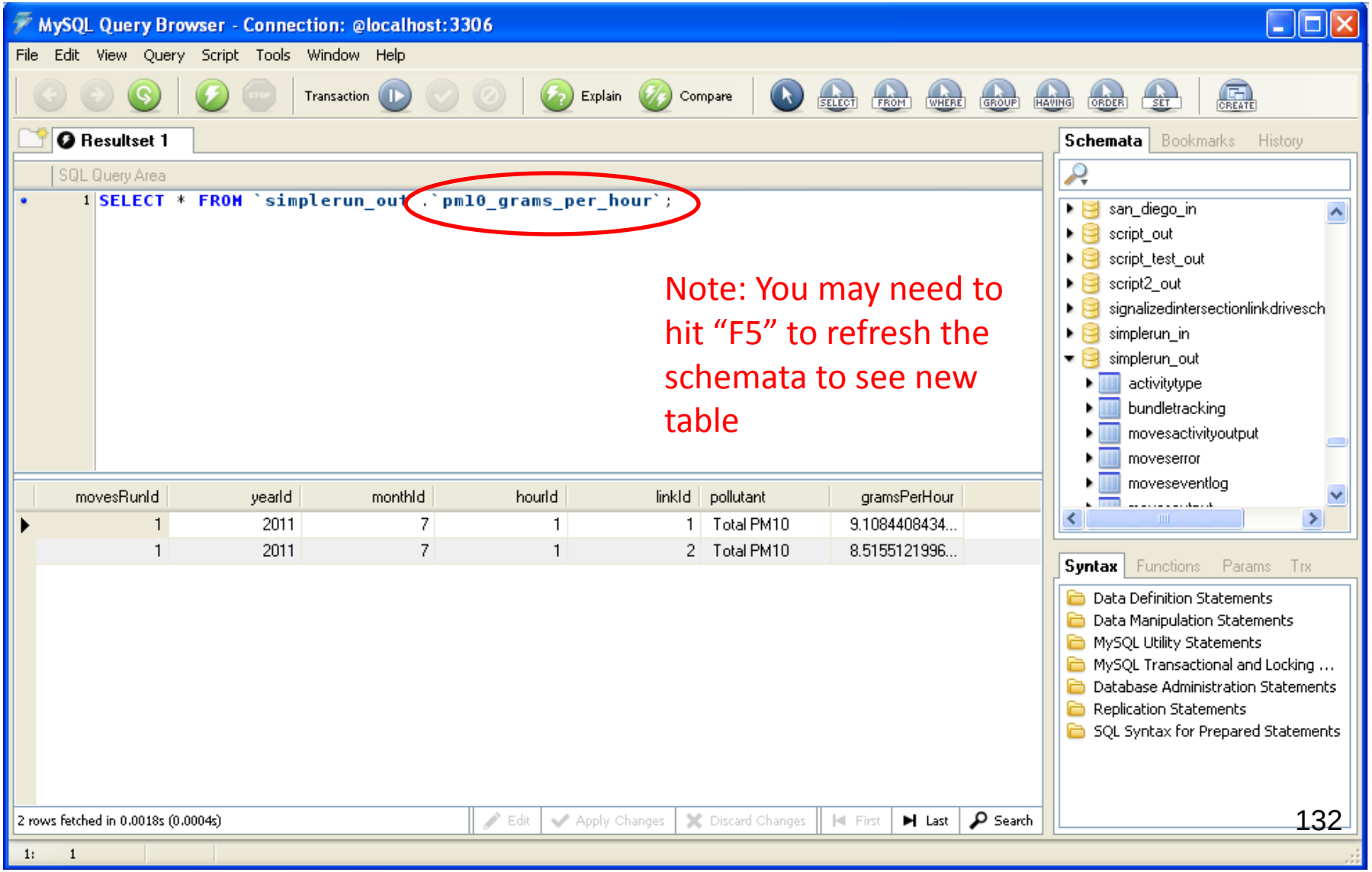
Script Name:	Produces:
"PM10 Grams Per Hour"	An EF for each link as grams/hour (AERMOD)
"PM10 Grams Per Mile"	An EF for each link as grams/veh-mile (CAL3QHCR)
"PM2.5 Grams Per Hour"	An EF for each link as grams/hour (AERMOD)
"PM2.5 Grams Per Mile"	An EF for each link as grams/veh-mile (CAL3QHCR)

Note: MOVES scripts are also available for CO project-level analyses.

Run Post-Processing Script on Output



New Summary Emission Factors Table



Options for Defining Activity: Option 2 – Link Drive Schedule

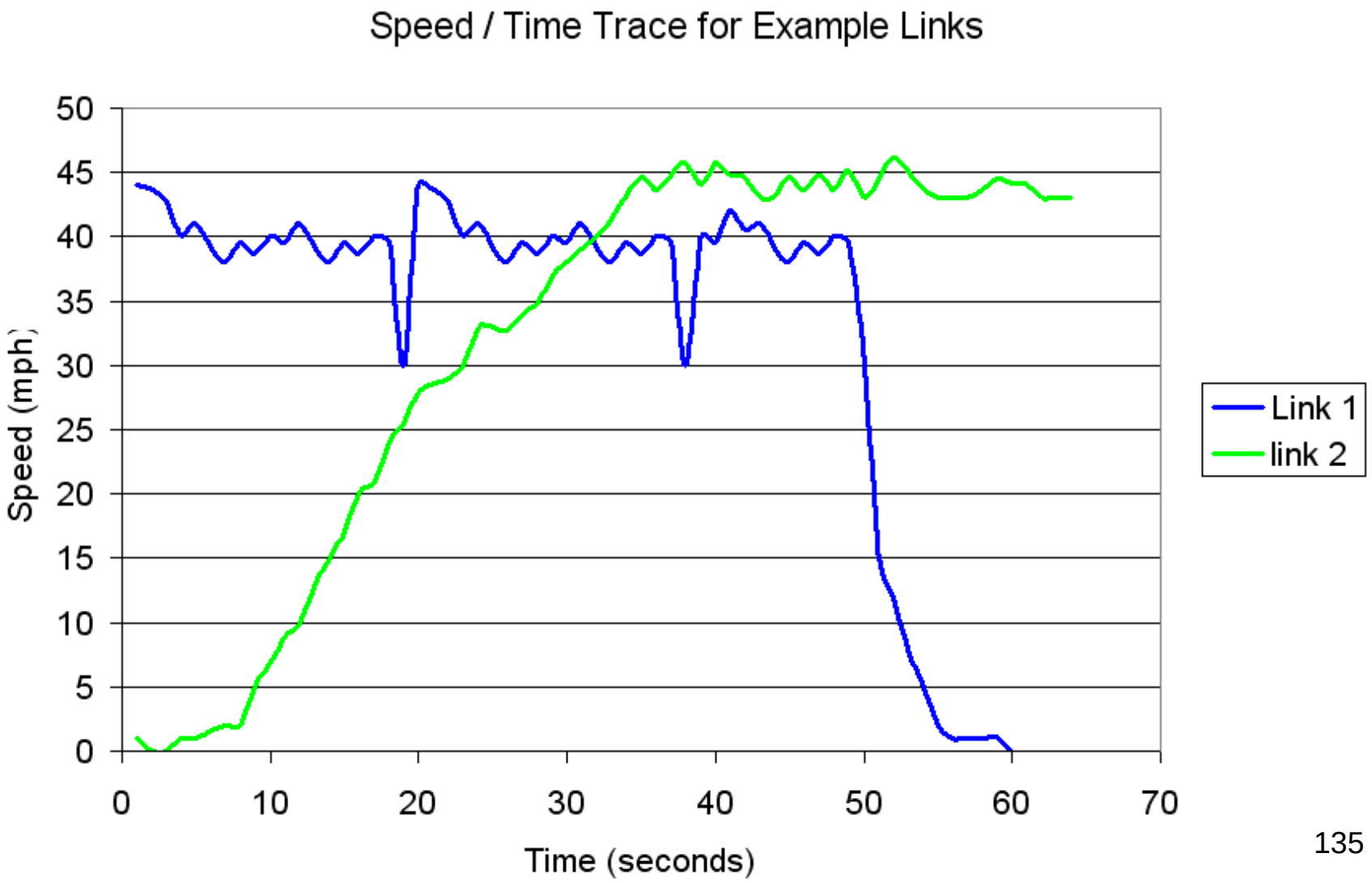
Defining a Link Drive Schedule

- For any link, user can provide a "link drive schedule," a second-by-second speed/grade profile (vehicle trajectory)
  - » Not necessary to define all seconds for a link… emissions from defined link drive schedule will be applied to entire link (for specified distance in Links table)
- MOVES uses internal algorithm to calculate an Op-Mode distribution from Link Drive Schedule and the subsequent emissions
- The vehicle trajectory represents all vehicles driving an identical path on the links
  - » "Overlapping links": Individual links may be defined to represent single (or multiple) vehicle trajectories

Guidance Reference:

Section 4.5.7

Vehicle Trajectory Data



Second-by-Second Link Drive Schedule Table

linkdrive.xls

	A	B	C	D	E	F	G	H
1	linkID	secondID	speed	grade				
2	1	1	44	0				
3	1	2	43.7	0				
4	1	3	42.6	0				
5	1	4	40	0				
6	1	5	41	0				
7	1	6	39	0				
8	1	7	38	0				
9	1	8	39.5	0				
10	1	9	38.7	0				
11	1	10	40	0				
12	1	11	39.6	0				
13	1	12	41	0				
14	1	13	39	0				
15	1	14	38	0				
16	1	15	39.5	0				
17	1	16	38.7	0				
18	1	17	40	0				
19	1	18	39.6	0				
20	1	19	30	0				
21	1	20	44	0				
22	1	21	43.7	0				
23	1	22	42.6	0				
24	1	23	40	0				
25	1	24	41	0				
26	1	25	39	0				
27	1	26	38	0				
28	1	27	39.5	0				
29	1	28	38.7	0				
30	1	29	40	0				
31	1	30	39.6	0				
32	1	31	41	0				

driveScheduleSecondLink

Possible Data Sources:

- Microsimulation model
- Calculated from highway geometry
  - » HCM
  - » Other methods
- Chase-Car Study

Guidance Reference: Section 4.5.7

Using Output from Microsimulation Models

- It is possible to model representative vehicle trajectories

  or

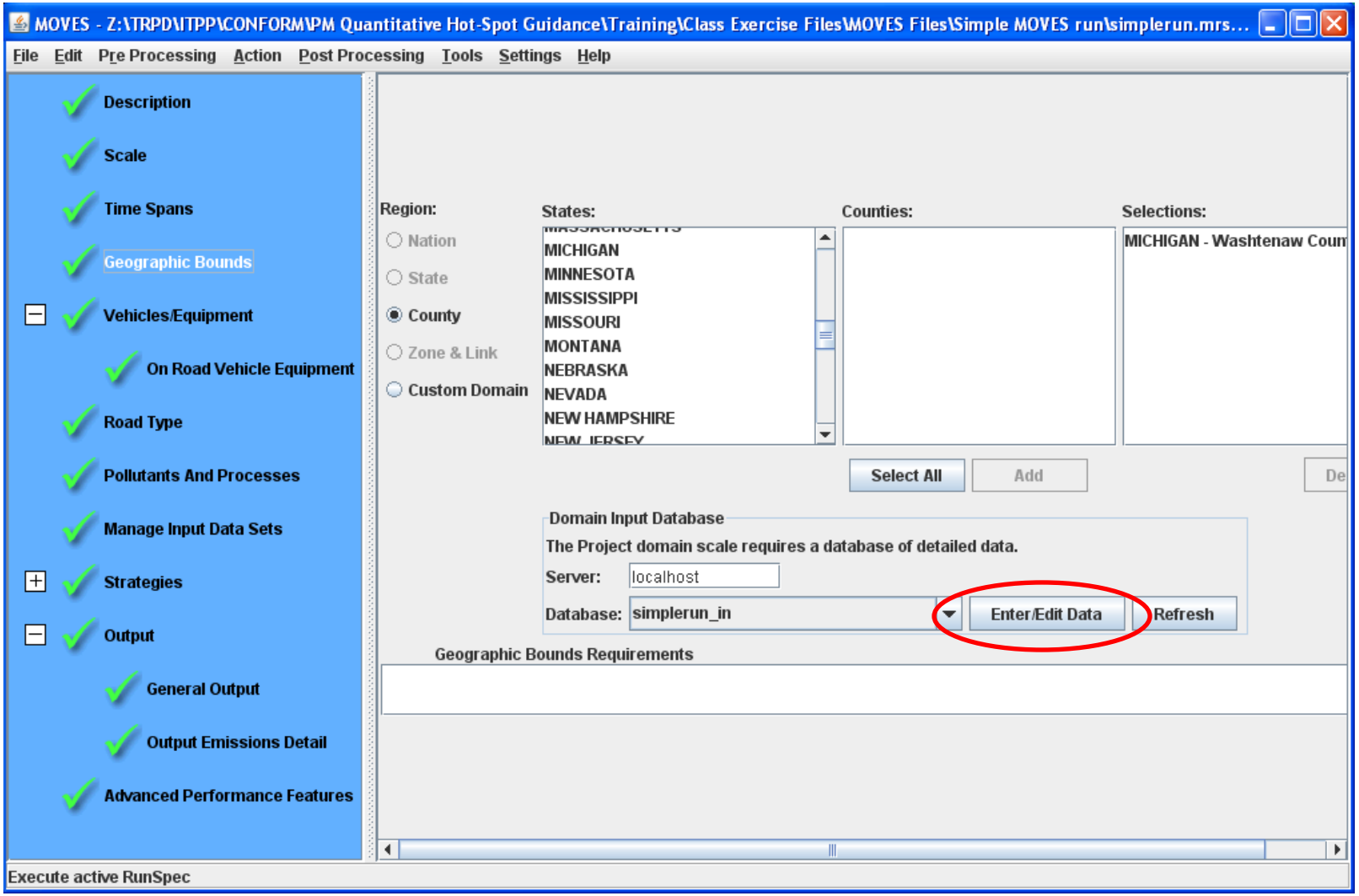
- Individual vehicle
  - » Each vehicle would be assigned a unique LinkID with a volume of “1”
  - » Emissions would then be aggregated in post-processing to calculate link total emission factors

- Users should note that run times increase as more links are defined

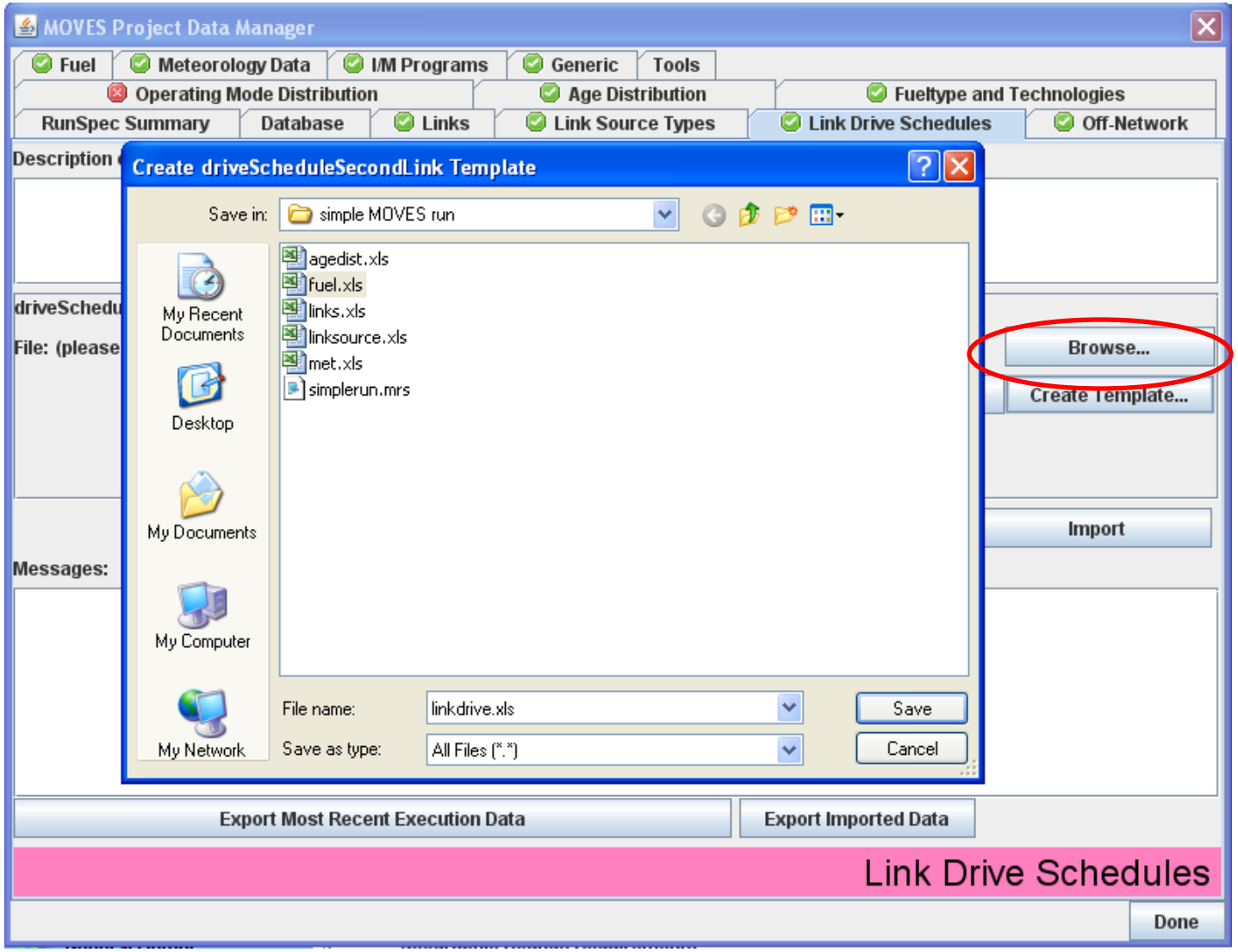
Guidance Reference:

Sec. 4.2.1, 4.6 & App D

Importing a Link Drive Schedule



Creating a Link Drive Schedule Template



Completing the Link Drive Schedule Template

linkdrive.xls [Compatibility Mode]

	A	B	C	D	E
1	linkID	secondID	speed	grade	
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					

driveScheduleSecon

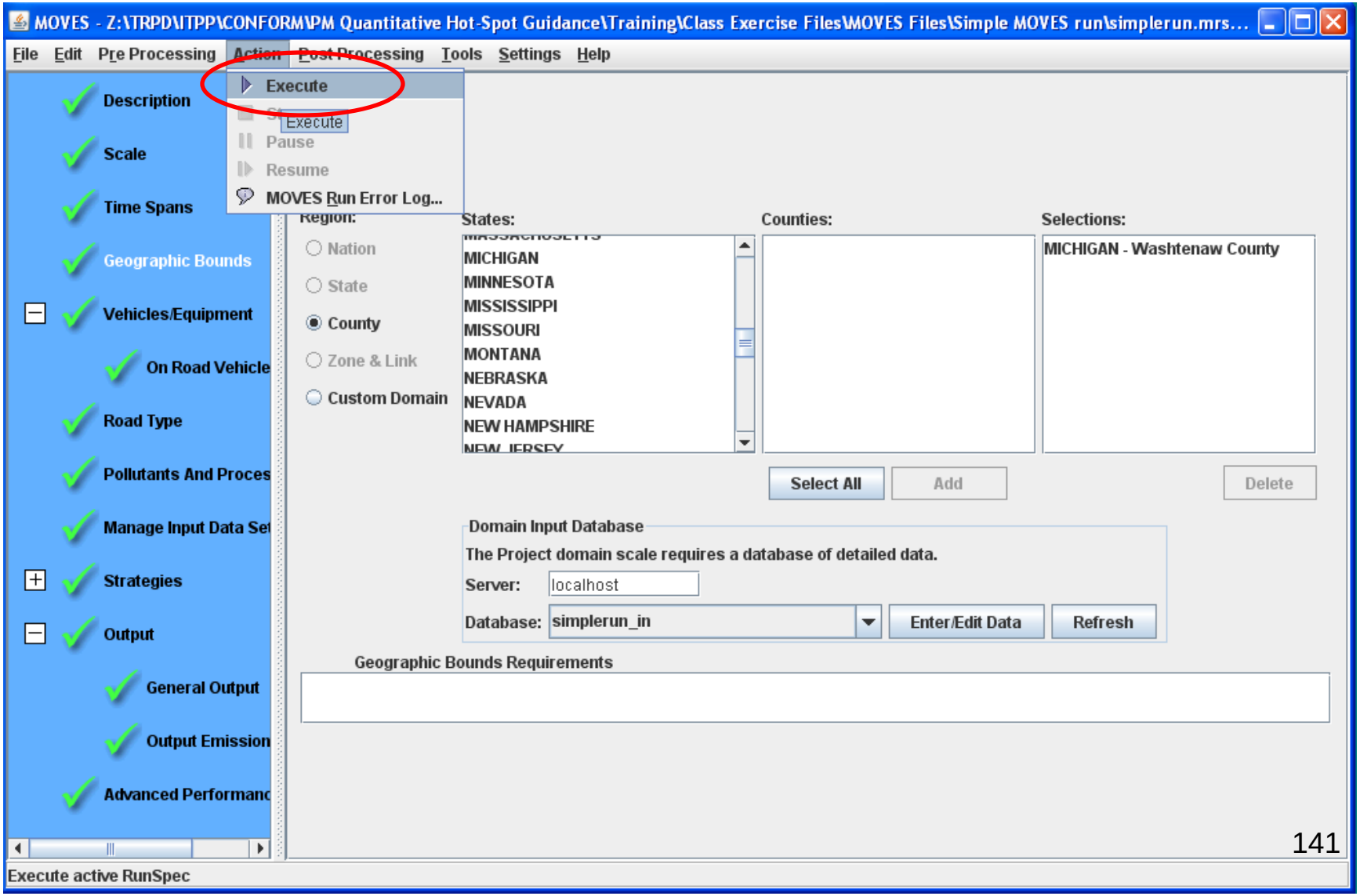
Create template, complete, then import **linkdrive.xls** file through MOVES PDM

linkdrive.xls [Compatibility Mode]

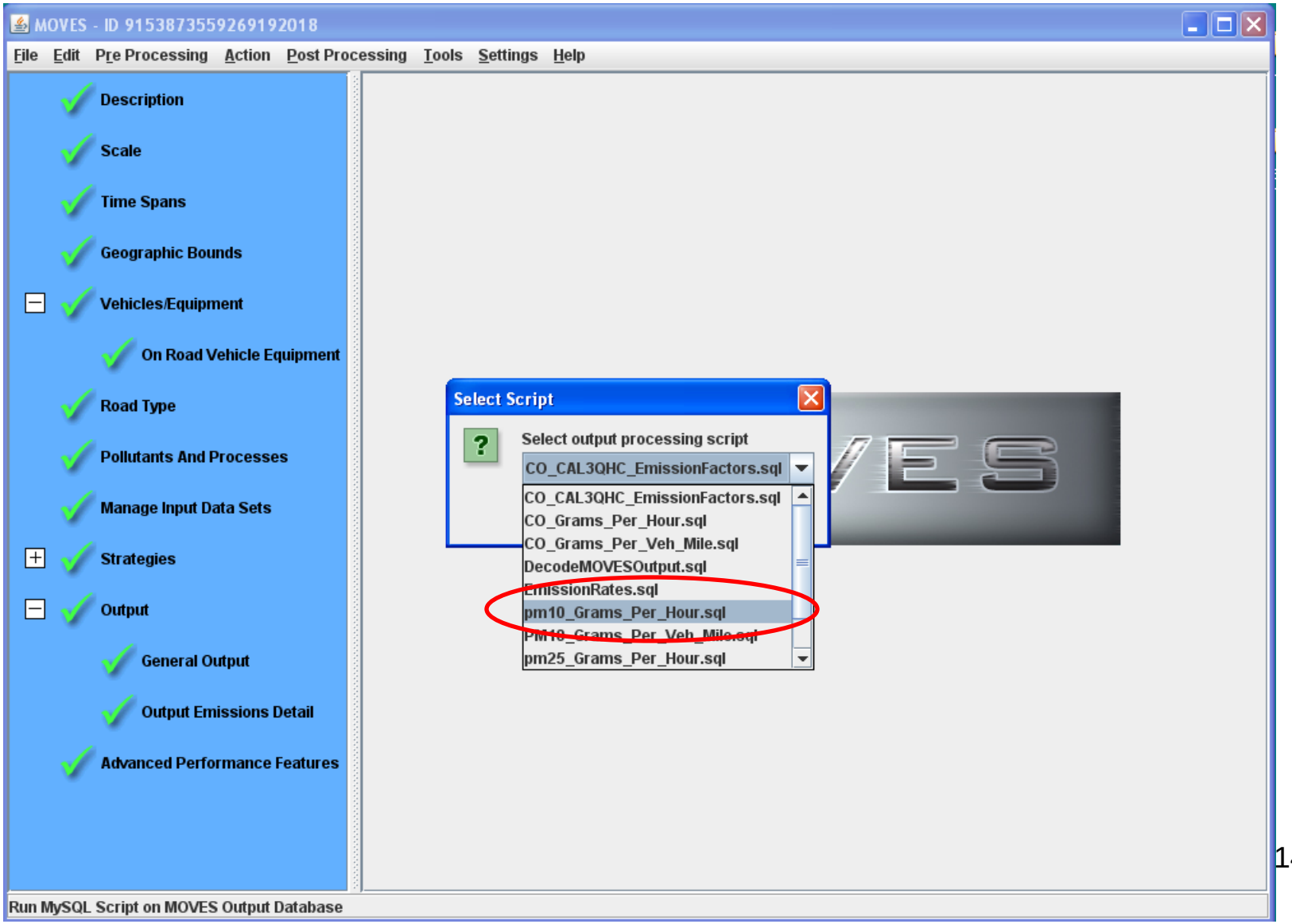
	A	B	C	D	E
1	linkID	secondID	speed	grade	
2	1	1	62.5	0	
3	1	2	62.5	0	
4	1	3	62.5	0	
5	1	4	62.5	0	
6	1	5	62.5	0	
7	1	6	62.5	0	
8	1	7	62.5	0	
9	1	8	62.5	0	
10	1	9	62.5	0	
11	1	10	62.5	0	
12	2	1	61	0	
13	2	2	61	0	
14	2	3	61	0	
15	2	4	61	0	
16	2	5	61	0	
17	2	6	61	0	
18	2	7	61	0	
19	2	8	61	0	
20	2	9	61	0	
21	2	10	61	0	
22					
23					
24					
25					
26					
27					
28					

driveScheduleSecon

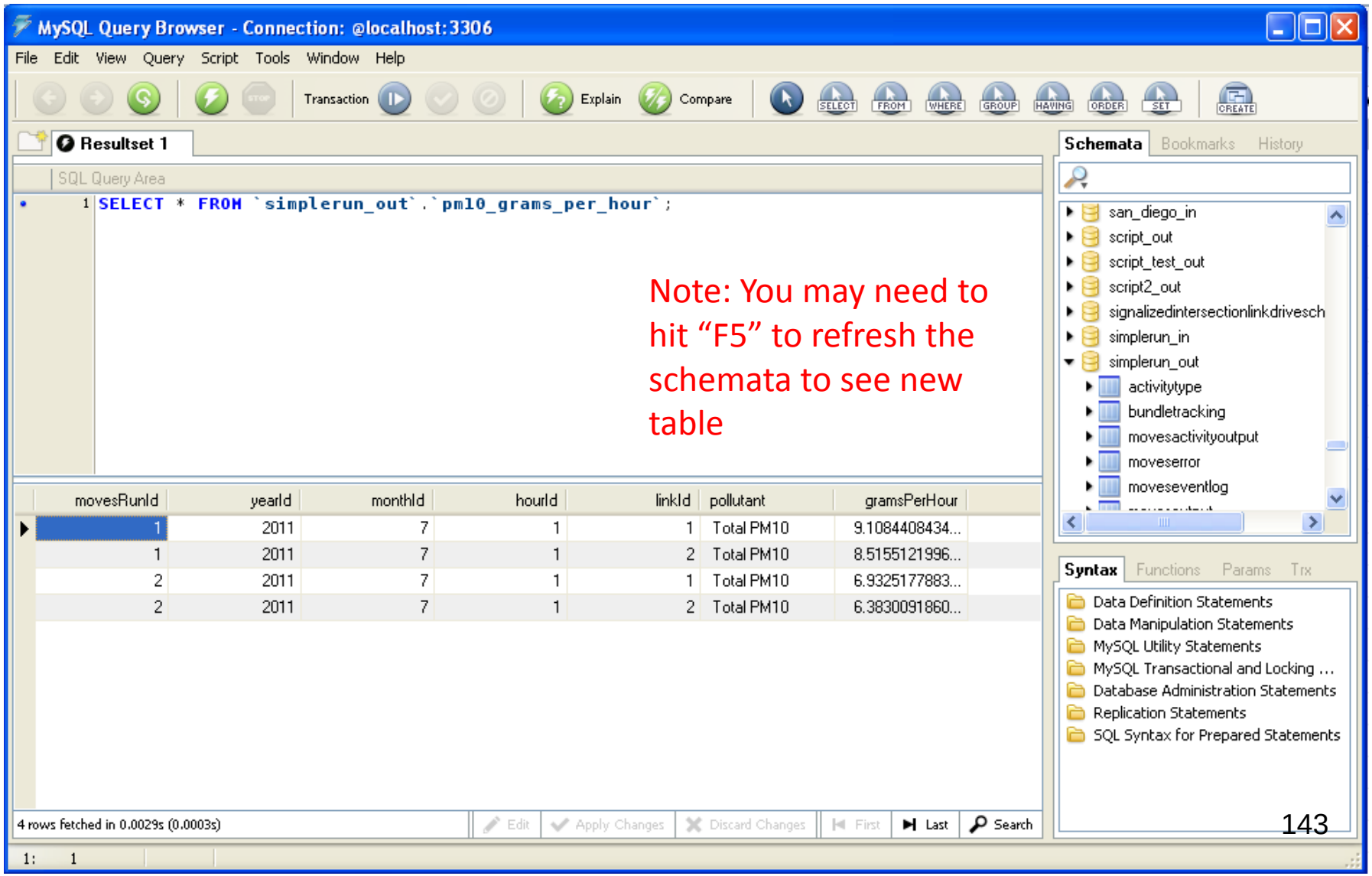
Executing the MOVES run



Run Post-Processing Script on Output



New Summary Emission Factors Table



movesRunId	yearId	monthId	hourId	linkId	pollutant	gramsPerHour
1	2011	7	1	1	Total PM10	9.1084408434...
1	2011	7	1	2	Total PM10	8.5155121996...
2	2011	7	1	1	Total PM10	6.9325177883...
2	2011	7	1	2	Total PM10	6.3830091860...

Options for Defining Activity: Option 3 – Operating Mode Distribution

Defining Highway/Intersection Vehicle Activity in MOVES

- User has the option to directly enter a link-specific OpMode distribution
  - This would describe the distribution of activity on a link (fraction of time spent in each OpMode bin)
  - Not a typical output from current traffic models, but can be derived

- We will not cover this input for highway links in this course

Guidance Reference:

Section 4.5.7

Importing Data for Off-Network Links in the Project Data Manager

Defining Start and Extended Idle Activity

- Off-network activity is entered in two importers

- The **Off-Network** table defines:
  - What vehicles?
  - How many are starting?
  - How many are extended idling?

- The **OpMode Distribution** table defines:
  - The soak-time distribution
    - Soak time = How long since the last vehicle start
    - OpModeIDs 101 through 108
  - Any extended Idling
    - If there is any extended idling, a fraction of "1" should be defined for OpModeID 200

Guidance Reference:

Section 4.5.9

Off-Network Inputs

- Source Type
- Vehicle Population
  - » Total number of vehicles parked, starting, or idling on the off-network area over the hour covered by the MOVES run
- Start Fraction
  - » Fraction of the total vehicle population that starts during the hour (may be greater than 1.0 if the average vehicle is started more than once per hour)
- Extended Idle Fraction
  - » Used only for hoteling long-haul diesel trucks (0 – 1.0 range)
  - » Fraction of time that vehicle population spends in extended idle operation in the hour (e.g., if vehicle population is 20 and 10 vehicles are idling for entire hour, Idle Fraction would be 0.5)
- Parked Vehicle Fraction
  - » Not required as an input – can be left blank

Guidance Reference:

Section 4.5.9

Off-Network Input Table

offnetwork.xls

	A	B	C	D	E	F
1	sourceTyp	vehiclePopulation	startFraction	extendedIdleFraction	parkedVehicleFraction	
2	21					
3	62					
4						
5						
6						
7						
8						
9						
10						

offNetworkLink | SourceUseType

Reminder – only required if project includes off-network activity

No defaults available

Guidance Reference:

Section 4.5.9

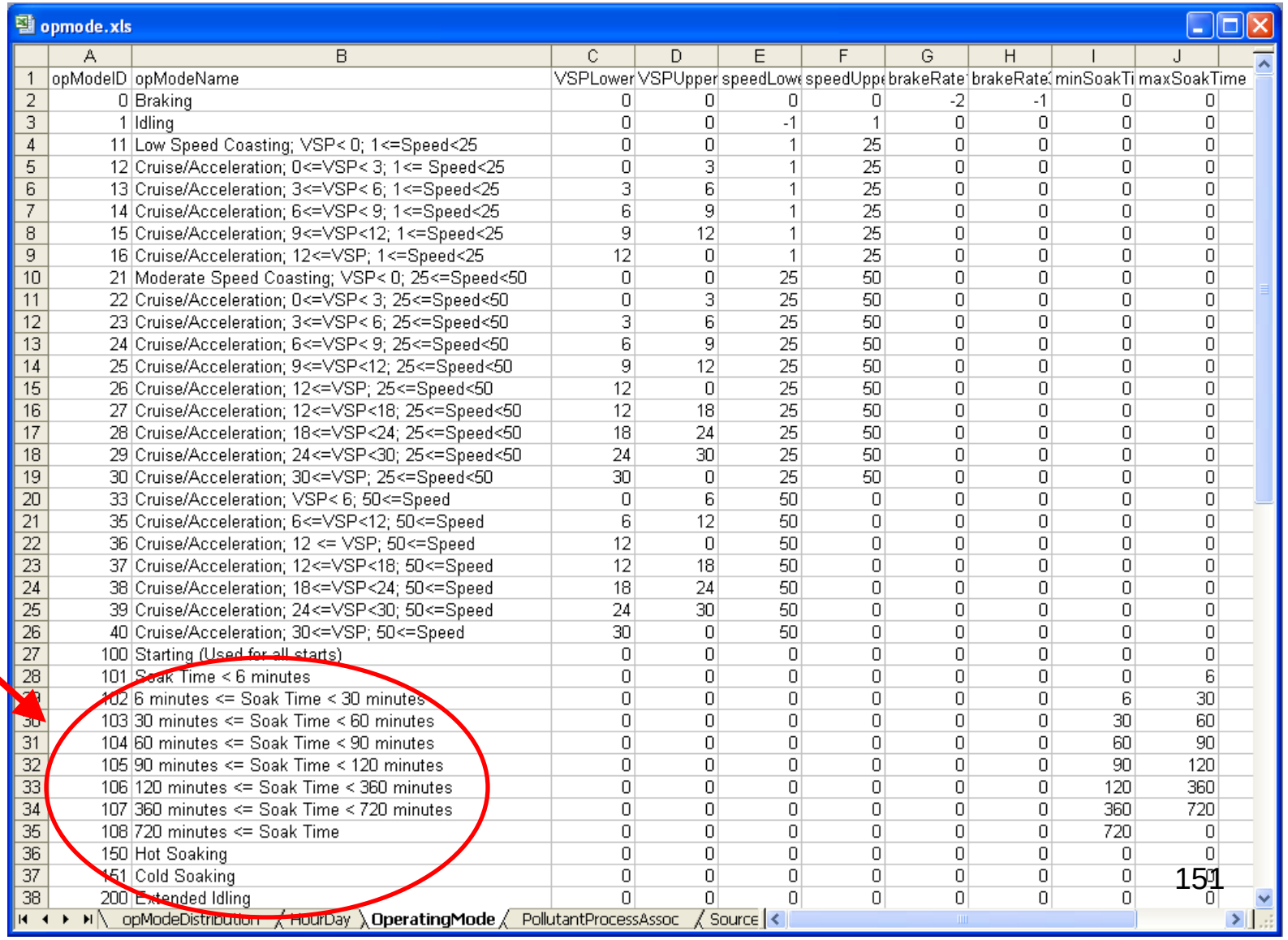
OpMode Distribution Input for Start and Extended Idle Activity

- Defining the “soak-time distribution”
  - » Soak times range in duration from less than 6 minutes to more than 720 minutes
  - » **OpModes 101-108** apply (see following slide)

- Defining “extended idle”
  - » Only relevant for long-haul heavy-duty trucks (source type 62) that are hoteling
  - » Should not be used for any other source type (e.g., transit buses and cars do not “extended idle” in MOVES)
  - » **OpMode 200** applies – this is the only extended idle OpMode

OpModeIDs for Start and Extended Idle Activity

Soak Time and Extended Idle OpModes (101-108 and 200)



opmode.xls

	A	B	C	D	E	F	G	H	I	J
1	opModeID	opModeName	VSPLower	VSPUpper	speedLowe	speedUppe	brakeRate	brakeRate	minSoakTi	maxSoakTime
2	0	Braking	0	0	0	0	-2	-1	0	0
3	1	Idling	0	0	-1	1	0	0	0	0
4	11	Low Speed Coasting; VSP< 0; 1<=Speed<25	0	0	1	25	0	0	0	0
5	12	Cruise/Acceleration; 0<=VSP< 3; 1<= Speed<25	0	3	1	25	0	0	0	0
6	13	Cruise/Acceleration; 3<=VSP< 6; 1<=Speed<25	3	6	1	25	0	0	0	0
7	14	Cruise/Acceleration; 6<=VSP< 9; 1<=Speed<25	6	9	1	25	0	0	0	0
8	15	Cruise/Acceleration; 9<=VSP<12; 1<=Speed<25	9	12	1	25	0	0	0	0
9	16	Cruise/Acceleration; 12<=VSP; 1<=Speed<25	12	0	1	25	0	0	0	0
10	21	Moderate Speed Coasting; VSP< 0; 25<=Speed<50	0	0	25	50	0	0	0	0
11	22	Cruise/Acceleration; 0<=VSP< 3; 25<=Speed<50	0	3	25	50	0	0	0	0
12	23	Cruise/Acceleration; 3<=VSP< 6; 25<=Speed<50	3	6	25	50	0	0	0	0
13	24	Cruise/Acceleration; 6<=VSP< 9; 25<=Speed<50	6	9	25	50	0	0	0	0
14	25	Cruise/Acceleration; 9<=VSP<12; 25<=Speed<50	9	12	25	50	0	0	0	0
15	26	Cruise/Acceleration; 12<=VSP; 25<=Speed<50	12	0	25	50	0	0	0	0
16	27	Cruise/Acceleration; 12<=VSP<18; 25<=Speed<50	12	18	25	50	0	0	0	0
17	28	Cruise/Acceleration; 18<=VSP<24; 25<=Speed<50	18	24	25	50	0	0	0	0
18	29	Cruise/Acceleration; 24<=VSP<30; 25<=Speed<50	24	30	25	50	0	0	0	0
19	30	Cruise/Acceleration; 30<=VSP; 25<=Speed<50	30	0	25	50	0	0	0	0
20	33	Cruise/Acceleration; VSP< 6; 50<=Speed	0	6	50	0	0	0	0	0
21	35	Cruise/Acceleration; 6<=VSP<12; 50<=Speed	6	12	50	0	0	0	0	0
22	36	Cruise/Acceleration; 12 <= VSP; 50<=Speed	12	0	50	0	0	0	0	0
23	37	Cruise/Acceleration; 12<=VSP<18; 50<=Speed	12	18	50	0	0	0	0	0
24	38	Cruise/Acceleration; 18<=VSP<24; 50<=Speed	18	24	50	0	0	0	0	0
25	39	Cruise/Acceleration; 24<=VSP<30; 50<=Speed	24	30	50	0	0	0	0	0
26	40	Cruise/Acceleration; 30<=VSP; 50<=Speed	30	0	50	0	0	0	0	0
27	100	Starting (Used for all starts)	0	0	0	0	0	0	0	0
28	101	Soak Time < 6 minutes	0	0	0	0	0	0	0	6
29	102	6 minutes <= Soak Time < 30 minutes	0	0	0	0	0	0	6	30
30	103	30 minutes <= Soak Time < 60 minutes	0	0	0	0	0	0	30	60
31	104	60 minutes <= Soak Time < 90 minutes	0	0	0	0	0	0	60	90
32	105	90 minutes <= Soak Time < 120 minutes	0	0	0	0	0	0	90	120
33	106	120 minutes <= Soak Time < 360 minutes	0	0	0	0	0	0	120	360
34	107	360 minutes <= Soak Time < 720 minutes	0	0	0	0	0	0	360	720
35	108	720 minutes <= Soak Time	0	0	0	0	0	0	720	0
36	150	Hot Soaking	0	0	0	0	0	0	0	0
37	151	Cold Soaking	0	0	0	0	0	0	0	0
38	200	Extended Idling	0	0	0	0	0	0	0	0

opModeDistribution | HourDay | OperatingMode | PollutantProcessAssoc | Source

Off-Network Activity Examples

- Let's look at how we might define off-network activity for three simple examples:
  - A transit bus facility (starts)
  - A park-and-ride lot (starts)
  - A truck rest area (extended idle)

- We will show the OpMode Distribution table (only) for each

Start Activity Example: Transit Facility

- 6 a.m. – 7 a.m. model run
- No extended idling (buses do not “extended idle”; only combination long-haul trucks can)
- Bus schedule indicates 100% of buses have been parked for 5 hours (300 minutes) prior to starting

OpMode Distribution Input
Defining Soak-Time Distribution for Starts

opmode.xls [Compatibility Mode]

	A	B	C	D	E	F	G
1	sourceTyp	hourDayID	linkID	polProcessID	opModeID	opModeFraction	
2	42	75	1	11002	106	1	
3	42	75	1	11016	106	1	
4	42	75	1	11102	106	1	
5	42	75	1	11116	106	1	
6	42	75	1	11202	106	1	
7	42	75	1	11216	106	1	
8	42	75	1	11502	106	1	
9	42	75	1	11516	106	1	
10							
11							
12							
13							
14							

opModeDistribution | HourDay | Opera

- 300 minute soak = OpMode 106
- Note – All relevant sourcetypeIDs, hourDayIDs, and polProcessIDs must also be included

Start Activity Example: Park-and-Ride Lot

- 5 p.m. – 6 p.m. model run
- No extended idling (cars do not “extended idle” – only long-haul combination trucks do)
- Survey data show most cars (95%) are parked for 9 hours prior to starting
- 5% are parked for less than 5 minutes

OpMode Distribution Input
Defining Soak-Time Distribution for Starts

- > 9 hour soak = OpMode 108
- < 5 minutes soak = OpMode 101
- Note – All relevant sourcetypeIDs, hourDayIDs, and polProcessIDs must also be included

opmode_temp.xls [Compatibility Mode]

	A	B	C	D	E	F	G
1	sourceTypeID	hourDayID	linkID	polProcessID	opModeID	opModeFraction	
2	21	175	1	11002	101	0.05	
3	21	175	1	11002	108	0.95	
4	21	175	1	11016	101	0.05	
5	21	175	1	11016	108	0.95	
6	21	175	1	11102	101	0.05	
7	21	175	1	11102	108	0.95	
8	21	175	1	11116	101	0.05	
9	21	175	1	11116	108	0.95	
10	21	175	1	11202	101	0.05	
11	21	175	1	11202	108	0.95	
12	21	175	1	11216	101	0.05	
13	21	175	1	11216	108	0.95	
14	21	175	1	11502	101	0.05	
15	21	175	1	11502	108	0.95	
16	21	175	1	11516	101	0.05	
17	21	175	1	11516	108	0.95	
18							
19							
20							
21							

opModeDistribution | HourDay | Opera

Extended Idle Activity Example: Truck Rest Area

- 12 a.m. – 1 a.m. model run
- All vehicles are combination long-haul trucks (SourceType 62)
- All trucks are in “extended idle” mode for the entire hour

OpMode Distribution Input
Defining Extended Idle Activity

- Extended Idle = OpMode 200
- Note: All relevant hourDayIDs, and polProcessIDs must also be included

opmode_temp.xls [Compatibility Mode]

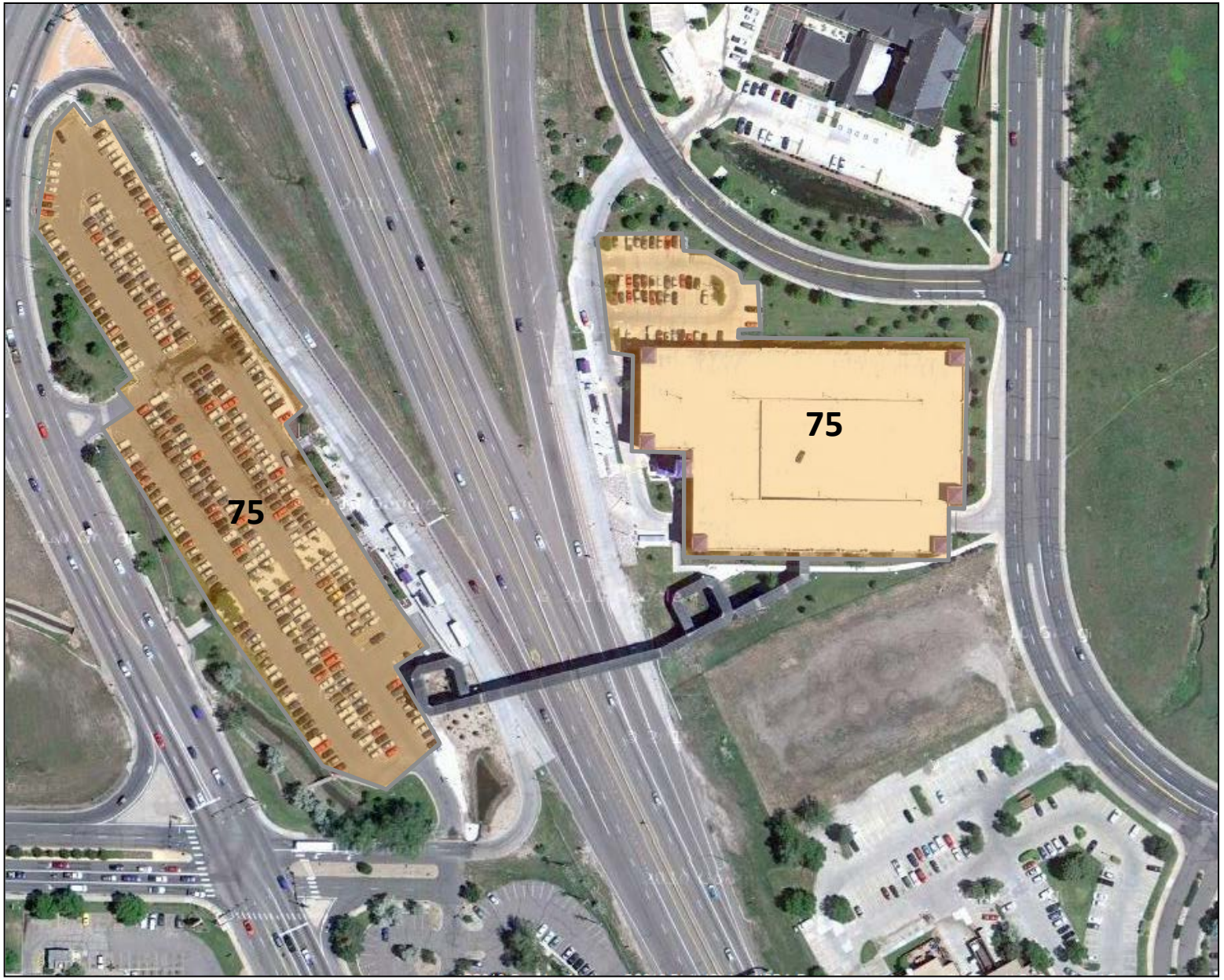
	A	B	C	D	E	F	G
1	sourceTypeID	hourDayID	linkID	polProcessID	opModeID	opModeFraction	
2	62	15	1	11017	200	1	
3	62	15	1	11090	200	1	
4	62	15	1	11117	200	1	
5	62	15	1	11190	200	1	
6	62	15	1	11217	200	1	
7	62	15	1	11290	200	1	
8	62	15	1	11517	200	1	
9	62	15	1	11590	200	1	
10							
11							
12							

opModeDistribution | HourDay | Operating

Considering Bus and Truck Idle Emissions

- Some terminals may have significant bus or truck idling emissions (not “extended idling”)
- It is necessary to estimate the “dwell time” for buses or trucks accessing the facility (e.g., 3 minutes per drop-off/pick-up)
- These emissions cannot be defined in off-network input
- By defining a link (through links input) with an average speed of “0”, MOVES will report idle emissions
  - » This assumes idling for the entire hour – must be adjusted for dwell time (demonstrated in example analysis)

From Example Analysis



Considering Running Emissions in Parking Lots

- Some parking lots may have significant running emissions from vehicles entering and exiting the lot or garage
- The decision to include these emissions should be based on:
  - » Average distance from parking spot to lot exit
  - » Fleet composition (e.g., passenger cars or diesel trucks)
  - » Parking lot volume
- Running links may be defined in Links Importer to account for this activity

Which Activity Importers are Necessary for MOVES to Run?

	Links	Link Drive Schedule	OpMode Distribution	Off-Network
Running Links (highways, intersections, etc.)	Yes	When data available*	When data available*	No
Off-Network Links (parking lots, transit facilities, etc.)	Yes	No	Yes	Yes

**Although not needed by MOVES to run, users are encouraged to use Link Drive Schedules and/or Op-Mode Distributions for defining activity on running links*

Guidance Reference:

Sections 4.2 & 4.5

PM Hot-Spot Training: Example Analysis

Project Details

- The project is a lane expansion of the existing highway and the addition of an interchange (on/off ramps) to access two park-and-ride lots and bus terminals

- MOVES2010b will be run to generate emission rates

- The air quality analysis for the project will be done with AERMOD


Existing
Proposed

Project Details

- Location: Washtenaw County, MI
- Area is in nonattainment for the annual $PM_{2.5}$ and 2006 24-hour $PM_{2.5}$ NAAQS
- The project is expected to be completed in 2019
  - Year of expected peak emissions (analysis year): 2020
  - Four-hour am/pm peak periods
- Determined through interagency consultation to be a project of local air quality concern
- The area surrounding the project is primarily residential and commercial, with no nearby sources that need to be included in modeling

Available Traffic Data

- Traffic estimates for all links
  - Peak hour volume and average speed
  - Off-peak hour volume and average speed

  ***Average speed approach will be used to define activity**

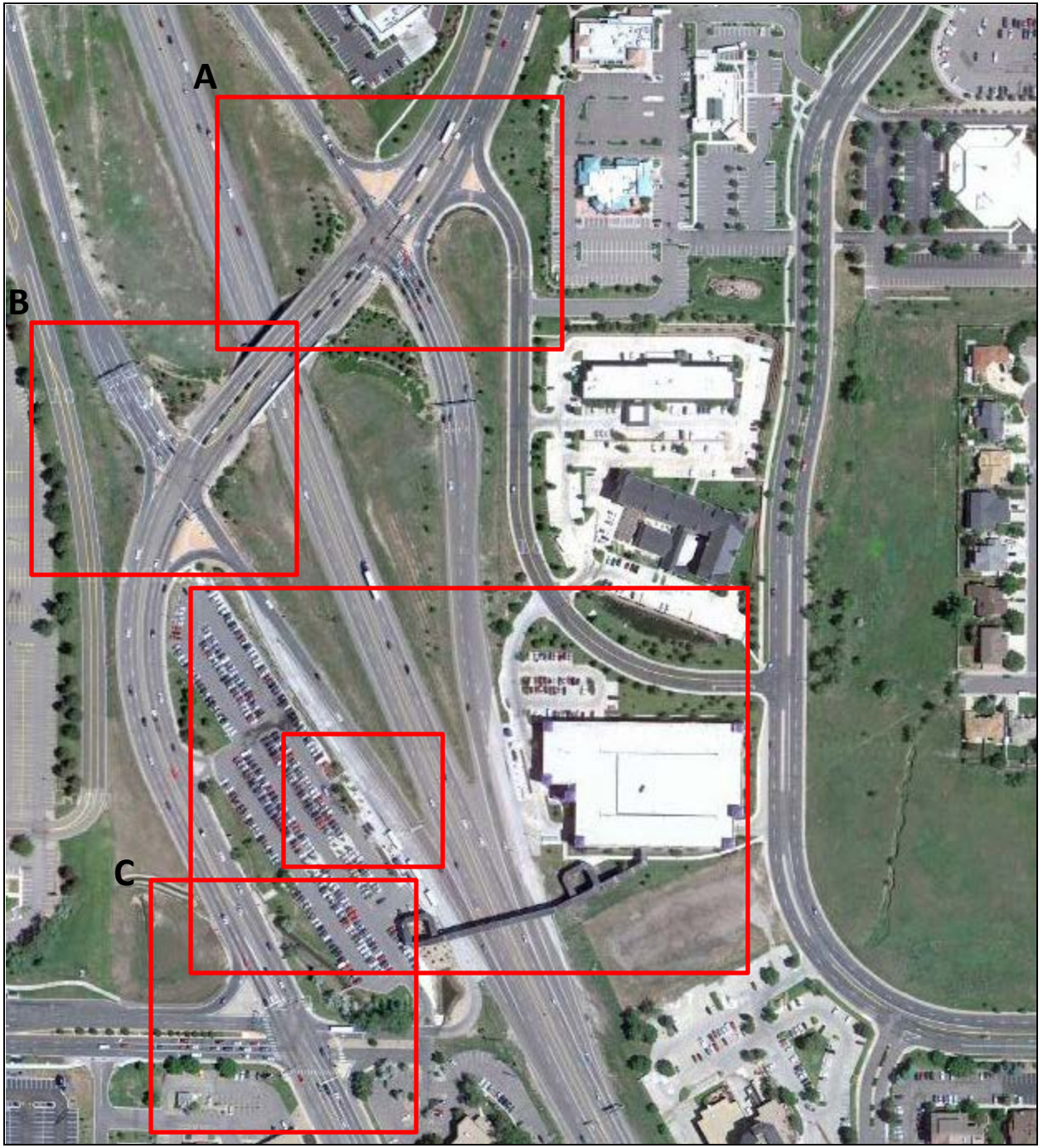
- Expected bus volumes for peak and off-peak periods
  - Also average dwell time in bus bays (3 minutes)

- Expected start activity on parking lots for peak and off-peak periods
  - Also soak time distribution

* This is one of several options that could be used to define links and characterize activity

Available Fleet Data

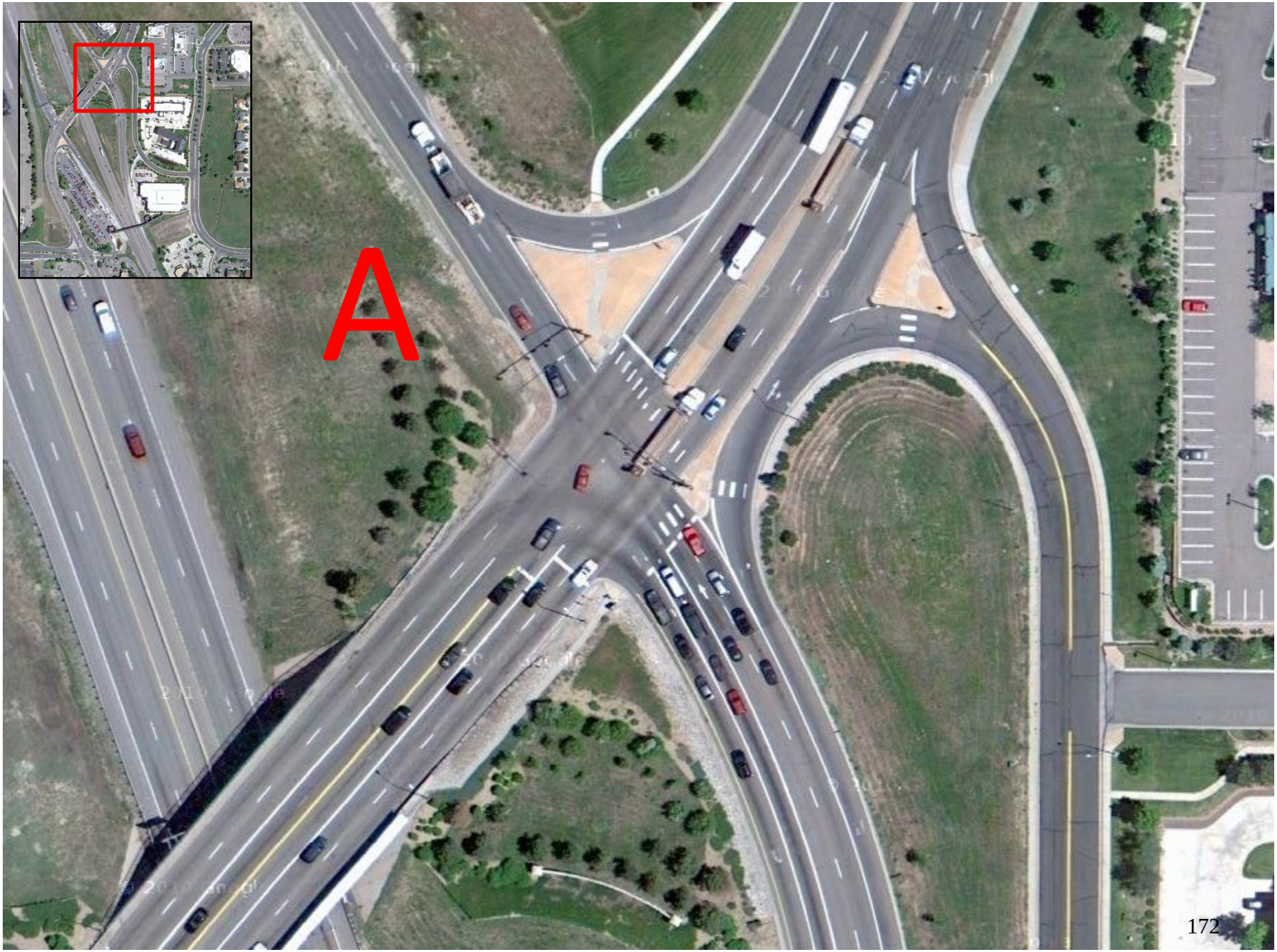
- Age distribution provided by MPO
  - Light-duty (LD) from state data
  - Heavy-duty (HD - long-haul trucks) from MOVES national defaults
- Fleet mix provided by MPO
  - Arterial mix, Highway mix
- Detailed bus roster (bus type and age distribution) provided by transit agency
  - All diesel buses

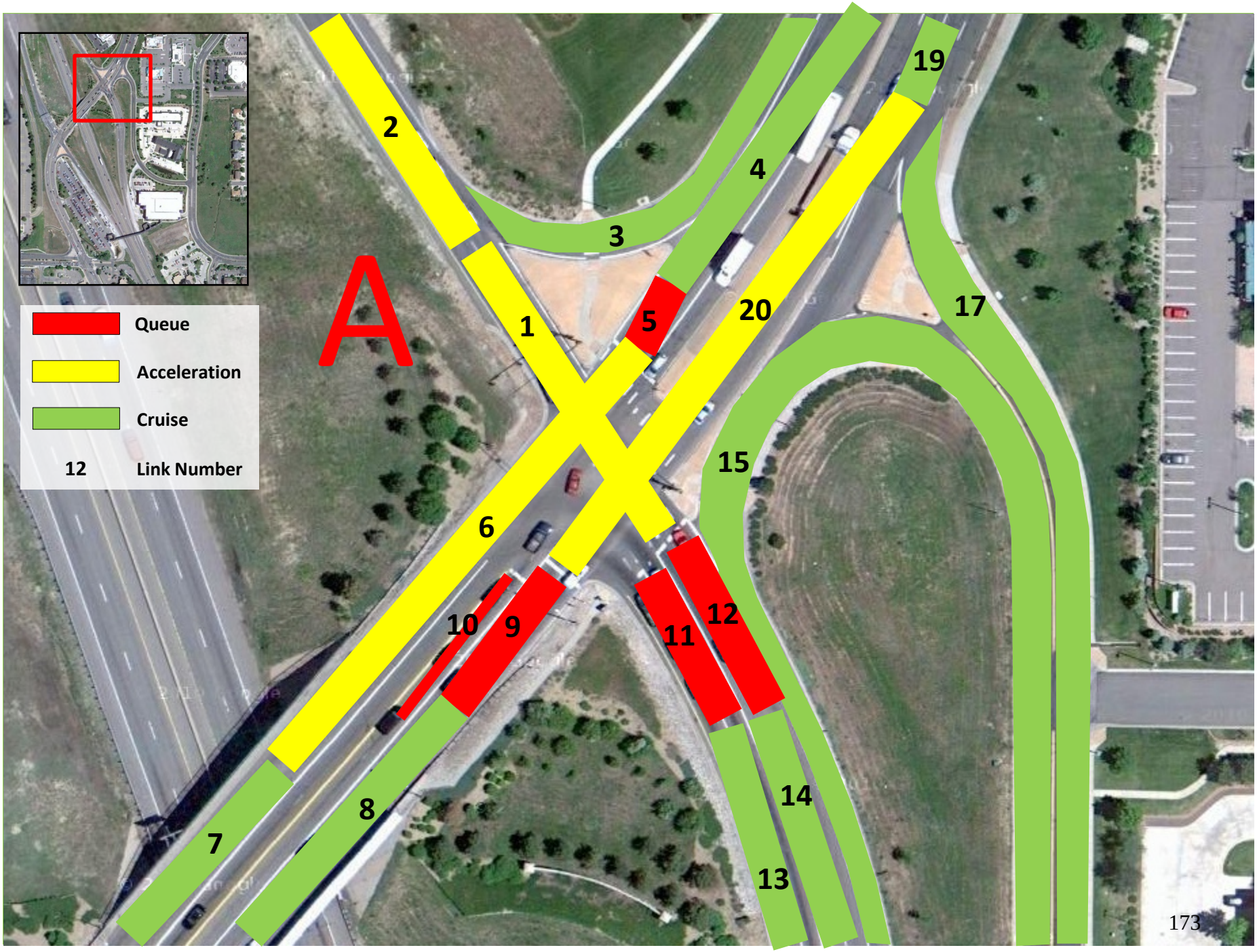

A
B
C

Steps before running MOVES

1. Divide project into links
   - Based on geometry and volumes
   - Activity information (average speed) based on V/C, signal timing, and free-flow speeds

2. Determine number of MOVES runs
   - Based on available data (peak/off peak): 16 for build analysis
     - For the example analysis, we will only be setting up one MOVES run
     - Results will be provided for all 16 runs


A


A
Queue
Acceleration
Cruise
12 Link Number
1
2
3
4
5
6
7
8
9
10
11
12
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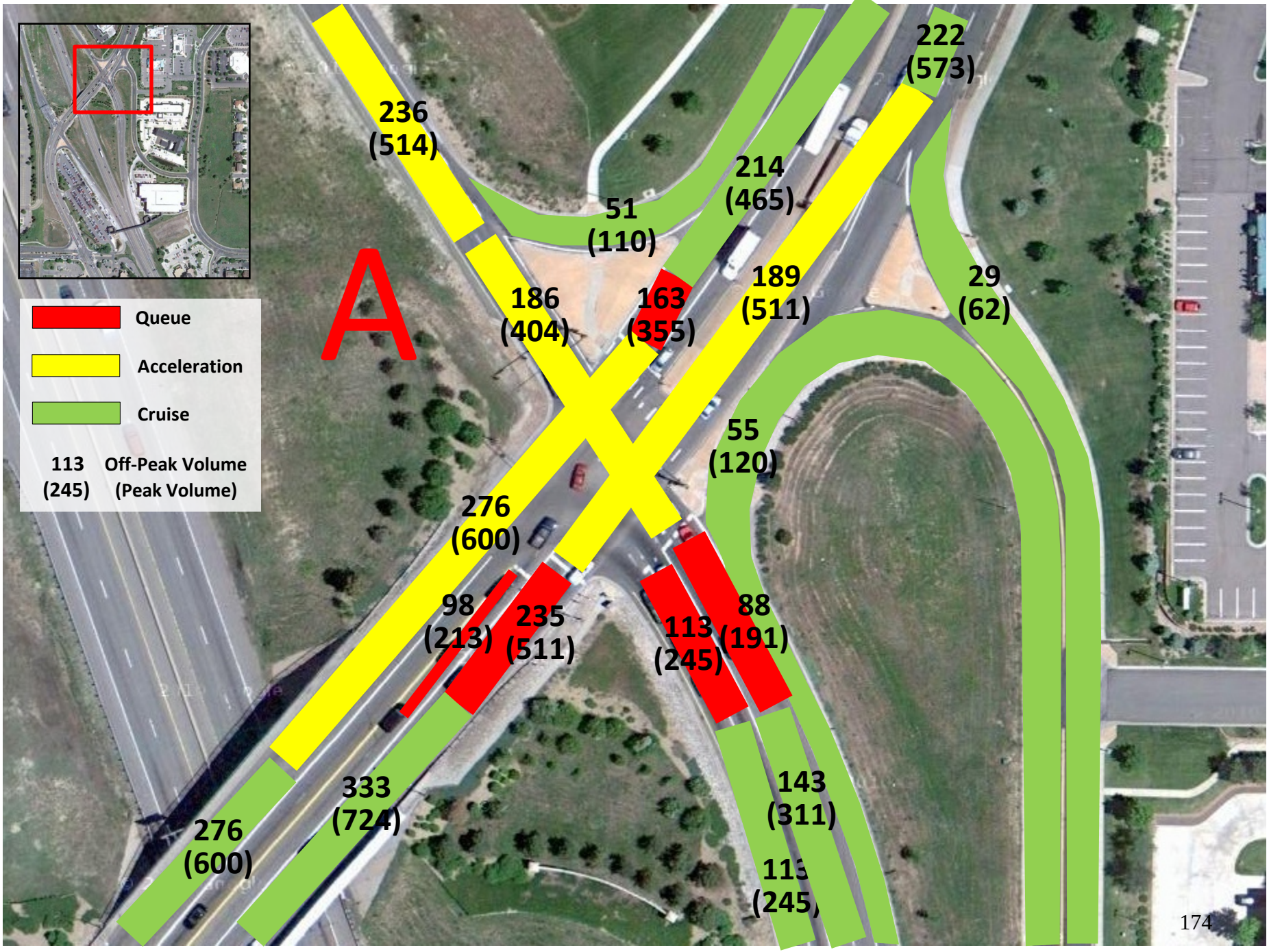
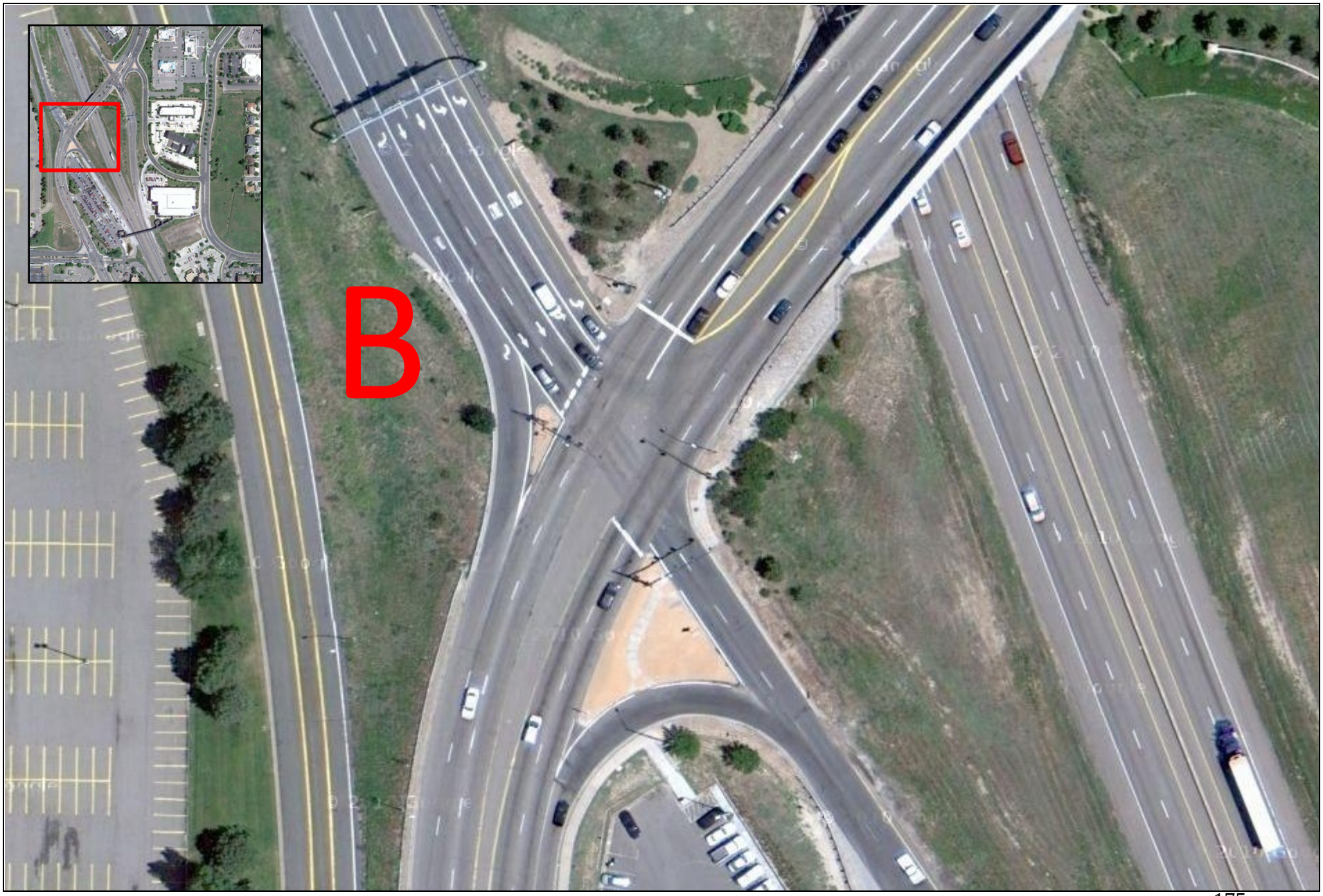
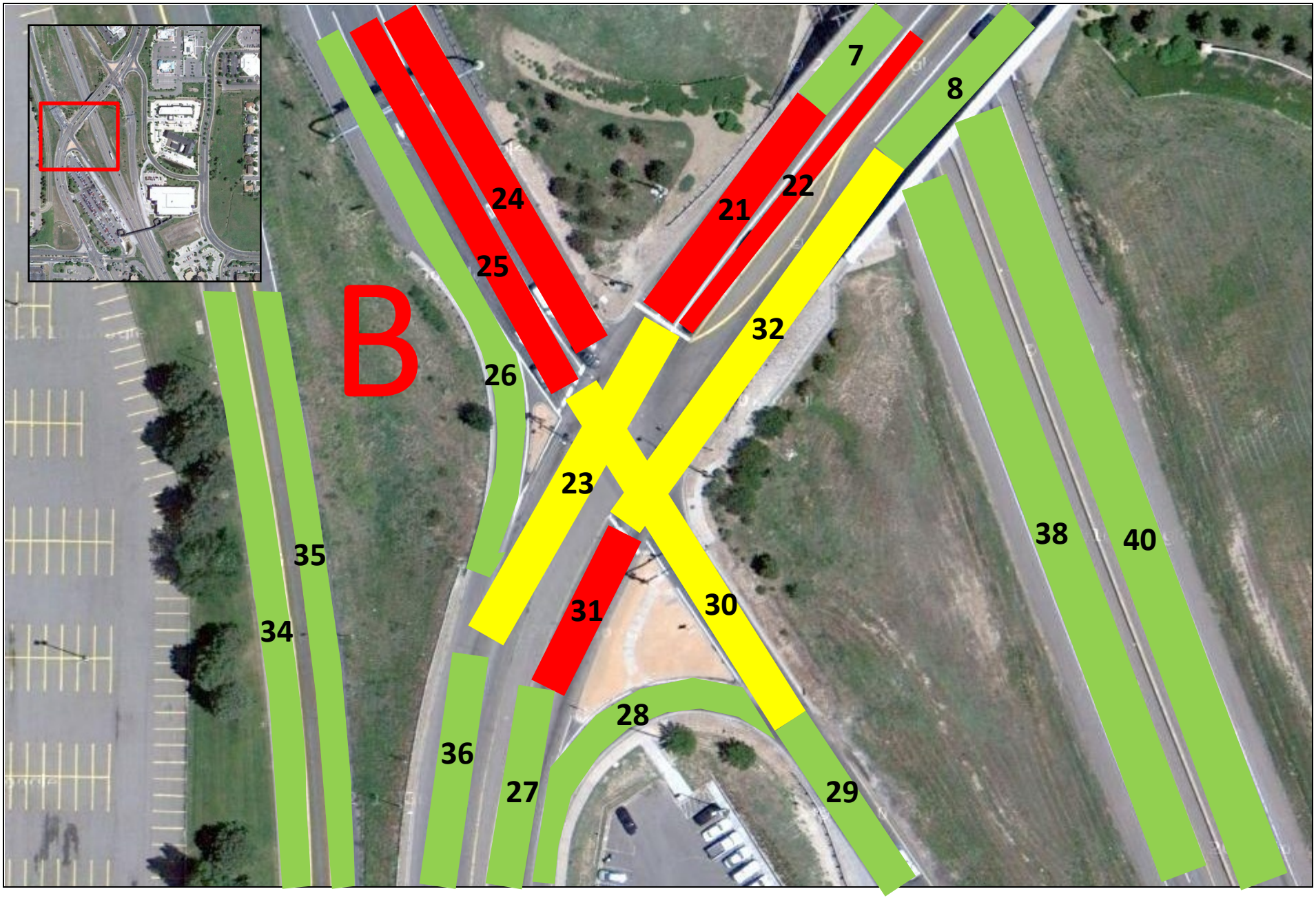
15
17
19
20


A
Queue
Acceleration
Cruise
113 (245) Off-Peak Volume (Peak Volume)
236 (514)
51 (110)
214 (465)
222 (573)
186 (404)
163 (355)
189 (511)
29 (62)
55 (120)
276 (600)
98 (213)
235 (511)
113 (245)
88 (191)
333 (724)
276 (600)
143 (311)
113 (245)


B


B
7
8
24
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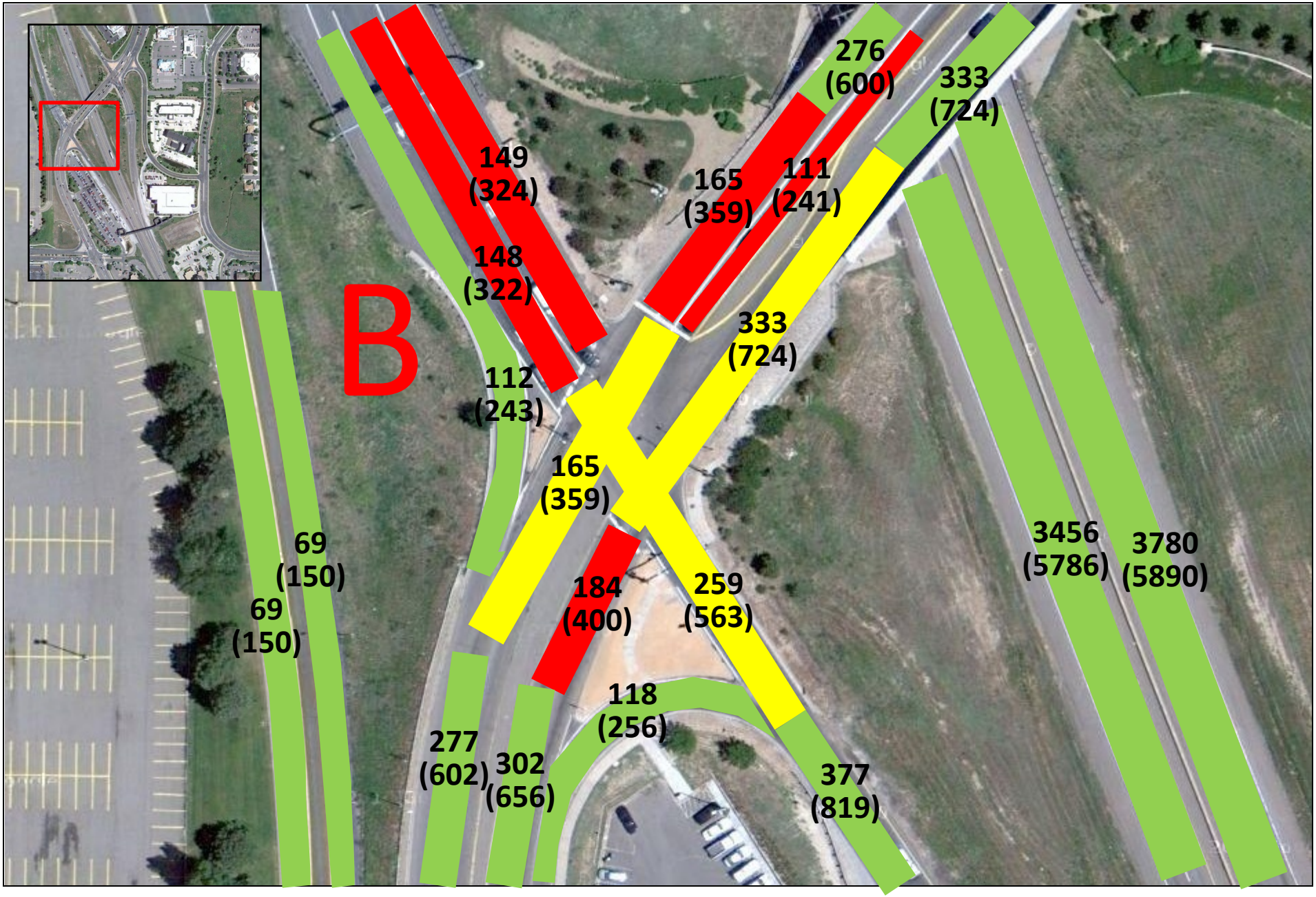
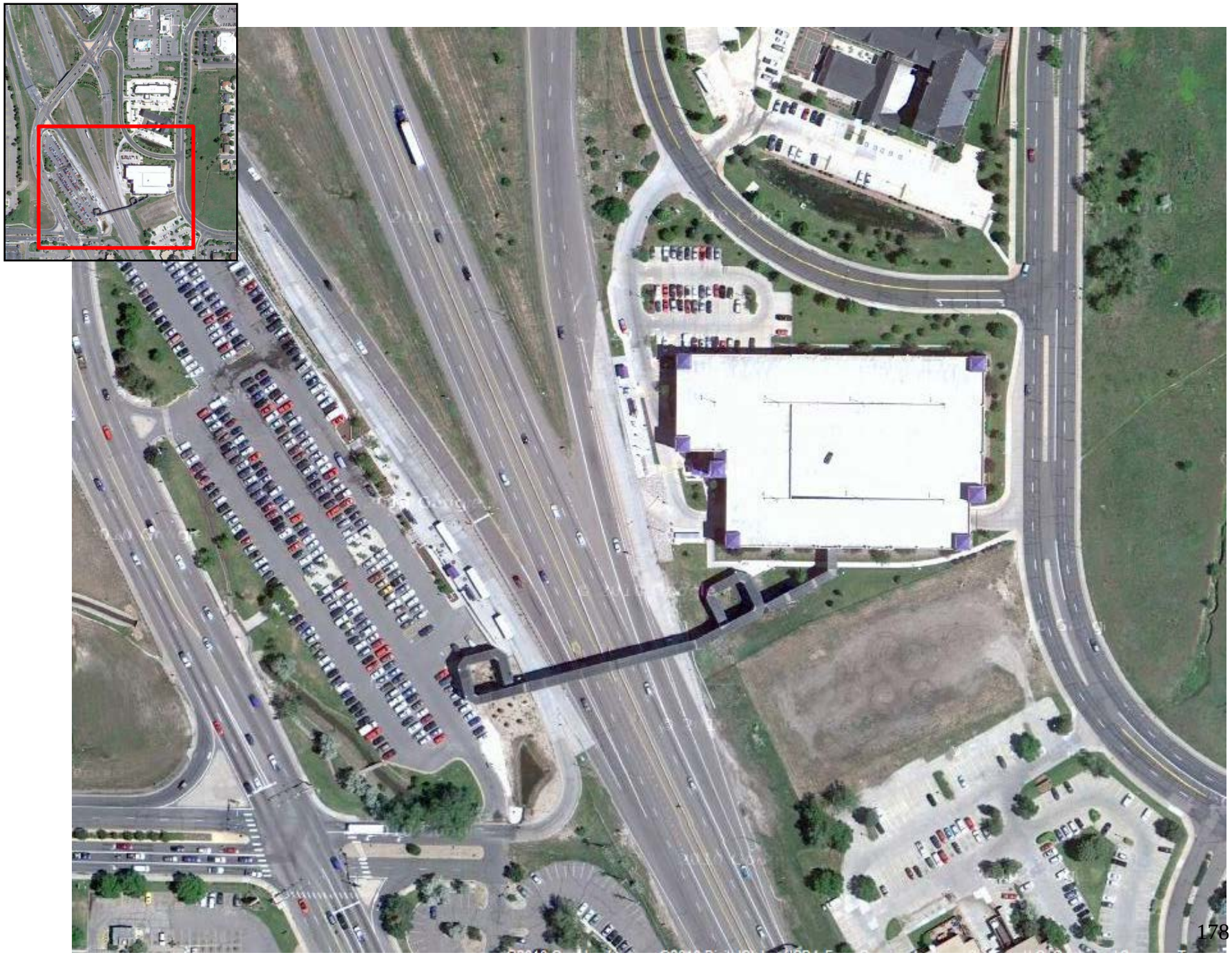
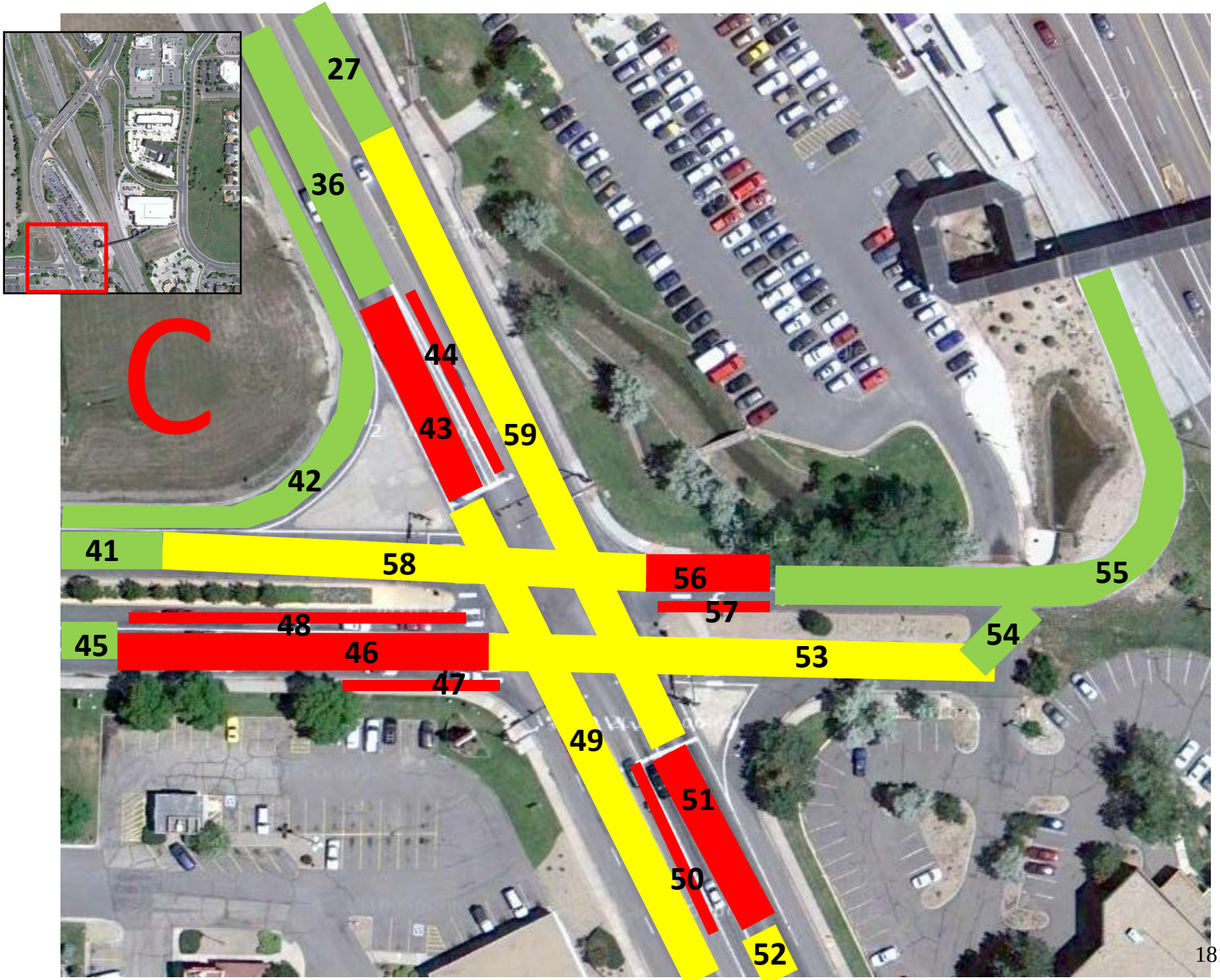

B
276
(600)
333
(724)
149
(324)
165
(359)
111
(241)
148
(322)
333
(724)
112
(243)
165
(359)
69
(150)
69
(150)
184
(400)
259
(563)
3456
(5786)
3780
(5890)
118
(256)
277
(602)
302
(656)
377
(819)




75
75

C


C
27
36
44
43
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42
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48
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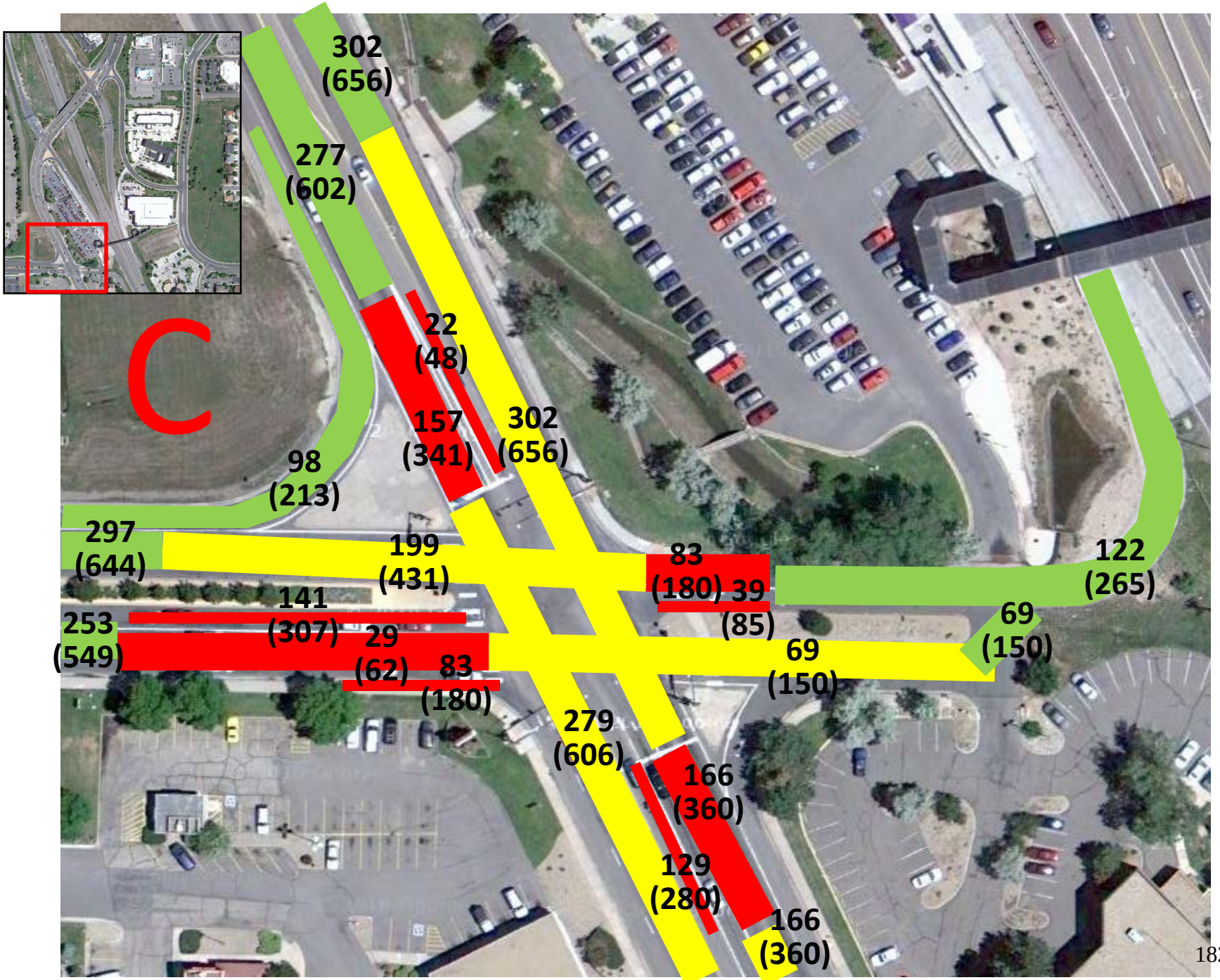
52


302
(656)
277
(602)
C
22
(48)
157
(341)
302
(656)
98
(213)
297
(644)
199
(431)
83
(180)
39
(85)
122
(265)
141
(307)
253
(549)
29
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(150)
69
(150)
279
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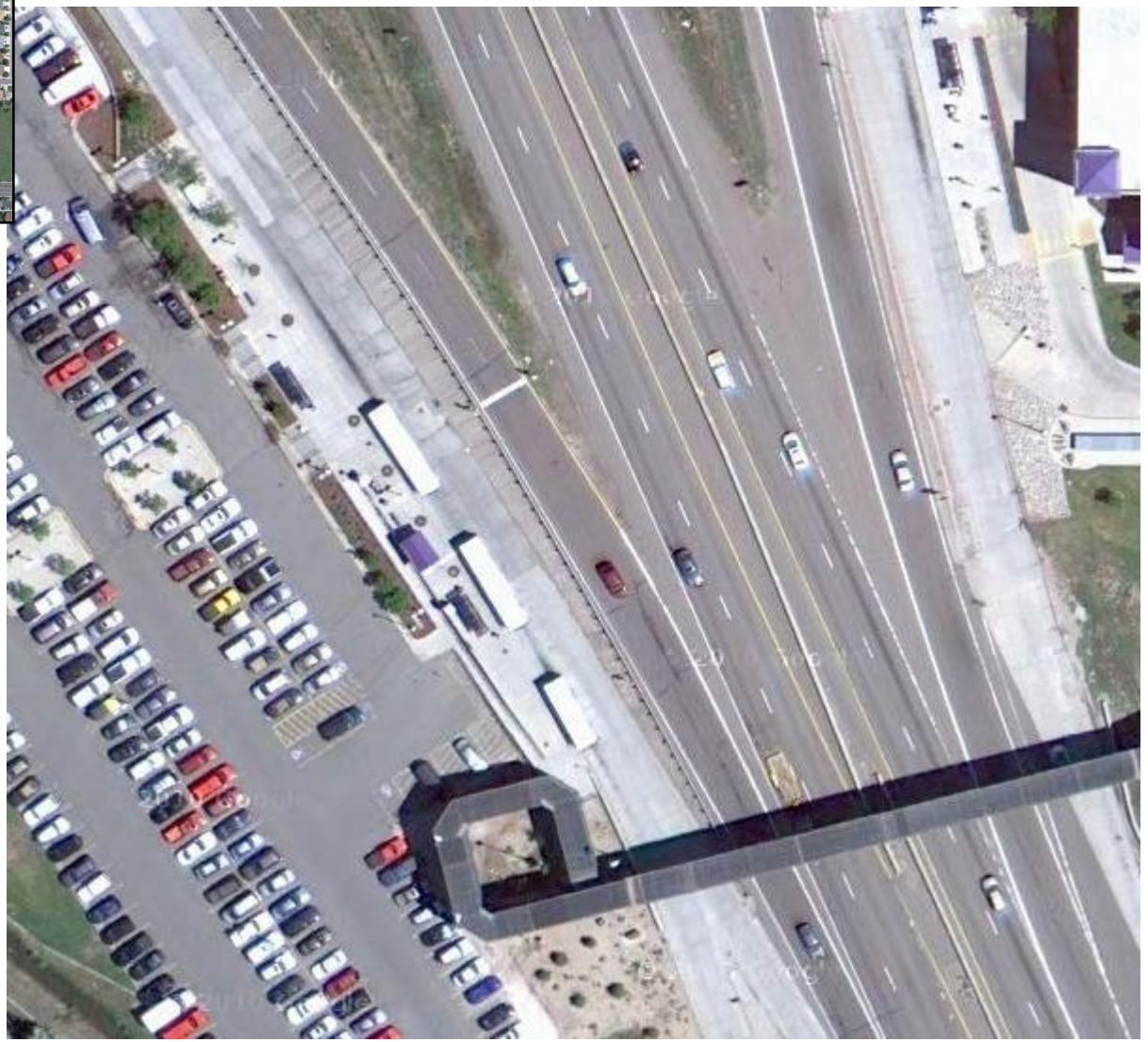
(280)
166
(360)




62
67
65
40
66
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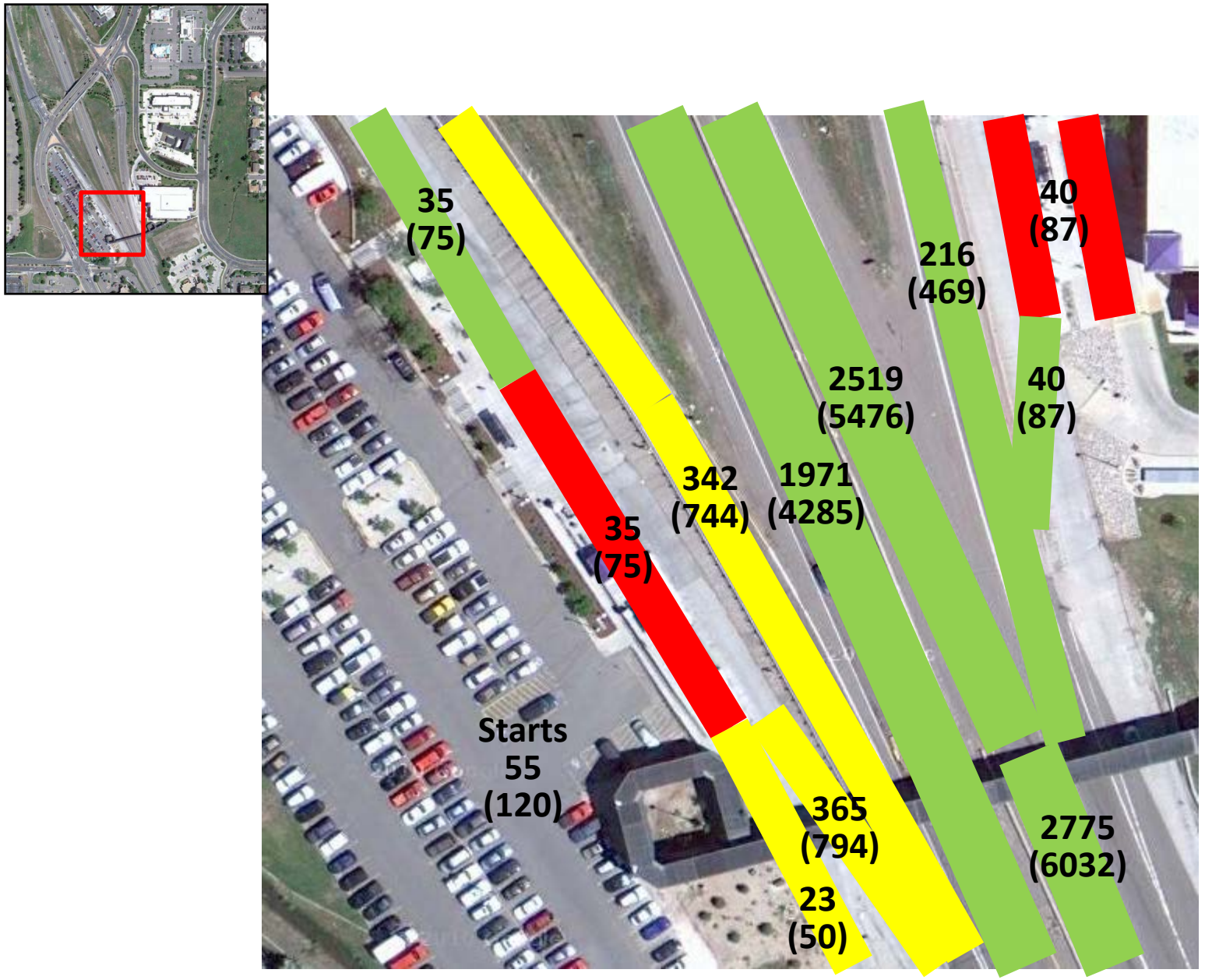
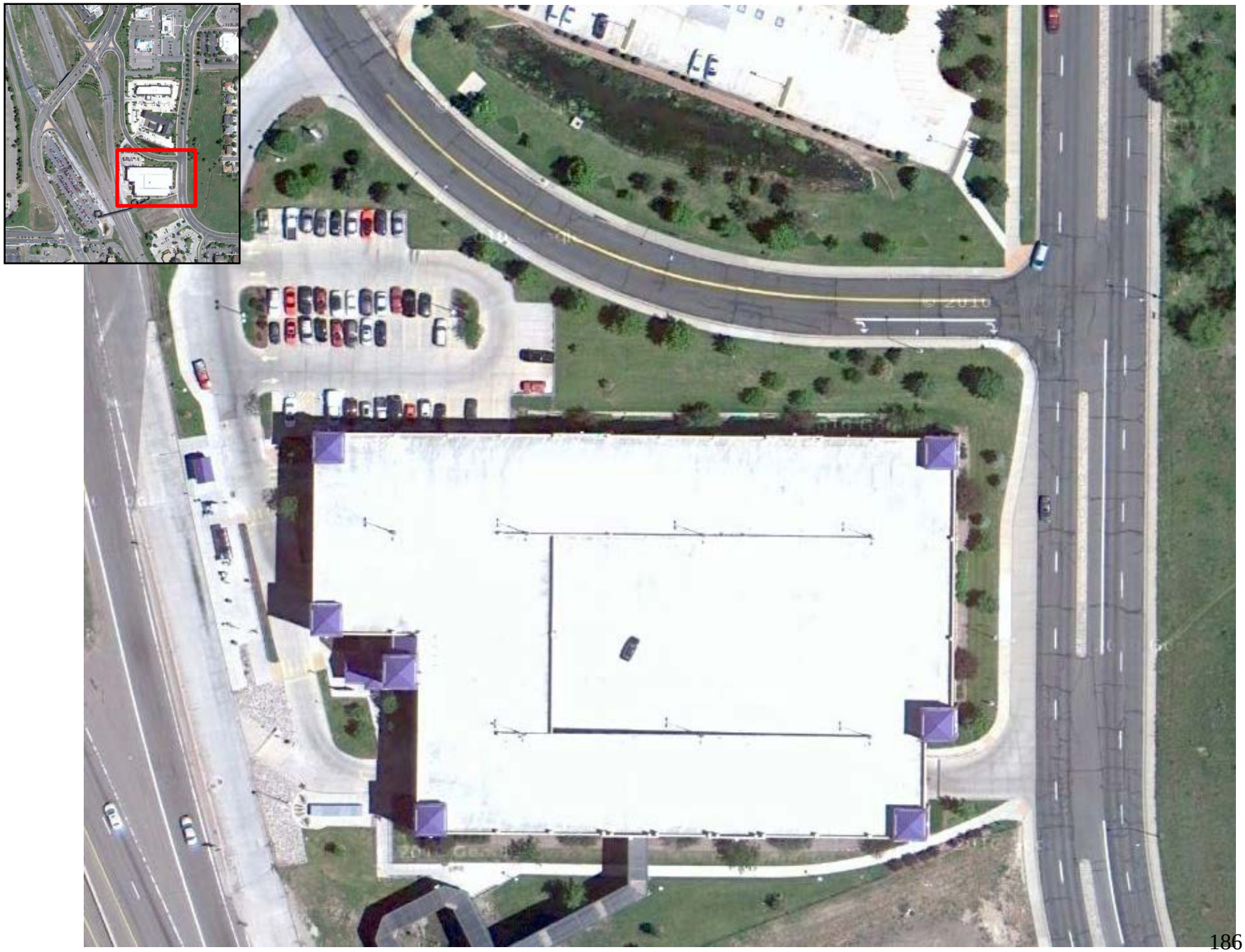
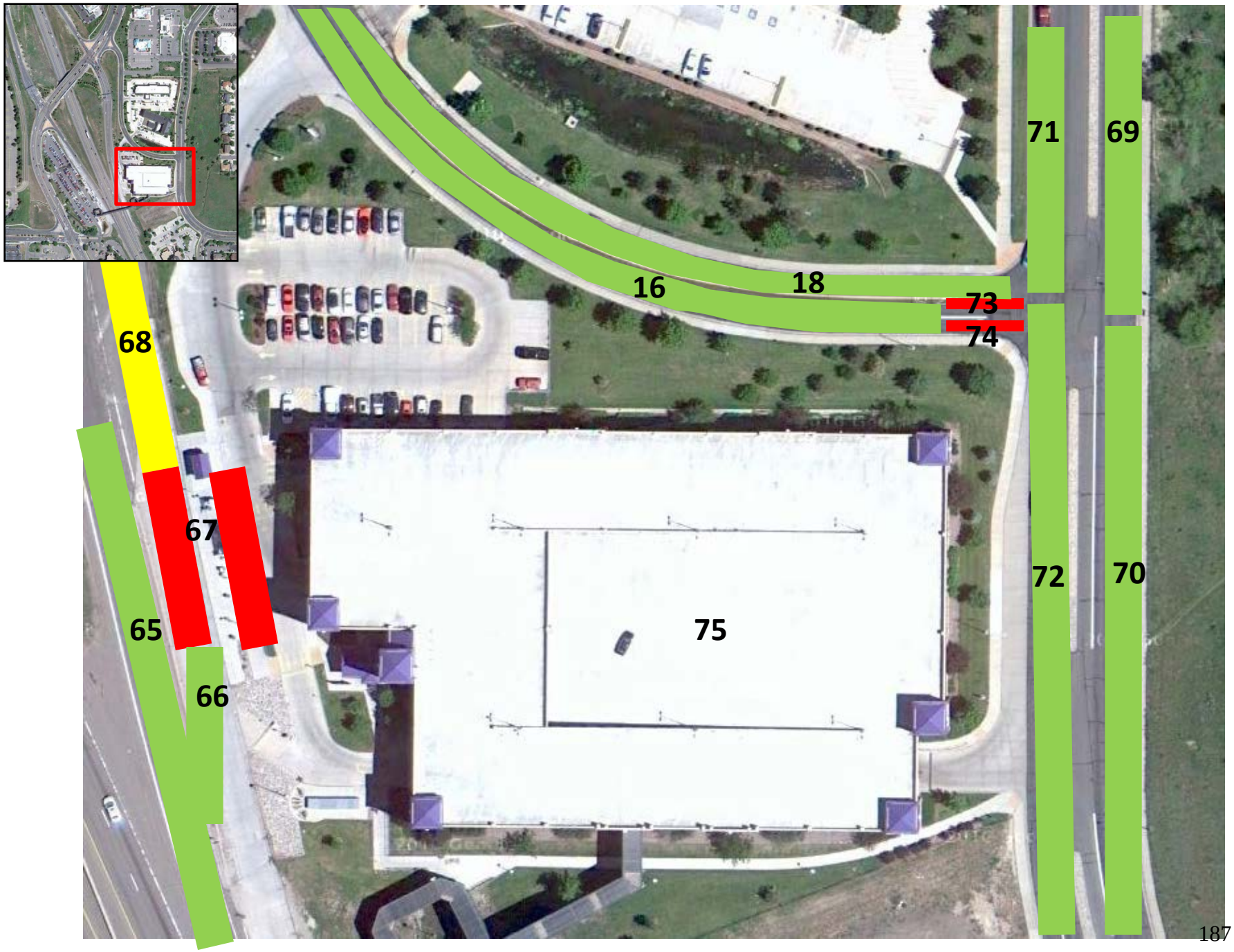
63
61
75
64
60
39


35
(75)
216
(469)
40
(87)
2519
(5476)
40
(87)
342
(744)
1971
(4285)
35
(75)
Starts
55
(120)
365
(794)
2775
(6032)
23
(50)




71
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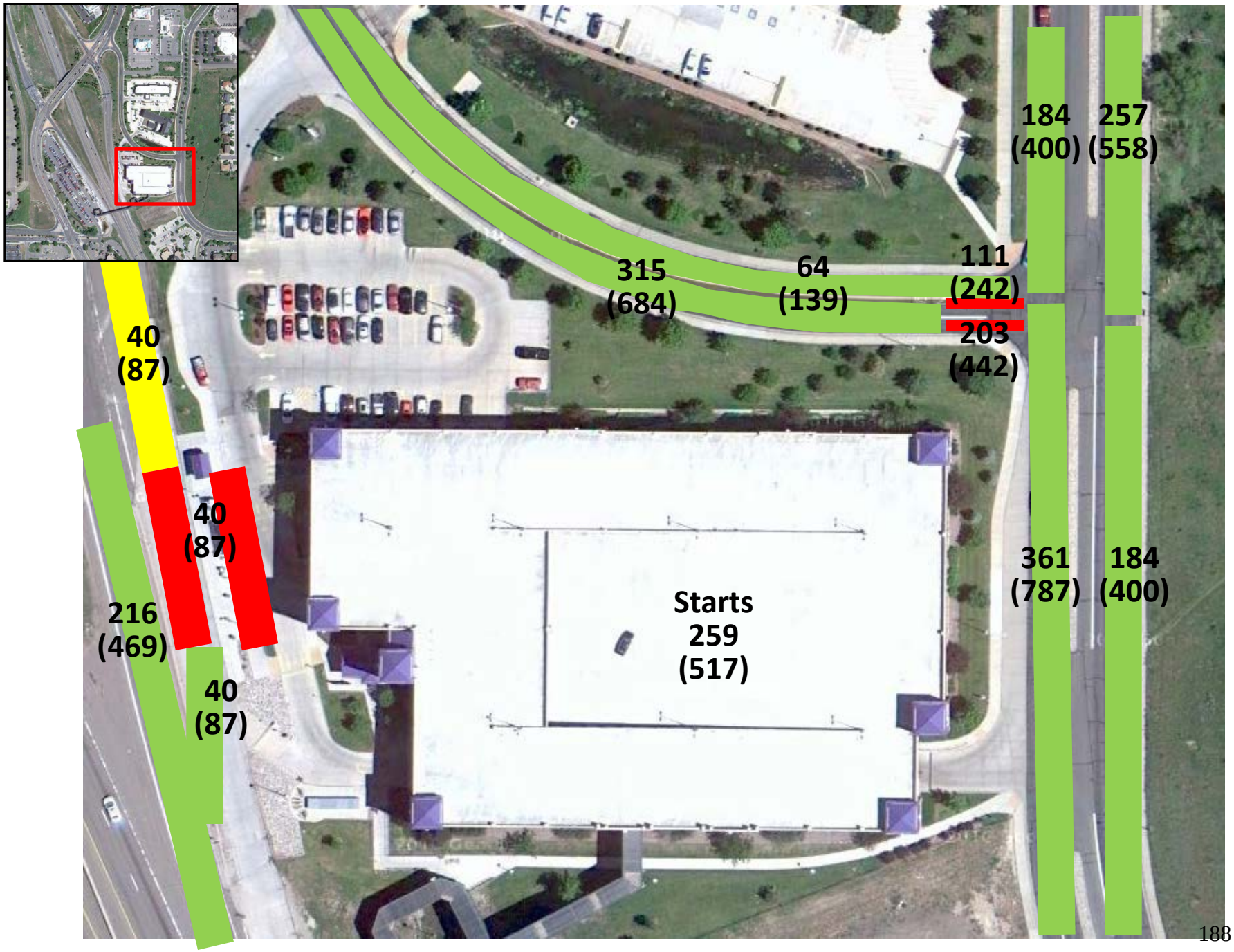
75
66


184
(400)
257
(558)
315
(684)
64
(139)
111
(242)
203
(442)
40
(87)
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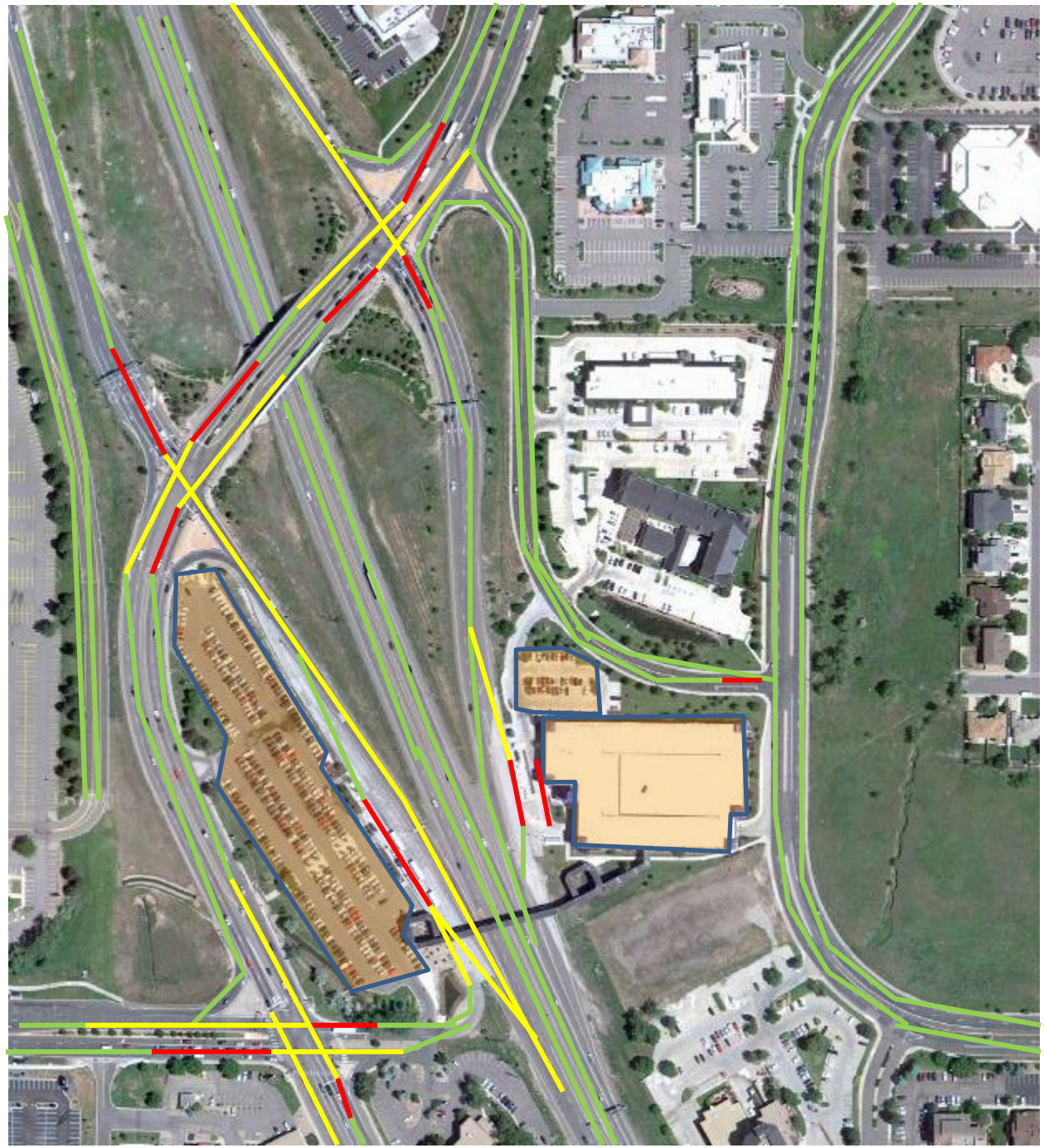
(87)
216
(469)
40
(87)
Starts
259
(517)
361
(787)
184
(400)



Traffic Data: Link Volumes/Speeds/Lengths

traffic_data.xls [Compatibility Mode]

	A	B	C	D	E	F	G	H	I
1	linkid	Link Description	Link Type	Link Volume (off-peak hour)	Link Volume (peak hour)	average speed - off-peak hour(mph)	average speed - peak hour(mph)	link length (meters)	link length (r
2	1	intersection (A) NW bound entrance ramp	accel	186	404	20.0	20.0	258.5	0.1606
3	2	intersection (A) NW bound entrance ramp	cruise	236	514	40.0	40.0	64.0	0.0397
4	3	intersection (A) WB RT lane	cruise	51	110	40.0	40.0	49.0	0.0304
5	4	intersection (A) SW bound approach	cruise	214	465	40.0	40.0	233.1	0.1448
6	5	intersection (A) SW bound queue	queue	163	355	5.9	5.9	22.1	0.0137
7	6	intersection (A) SW bound departure	accel	276	600	25.8	25.8	90.5	0.0562
8	7	intersection (A) SW bound connect	cruise	276	600	40.0	40.0	68.9	0.0428
9	8	intersection (A) NE bound approach	cruise	333	724	40.0	40.0	68.6	0.0426
10	9	intersection (A) NE bound queue	queue	235	511	12.7	6.2	27.4	0.0170
11	10	intersection (A) NB LT queue	queue	98	213	5.9	5.9	39.6	0.024
12	11	intersection (A) WB LT queue	queue	113	245	5.9	5.9	21.3	0.0132
13	12	intersection (A) NB queue	queue	88	191	5.9	5.9	17.5	0.0108
14	13	intersection (A) WB LT approach	cruise	113	245	40.0	40.0	127.9	0.0794
15	14	intersection (A) NB approach	cruise	143	311	40.0	40.0	142.7	0.0886
16	15	intersection (A) SB to E Transit Center	cruise	55	120	30.0	30.0	294.1	0.1827
17	16	intersection (A) SB to E Transit Center	cruise	315	684	30.0	30.0	86.5	0.0537
18	17	intersection (A) NB from E Transit Center	cruise	29	62	30.0	30.0	257.6	0.1600
19	18	intersection (A) NB from E Transit Center	cruise	64	139	15.0	15.0	116.4	0.072
20	19	intersection (A) NE bound	cruise	264	573	40.0	40.0	215.4	0.133
21	20	intersection (A) NE bound departure	accel	235	511	20.0	20.0	85.1	0.0528
22	21	intersection (B) SW bound queue	queue	165	359	5.9	5.9	17.5	0.0108
23	22	intersection (B) SE LT queue	queue	111	241	5.9	5.9	48	0.0298
24	23	intersection (B) SW bound departure	accel	165	359	20.0	20.0	73.1	0.0454
25	24	intersection (B) NE bound LT queue	queue	149	324	5.9	5.9	30.5	0.0189

Traffic Data | AERMOD input info | Fleet Mix | Bus Roster | Bus Age Distri

Traffic Data: Fleet Mix

traffic_data.xls [Compatibility Mode]

	A	B	C	D	E	F	G	H	I	J	K
1	All Bus										
2	11	Motorcycle	0								
3	21	Passenger Car	0								
4	31	Passenger Truck	0								
5	32	Light Commercial Tı	0								
6	41	Intercity Bus	0								
7	42	Transit Bus	1								
8	43	School Bus	0								
9	51	Refuse Truck	0								
10	52	Single Unit Short-ha	0								
11	53	Single Unit Long-ha	0								
12	54	Motor Home	0								
13	61	Combination Short-	0								
14	62	Combination Long-l	0								
15	Highway										
16	11	Motorcycle	0.0058								
17	21	Passenger Car	0.5170								
18	31	Passenger Truck	0.3350								
19	32	Light Commercial Tı	0.0204								
20	41	Intercity Bus	0.0030								
21	42	Transit Bus	0.0002								
22	43	School Bus	0.0020								
23	51	Refuse Truck	0.0002								
24	52	Single Unit Short-ha	0.0115								
25	53	Single Unit Long-ha	0.0100								
26	54	Motor Home	0.0028								
27	61	Combination Short-	0.0100								
28	62	Combination Long-l	0.0821								
29	Arterial										
30	11	Motorcycle	0.0082								
31	21	Passenger Car	0.5919								
32	31	Passenger Truck	0.3336								
33	32	Light Commercial Tı	0.0290								

AERMOD links | Traffic Data | AERMOD input info | Fleet Mix | Bus R

Age Distribution Based on Bus Roster

traffic_data.xls [Compatibility Mode]

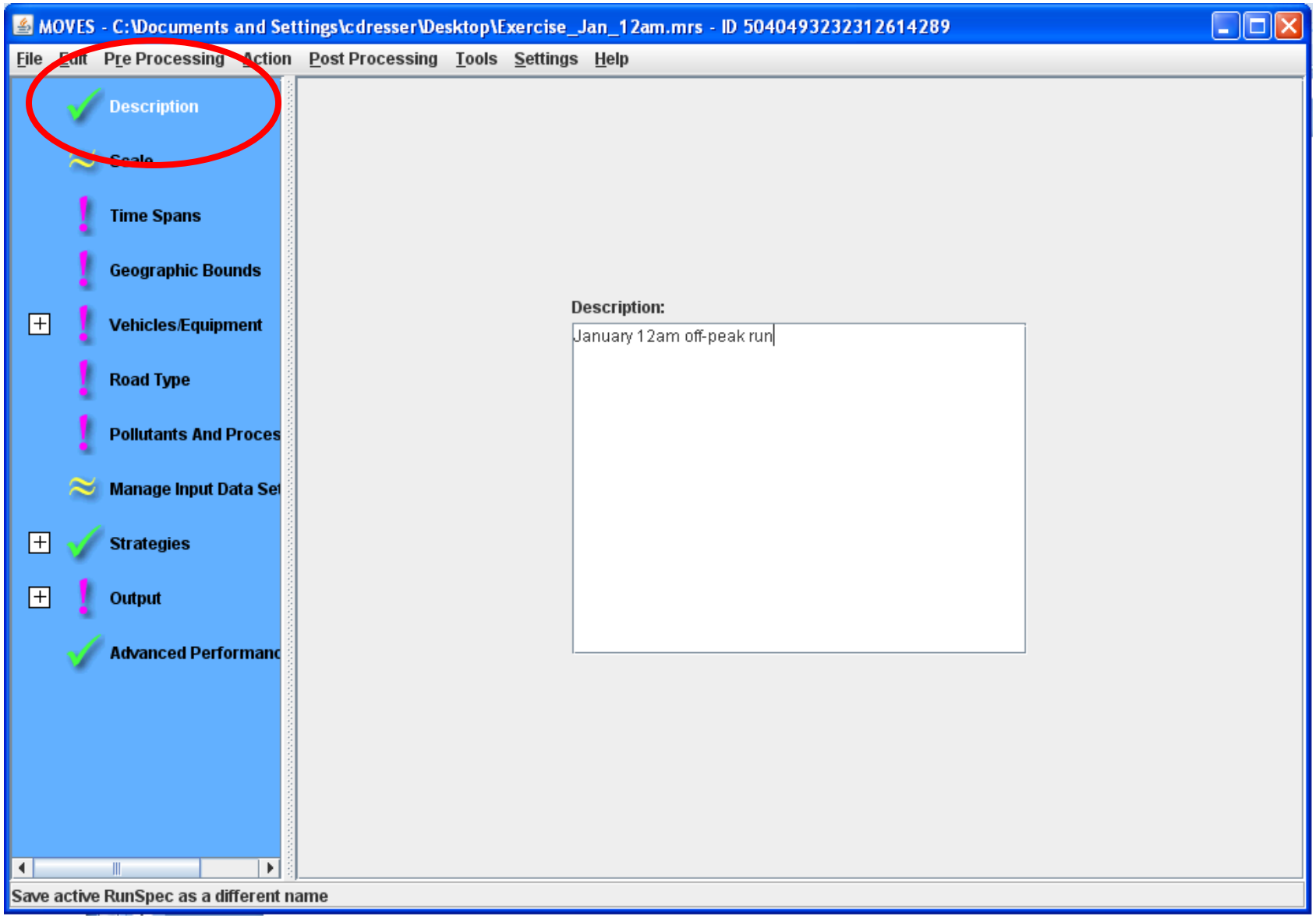
	A	B	C	D	E	F	G	H	I	J	K
1	Bus ID	Type	Age	Fuel			age	count	fraction of total		
2	11	BUS	2	Diesel			2	6	0.061224		
3	12	BUS	2	Diesel			3	22	0.22449		
4	13	BUS	2	Diesel			4	3	0.030612		
5	14	BUS	2	Diesel			5	1	0.010204		
6	86	BUS	2	Diesel			6	2	0.020408		
7	87	BUS	2	Diesel			7	25	0.255102		
8	48	BUS	3	Diesel			8	11	0.112245		
9	88	BUS	3	Diesel			9	9	0.091837		
10	89	BUS	3	Diesel			10	4	0.040816		
11	90	BUS	3	Diesel			12	12	0.122449		
12	91	BUS	3	Diesel			13	1	0.010204		
13	92	BUS	3	Diesel			14	1	0.010204		
14	93	BUS	3	Diesel			15	1	0.010204		
15	94	BUS	3	Diesel							
16	95	BUS	3	Diesel							
17	96	BUS	3	Diesel							
18	97	BUS	3	Diesel							
19	98	BUS	3	Diesel							
20	99	BUS	3	Diesel							
21	100	BUS	3	Diesel							
22	101	BUS	3	Diesel							
23	102	BUS	3	Diesel							
24	103	BUS	3	Diesel							
25	104	BUS	3	Diesel							
26	105	BUS	3	Diesel							
27	106	BUS	3	Diesel							
28	107	BUS	3	Diesel							
29	108	BUS	3	Diesel							
30	9	BUS	4	Diesel							
31	10	BUS	4	Diesel							
32	47	BUS	4	Diesel							
33	8	BUS	5	Diesel							

Traffic Data | AERMOD input info | Fleet Mix | Bus Roster

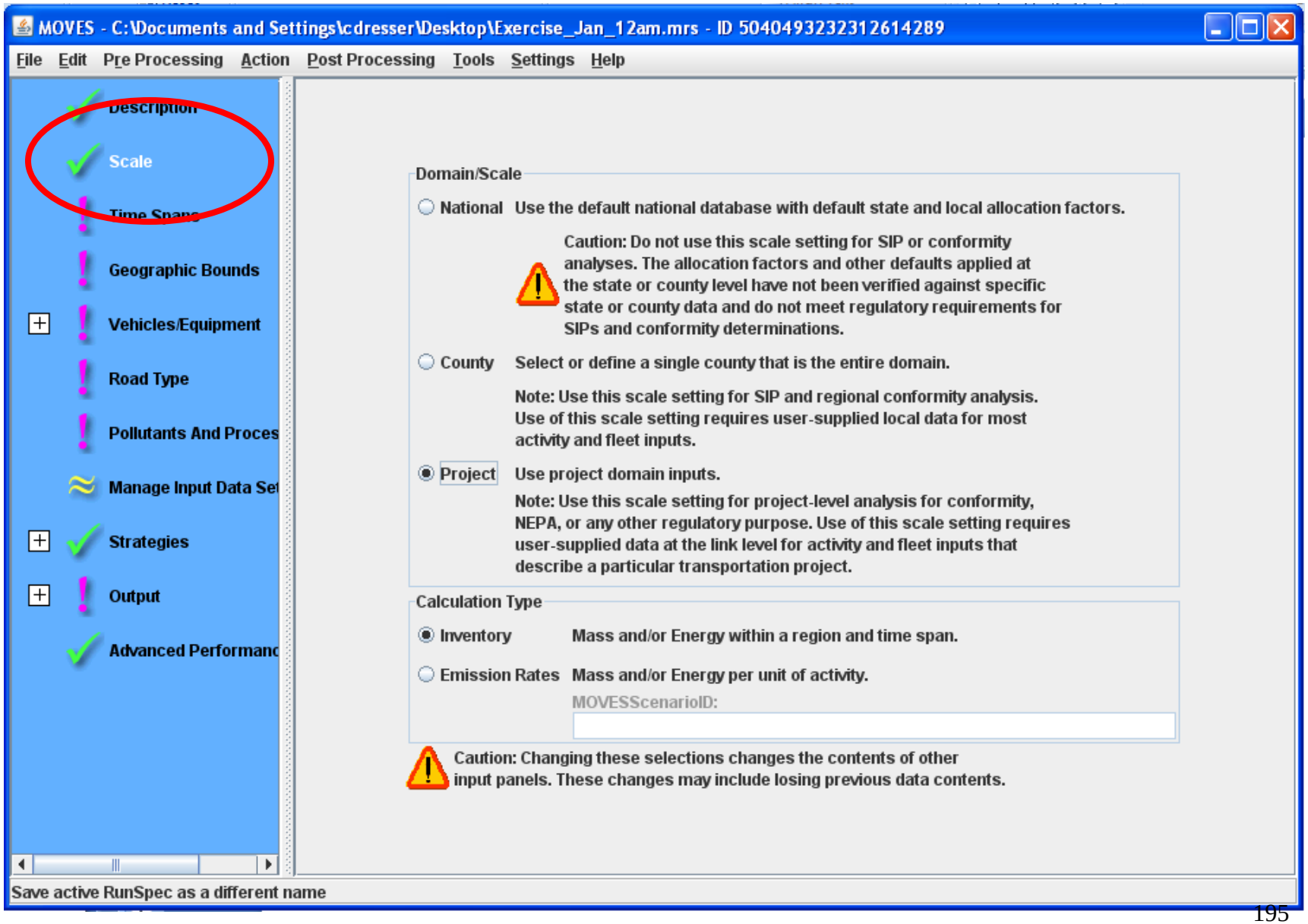
Age and fuel type of each individual bus

Running MOVES

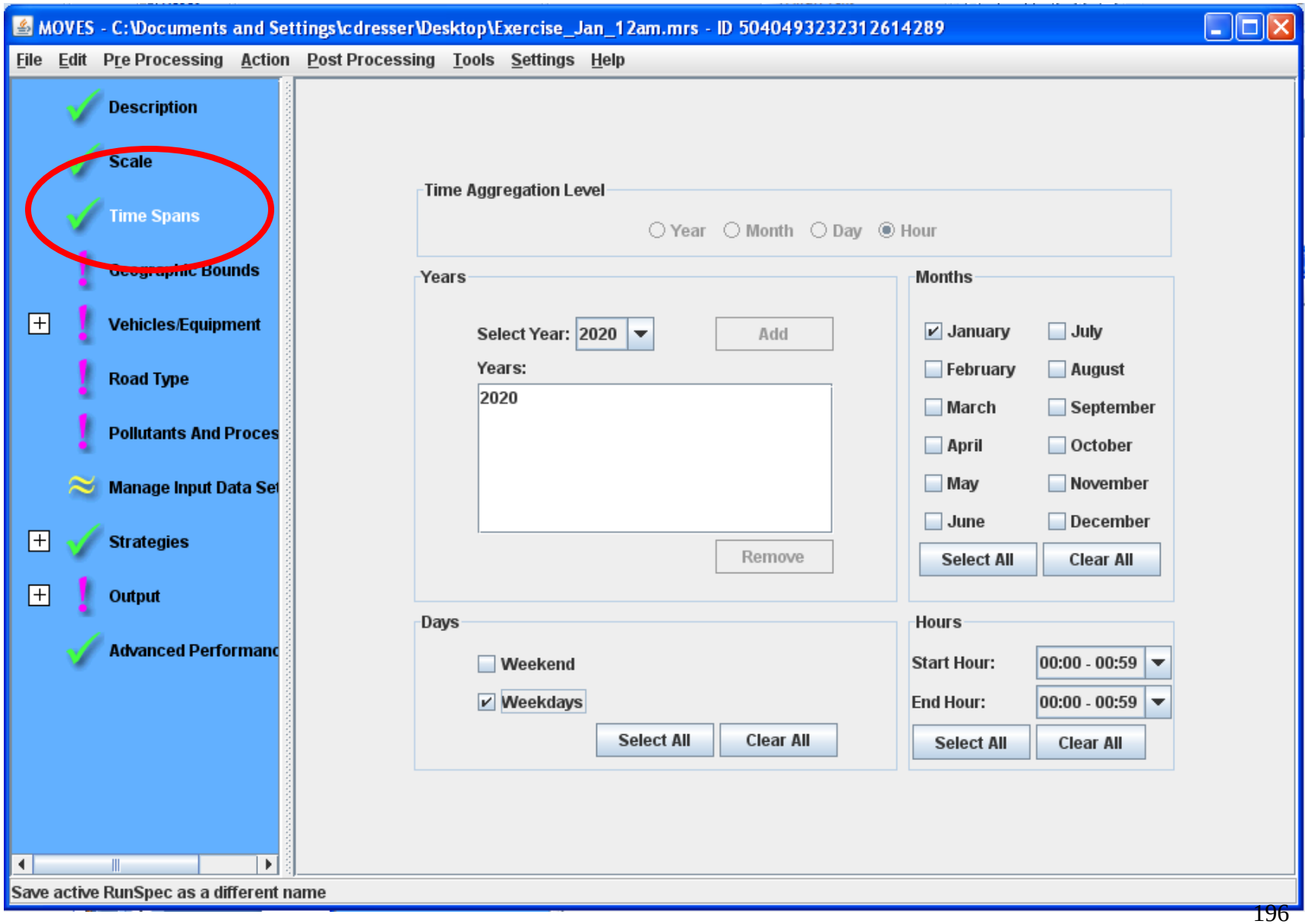
Run Description



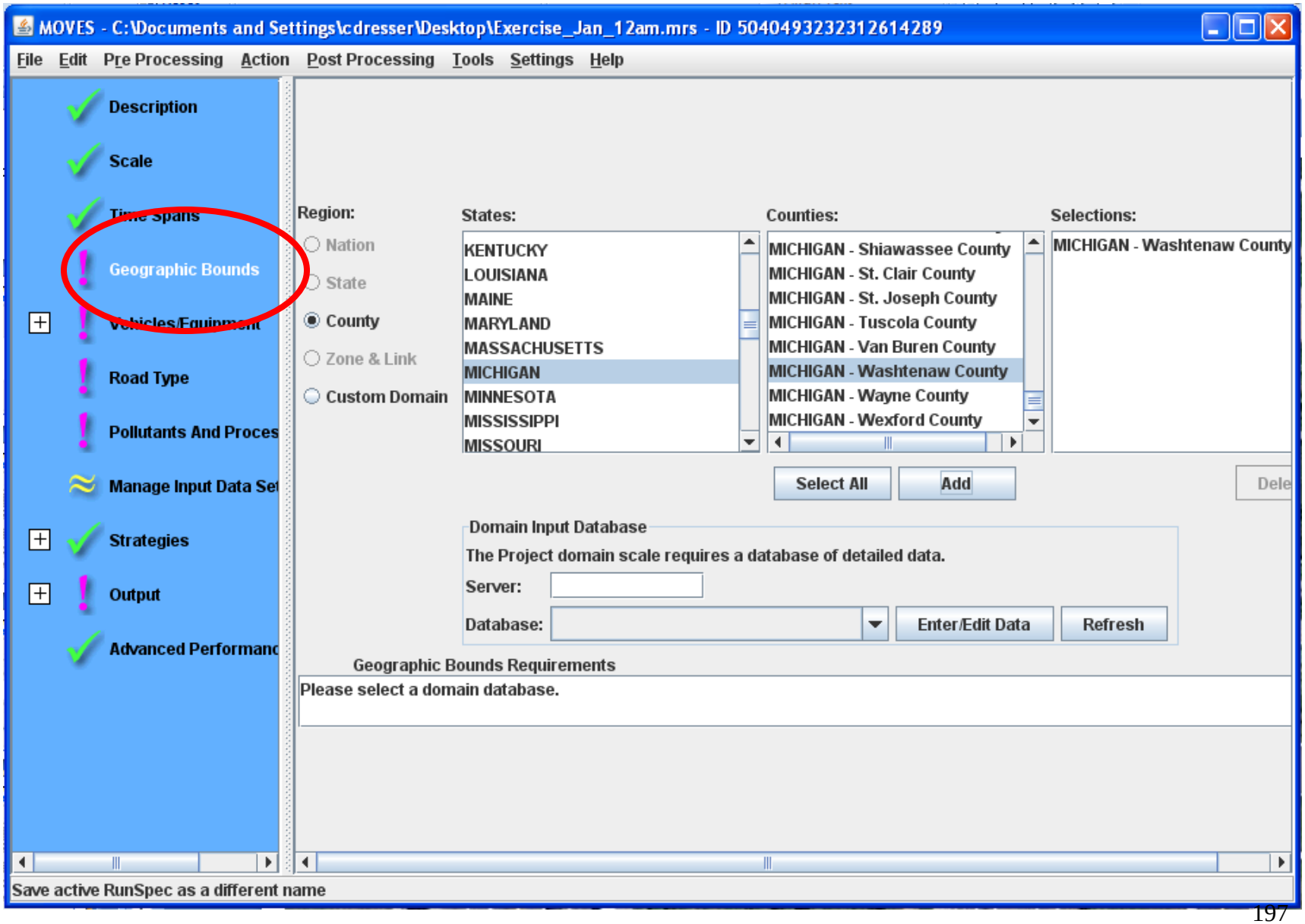
Scale and Calculation Type



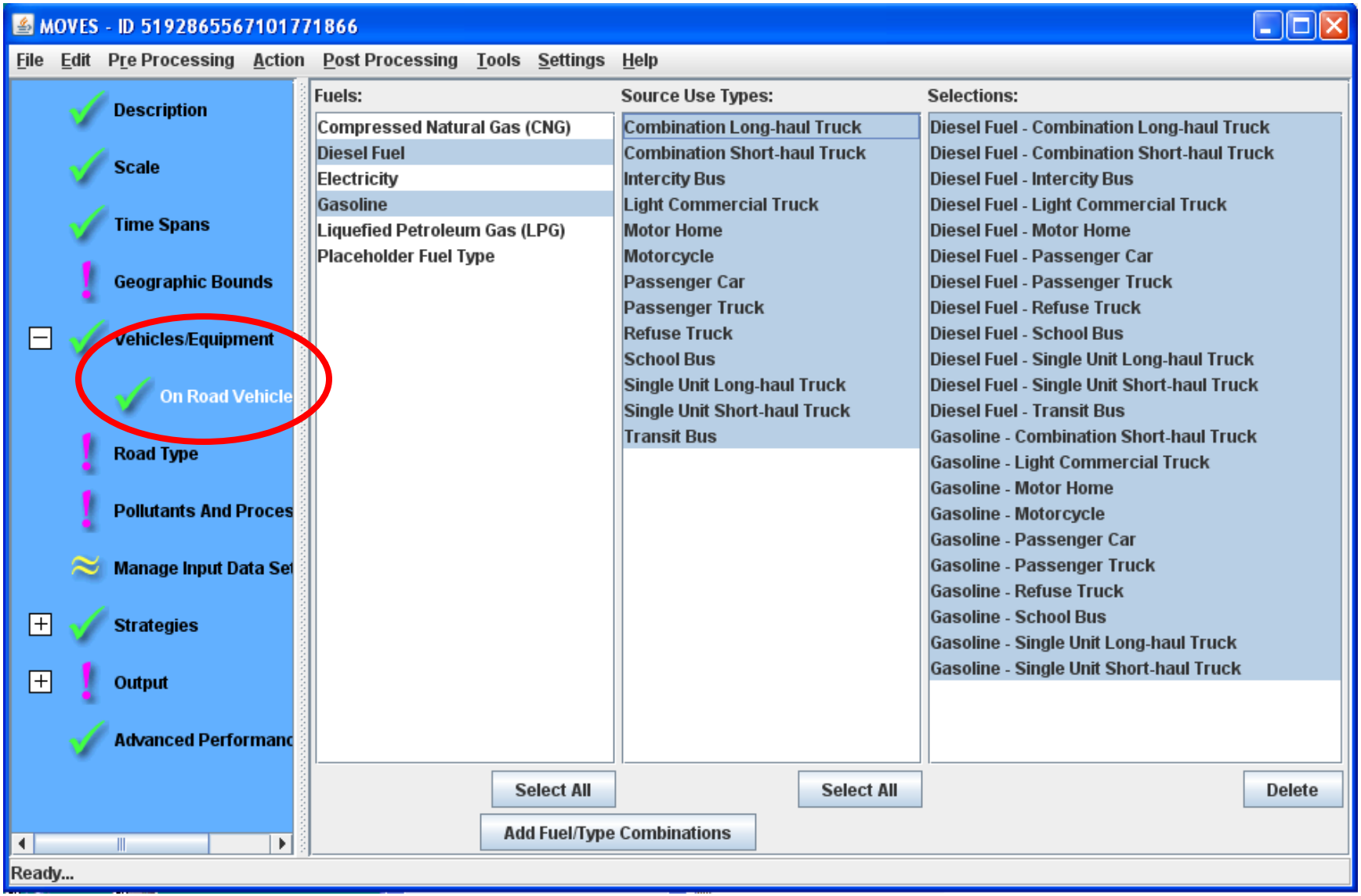
Time Spans


MOVES - C:\Documents and Settings\cdresser\Desktop\Exercise_Jan_12am.mrs - ID 5040493232312614289
File Edit Pre Processing Action Post Processing Tools Settings Help
Description
Scale
Time Spans
Vehicles/Equipment
Road Type
Pollutants And Proces
Manage Input Data Set
Strategies
Output
Advanced Performanc
Time Aggregation Level
Year Month Day Hour
Years
Select Year: 2020
Add
Years:
2020
Remove
Months
January
February
March
April
May
June
July
August
September
October
November
December
Select All
Clear All
Days
Weekend
Weekdays
Select All
Clear All
Hours
Start Hour: 00:00 - 00:59
End Hour: 00:00 - 00:59
Select All
Clear All
Save active RunSpec as a different name

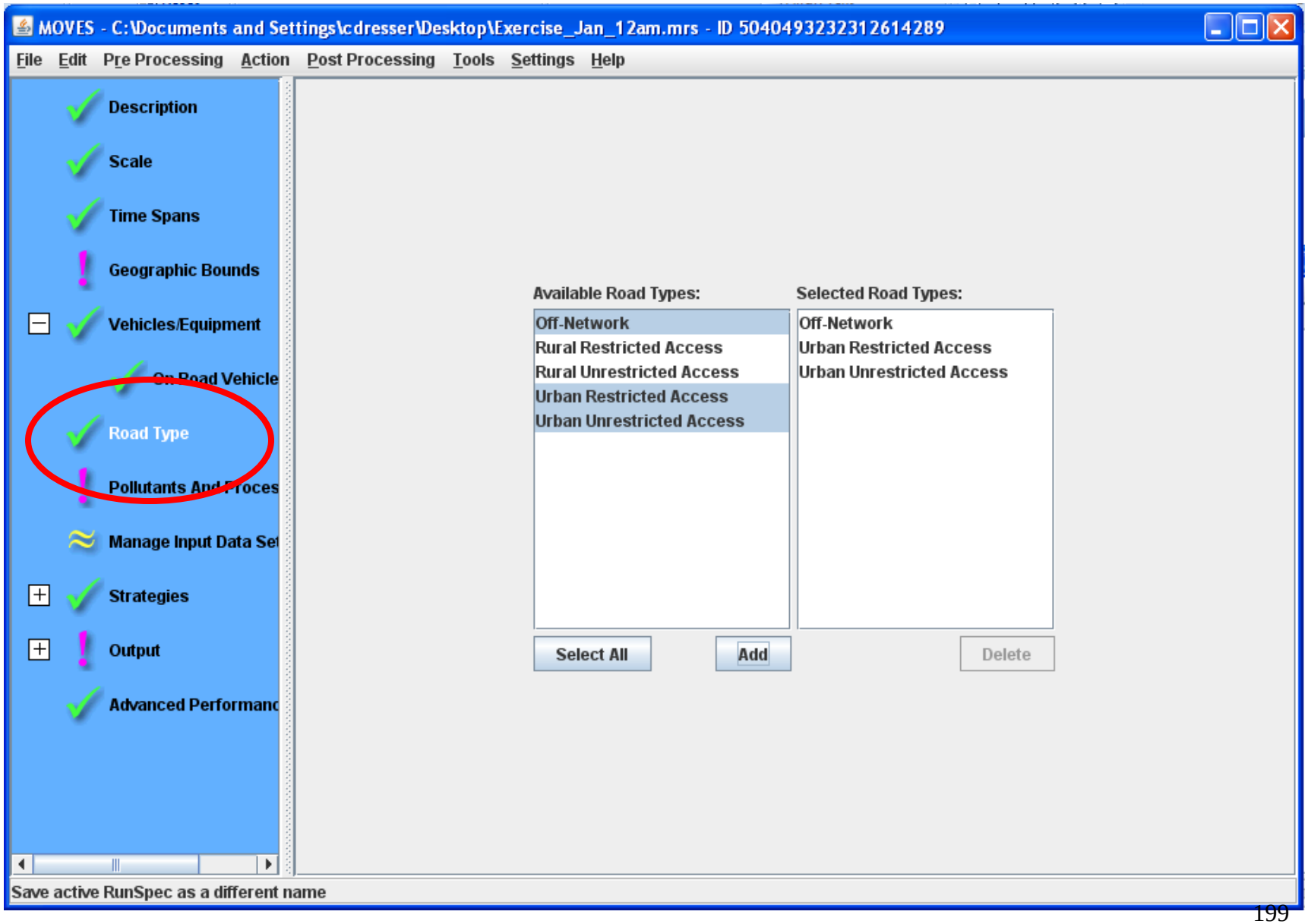
Geographic Bounds



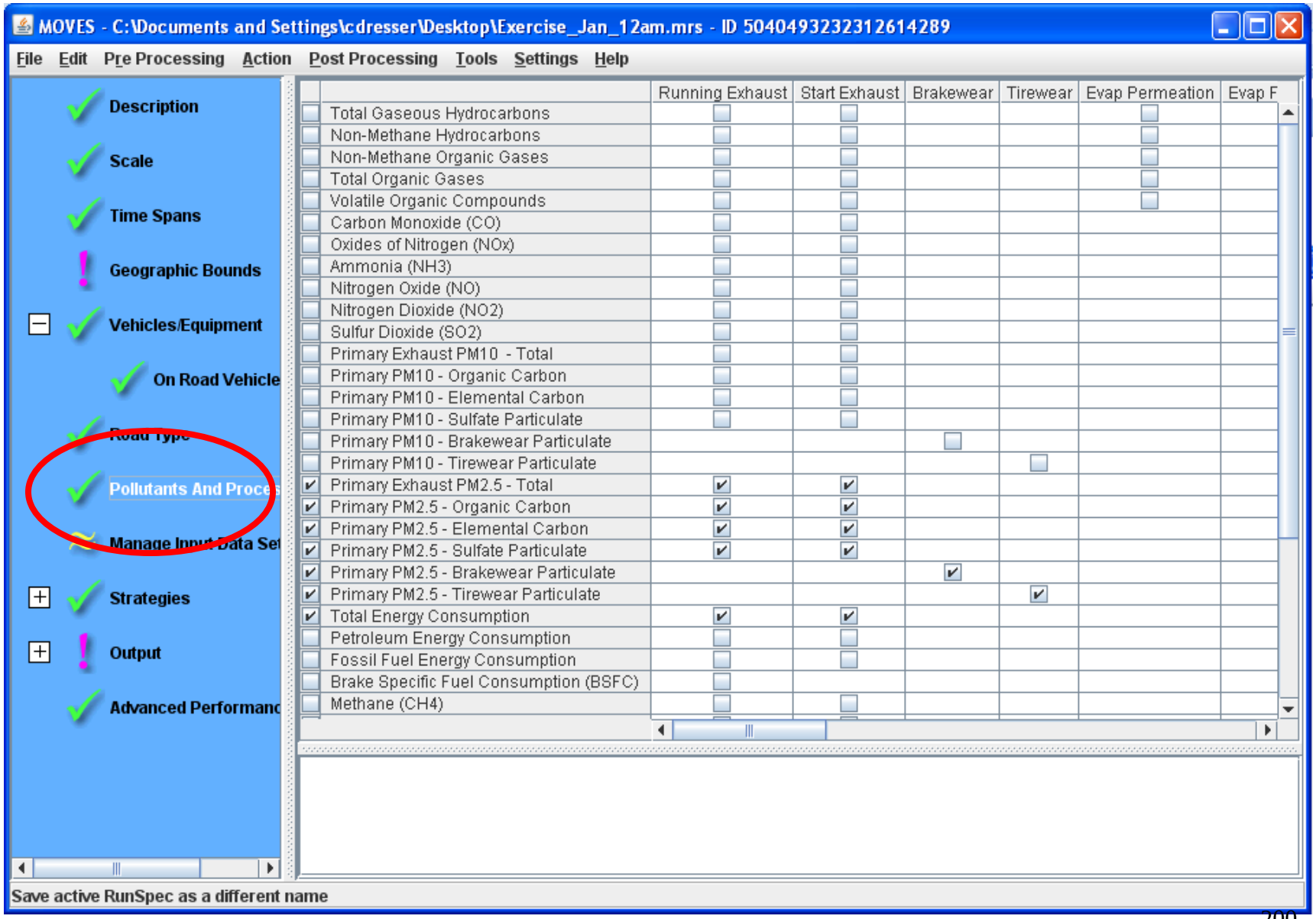
Fuel/Source Use Types



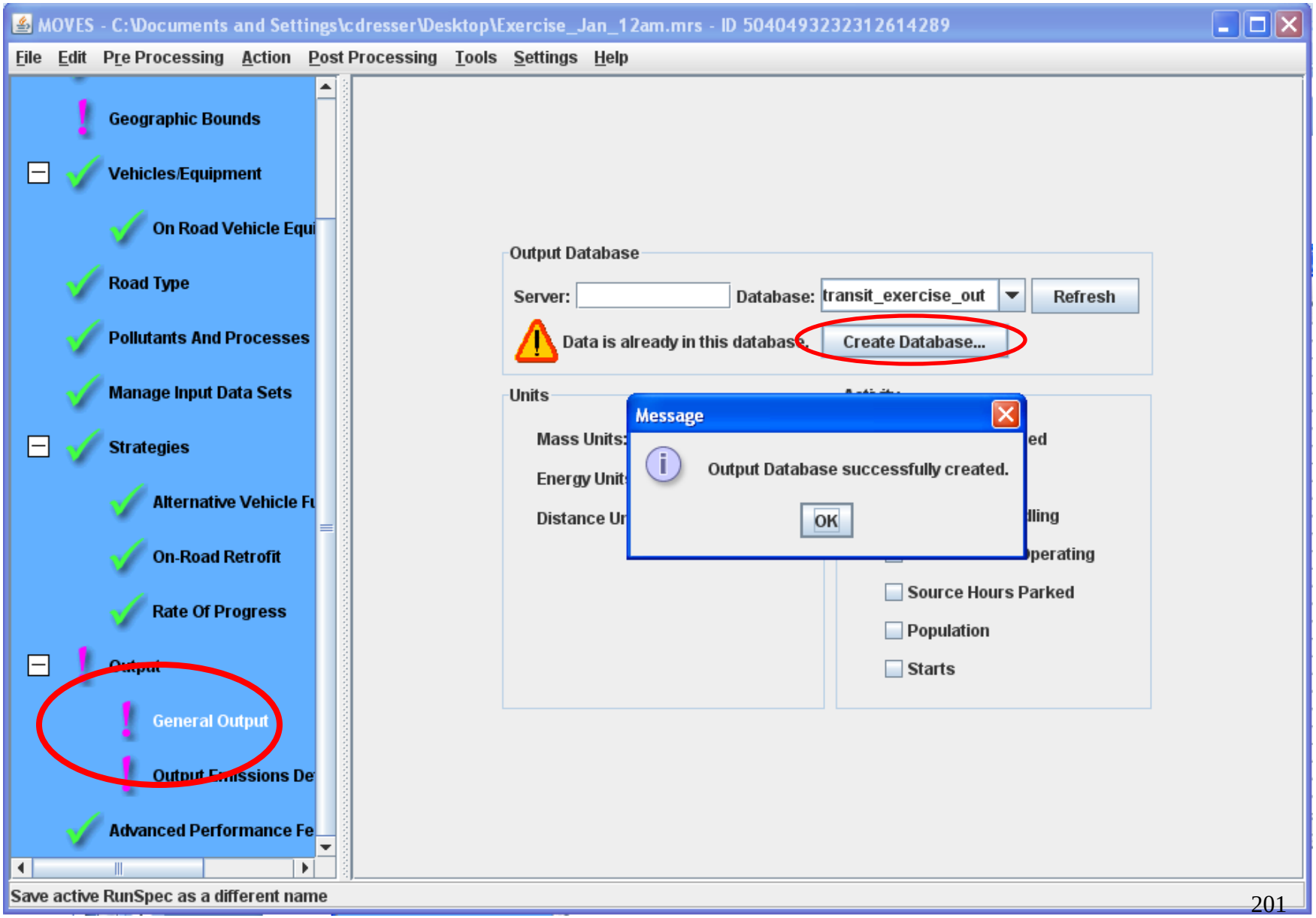
Road Type


MOVES - C:\Documents and Settings\cdresser\Desktop\Exercise_Jan_12am.mrs - ID 5040493232312614289
File Edit Pre Processing Action Post Processing Tools Settings Help
Description
Scale
Time Spans
Geographic Bounds
Vehicles/Equipment
Road Type
Manage Input Data Set
Strategies
Output
Advanced Performanc
Available Road Types:
Off-Network
Rural Restricted Access
Rural Unrestricted Access
Urban Restricted Access
Urban Unrestricted Access
Selected Road Types:
Off-Network
Urban Restricted Access
Urban Unrestricted Access
Select All
Add
Delete
Save active RunSpec as a different name

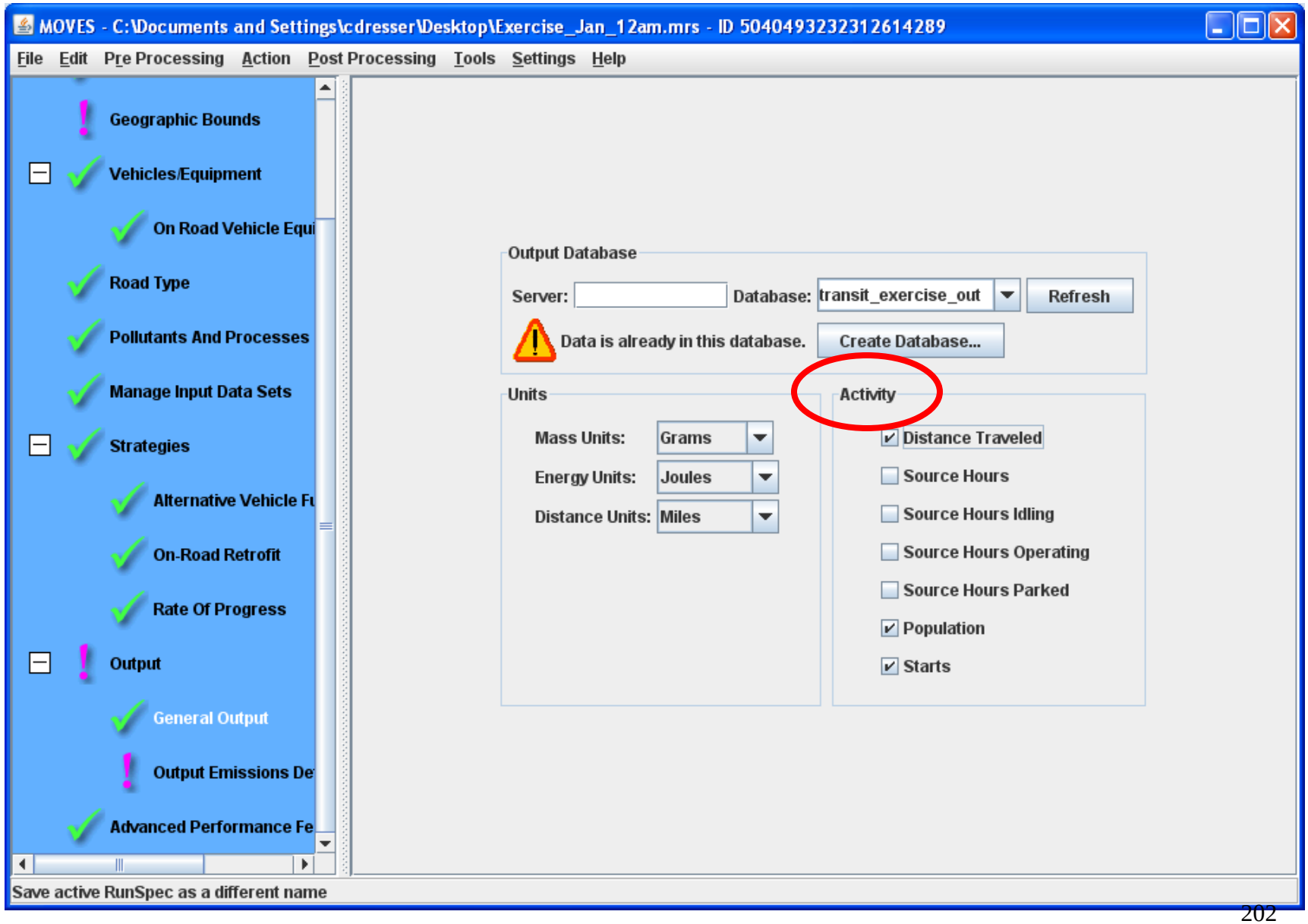
Pollutants and Processes



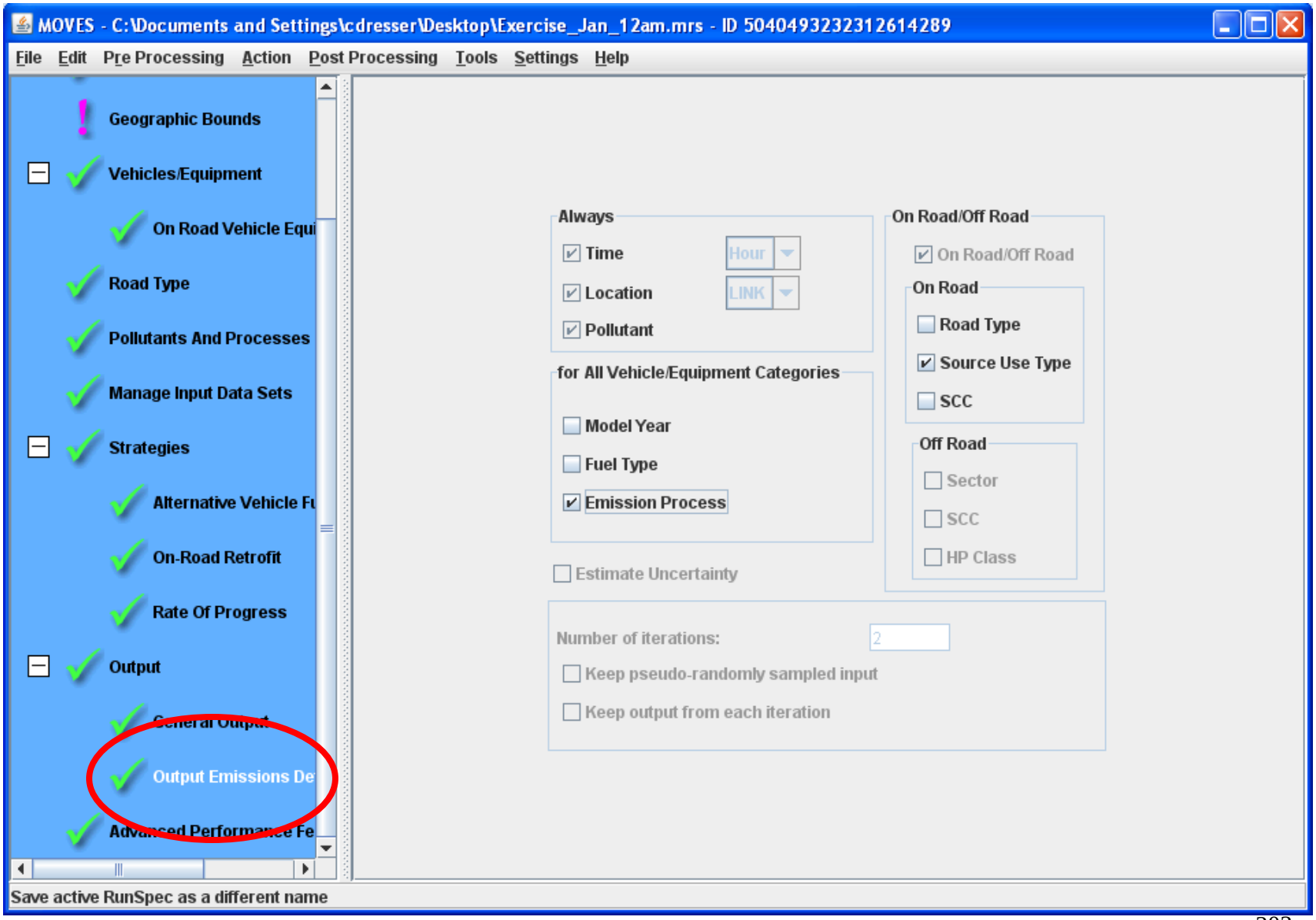
Creating Output Database



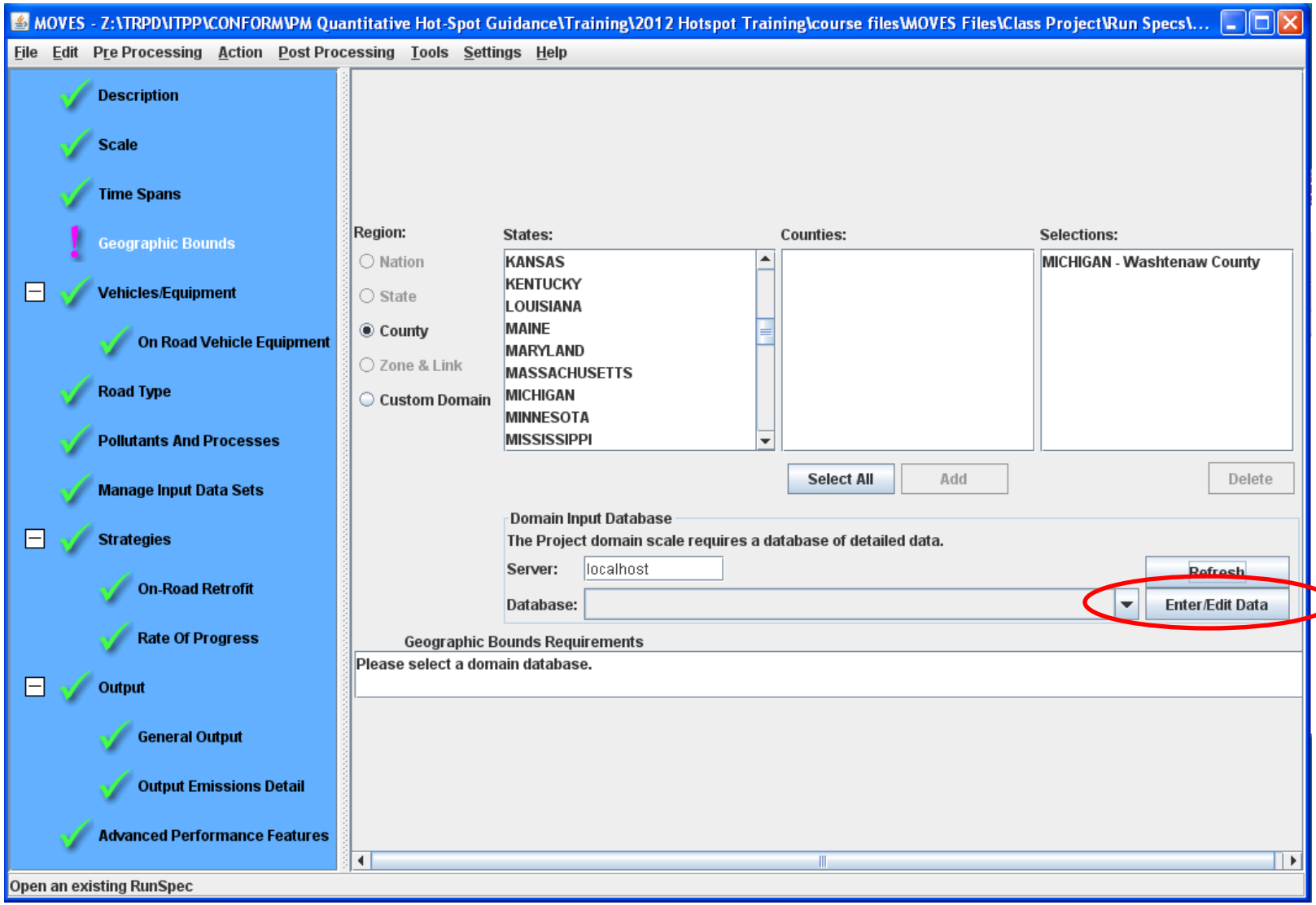
Selecting Output Activity



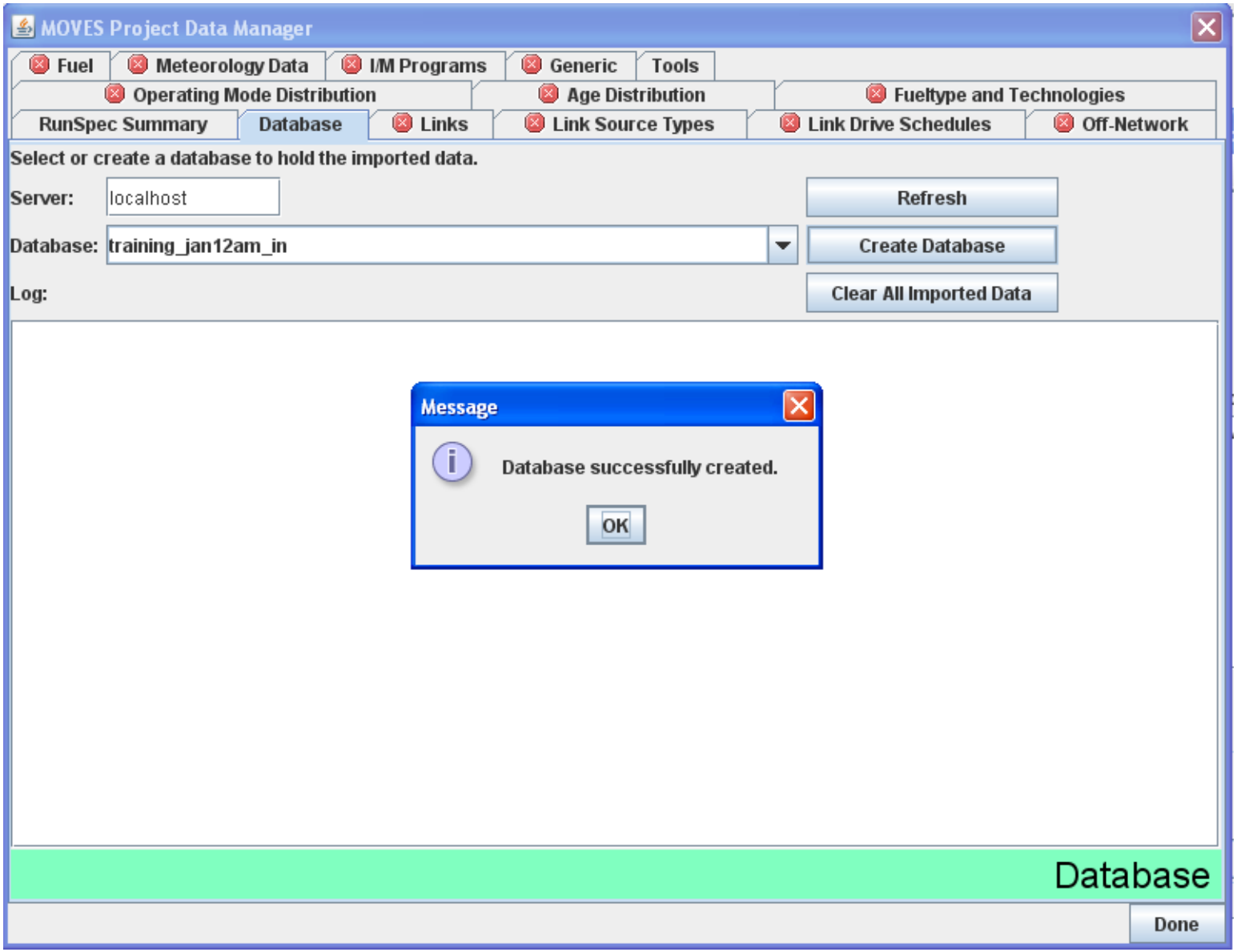
Output Emissions Detail



Importing Project Data: PDM



Creating Input Database



Importing Data

Links: Links_offpeak.xls

Link Source Types: linksource.xls

Link Drive Schedule: not used

Fuel: fuels_jan.xls

Age Distribution: agedist.xls

Operating Mode Distribution: opmode.xls

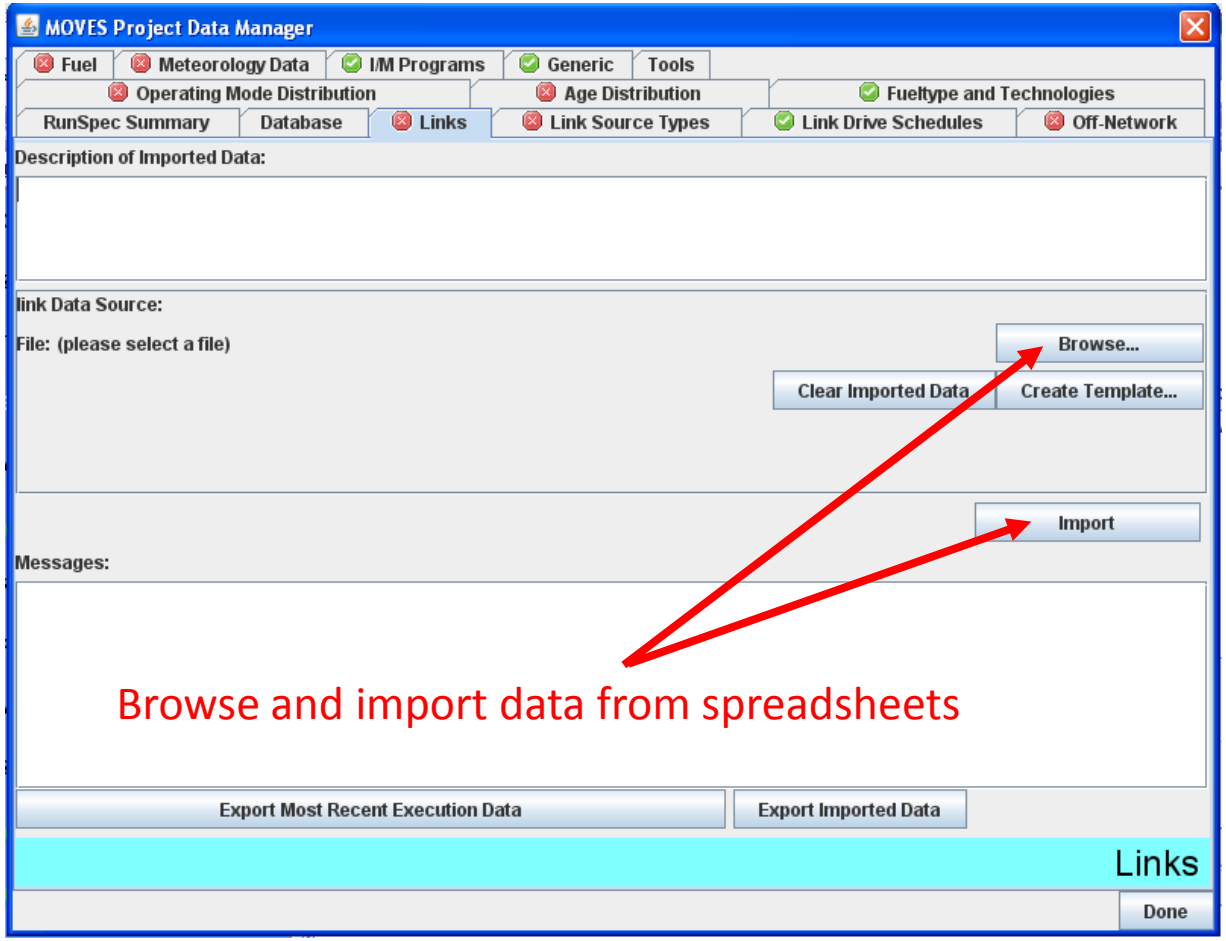
Off-Network: offnetwork.xls

Meteorology Data: met_jan12am.xls

I/M Programs: not used

Fueltype and Technology: AVFT_revised.xls

Generic: not used



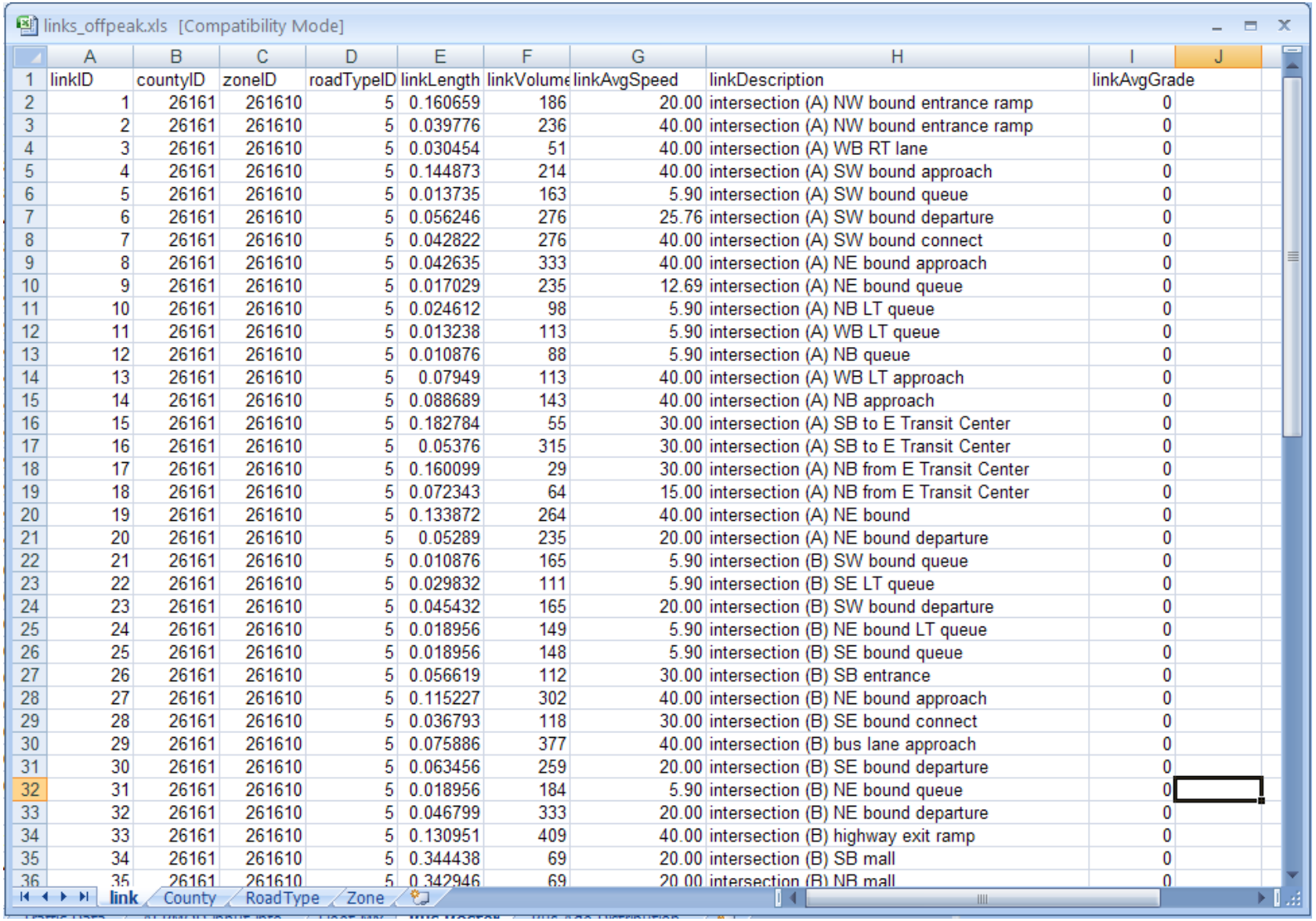
Deriving Links Table from Traffic Data

traffic_data.xls [Compatibility Mode]

	A	B	C	D	E	F	G	H	I
1	linkid	Link Description	Link Type	Link Volume (off-peak hour)	Link Volume (peak hour)	average speed - off-peak hour(mph)	average speed - peak hour(mph)	link length (meters)	link length (r
2	1	intersection (A) NW bound entrance ramp	accel	186	404	20.0	20.0	258.5	0.1606
3	2	intersection (A) NW bound entrance ramp	cruise	236	514	40.0	40.0	64.0	0.0397
4	3	intersection (A) WB RT lane	cruise	51	110	40.0	40.0	49.0	0.0304
5	4	intersection (A) SW bound approach	cruise	214	465	40.0	40.0	233.1	0.1448
6	5	intersection (A) SW bound queue	queue	163	355	5.9	5.9	22.1	0.0137
7	6	intersection (A) SW bound departure	accel	276	600	25.8	25.8	90.5	0.0562
8	7	intersection (A) SW bound connect	cruise	276	600	40.0	40.0	68.9	0.0428
9	8	intersection (A) NE bound approach	cruise	333	724	40.0	40.0	68.6	0.0426
10	9	intersection (A) NE bound queue	queue	235	511	12.7	6.2	27.4	0.0170
11	10	intersection (A) NB LT queue	queue	98	213	5.9	5.9	39.6	0.024
12	11	intersection (A) WB LT queue	queue	113	245	5.9	5.9	21.3	0.0132
13	12	intersection (A) NB queue	queue	88	191	5.9	5.9	17.5	0.0108
14	13	intersection (A) WB LT approach	cruise	113	245	40.0	40.0	127.9	0.0794
15	14	intersection (A) NB approach	cruise	143	311	40.0	40.0	142.7	0.0886
16	15	intersection (A) SB to E Transit Center	cruise	55	120	30.0	30.0	294.1	0.1827
17	16	intersection (A) SB to E Transit Center	cruise	315	684	30.0	30.0	86.5	0.0537
18	17	intersection (A) NB from E Transit Center	cruise	29	62	30.0	30.0	257.6	0.1600
19	18	intersection (A) NB from E Transit Center	cruise	64	139	15.0	15.0	116.4	0.072
20	19	intersection (A) NE bound	cruise	264	573	40.0	40.0	215.4	0.133
21	20	intersection (A) NE bound departure	accel	235	511	20.0	20.0	85.1	0.0528
22	21	intersection (B) SW bound queue	queue	165	359	5.9	5.9	17.5	0.0108
23	22	intersection (B) SE LT queue	queue	111	241	5.9	5.9	48	0.0298
24	23	intersection (B) SW bound departure	accel	165	359	20.0	20.0	73.1	0.0454
25	24	intersection (B) NE bound LT queue	queue	149	324	5.9	5.9	30.5	0.0189

Traffic Data | AERMOD input info | Fleet Mix | Bus Roster | Bus Age Distri

Links Input (links_offpeak.xls)



links_offpeak.xls [Compatibility Mode]

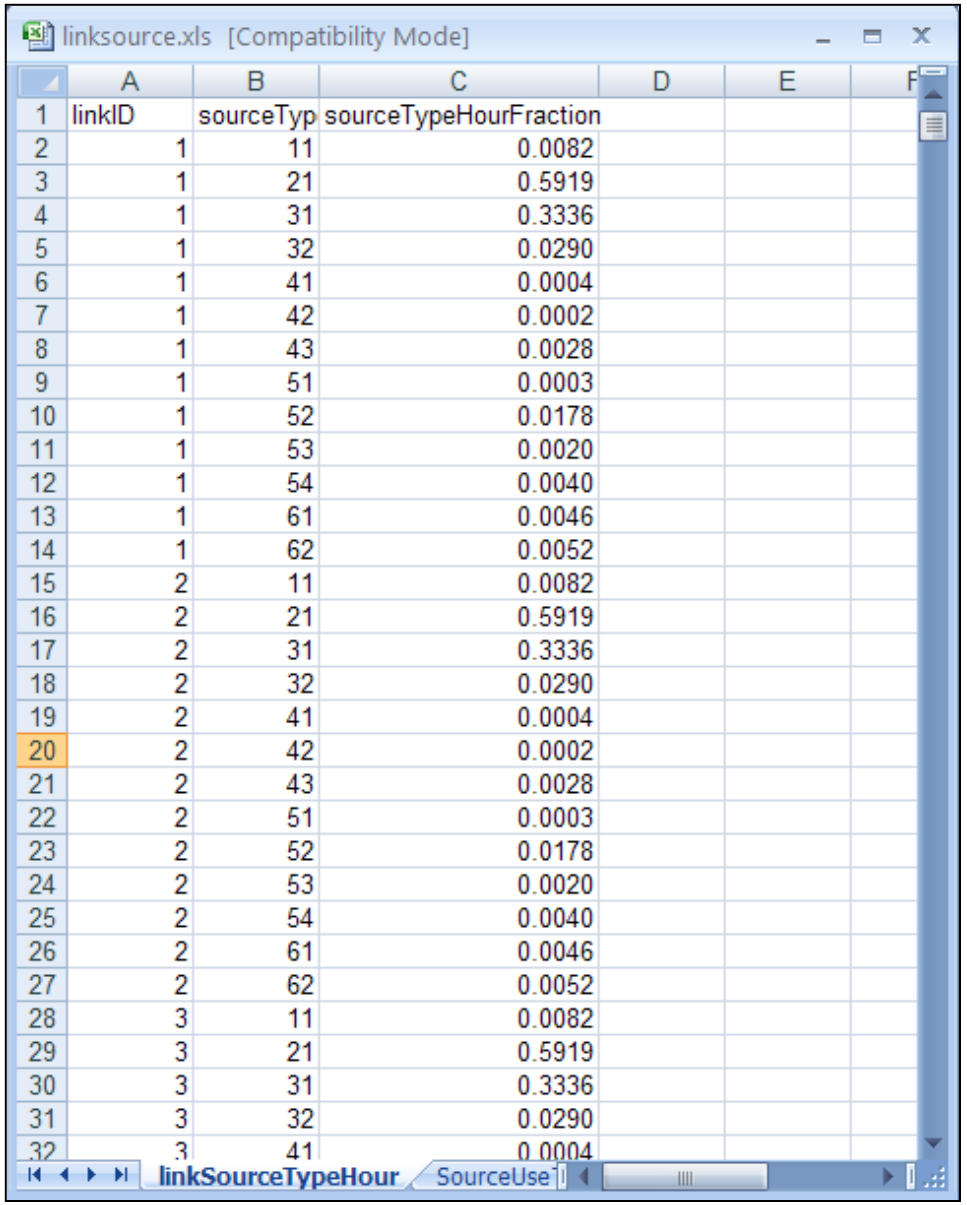
	A	B	C	D	E	F	G	H	I	J
1	linkID	countyID	zoneID	roadTypeID	linkLength	linkVolume	linkAvgSpeed	linkDescription	linkAvgGrade	
2	1	26161	261610	5	0.160659	186	20.00	intersection (A) NW bound entrance ramp	0	
3	2	26161	261610	5	0.039776	236	40.00	intersection (A) NW bound entrance ramp	0	
4	3	26161	261610	5	0.030454	51	40.00	intersection (A) WB RT lane	0	
5	4	26161	261610	5	0.144873	214	40.00	intersection (A) SW bound approach	0	
6	5	26161	261610	5	0.013735	163	5.90	intersection (A) SW bound queue	0	
7	6	26161	261610	5	0.056246	276	25.76	intersection (A) SW bound departure	0	
8	7	26161	261610	5	0.042822	276	40.00	intersection (A) SW bound connect	0	
9	8	26161	261610	5	0.042635	333	40.00	intersection (A) NE bound approach	0	
10	9	26161	261610	5	0.017029	235	12.69	intersection (A) NE bound queue	0	
11	10	26161	261610	5	0.024612	98	5.90	intersection (A) NB LT queue	0	
12	11	26161	261610	5	0.013238	113	5.90	intersection (A) WB LT queue	0	
13	12	26161	261610	5	0.010876	88	5.90	intersection (A) NB queue	0	
14	13	26161	261610	5	0.07949	113	40.00	intersection (A) WB LT approach	0	
15	14	26161	261610	5	0.088689	143	40.00	intersection (A) NB approach	0	
16	15	26161	261610	5	0.182784	55	30.00	intersection (A) SB to E Transit Center	0	
17	16	26161	261610	5	0.05376	315	30.00	intersection (A) SB to E Transit Center	0	
18	17	26161	261610	5	0.160099	29	30.00	intersection (A) NB from E Transit Center	0	
19	18	26161	261610	5	0.072343	64	15.00	intersection (A) NB from E Transit Center	0	
20	19	26161	261610	5	0.133872	264	40.00	intersection (A) NE bound	0	
21	20	26161	261610	5	0.05289	235	20.00	intersection (A) NE bound departure	0	
22	21	26161	261610	5	0.010876	165	5.90	intersection (B) SW bound queue	0	
23	22	26161	261610	5	0.029832	111	5.90	intersection (B) SE LT queue	0	
24	23	26161	261610	5	0.045432	165	20.00	intersection (B) SW bound departure	0	
25	24	26161	261610	5	0.018956	149	5.90	intersection (B) NE bound LT queue	0	
26	25	26161	261610	5	0.018956	148	5.90	intersection (B) SE bound queue	0	
27	26	26161	261610	5	0.056619	112	30.00	intersection (B) SB entrance	0	
28	27	26161	261610	5	0.115227	302	40.00	intersection (B) NE bound approach	0	
29	28	26161	261610	5	0.036793	118	30.00	intersection (B) SE bound connect	0	
30	29	26161	261610	5	0.075886	377	40.00	intersection (B) bus lane approach	0	
31	30	26161	261610	5	0.063456	259	20.00	intersection (B) SE bound departure	0	
32	31	26161	261610	5	0.018956	184	5.90	intersection (B) NE bound queue	0	
33	32	26161	261610	5	0.046799	333	20.00	intersection (B) NE bound departure	0	
34	33	26161	261610	5	0.130951	409	40.00	intersection (B) highway exit ramp	0	
35	34	26161	261610	5	0.344438	69	20.00	intersection (B) SB mall	0	
36	35	26161	261610	5	0.342946	69	20.00	intersection (B) NB mall	0	

link | County | RoadType | Zone

Link Source Type Input (linksource.xls)

Arterial and Highway Fleet Mix from MPO county-level analysis

Bus-only links are entirely sourcetype 42



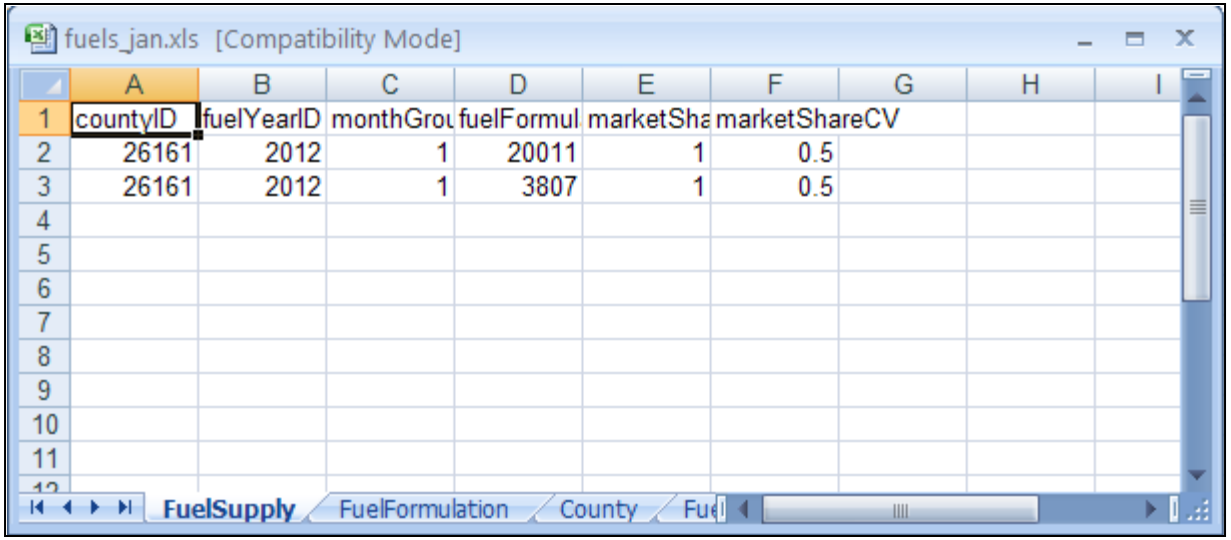
linksource.xls [Compatibility Mode]

	A	B	C	D	E	F
1	linkID	sourceTyp	sourceTypeHourFraction			
2	1	11	0.0082			
3	1	21	0.5919			
4	1	31	0.3336			
5	1	32	0.0290			
6	1	41	0.0004			
7	1	42	0.0002			
8	1	43	0.0028			
9	1	51	0.0003			
10	1	52	0.0178			
11	1	53	0.0020			
12	1	54	0.0040			
13	1	61	0.0046			
14	1	62	0.0052			
15	2	11	0.0082			
16	2	21	0.5919			
17	2	31	0.3336			
18	2	32	0.0290			
19	2	41	0.0004			
20	2	42	0.0002			
21	2	43	0.0028			
22	2	51	0.0003			
23	2	52	0.0178			
24	2	53	0.0020			
25	2	54	0.0040			
26	2	61	0.0046			
27	2	62	0.0052			
28	3	11	0.0082			
29	3	21	0.5919			
30	3	31	0.3336			
31	3	32	0.0290			
32	3	41	0.0004			

linkSourceTypeHour | SourceUse

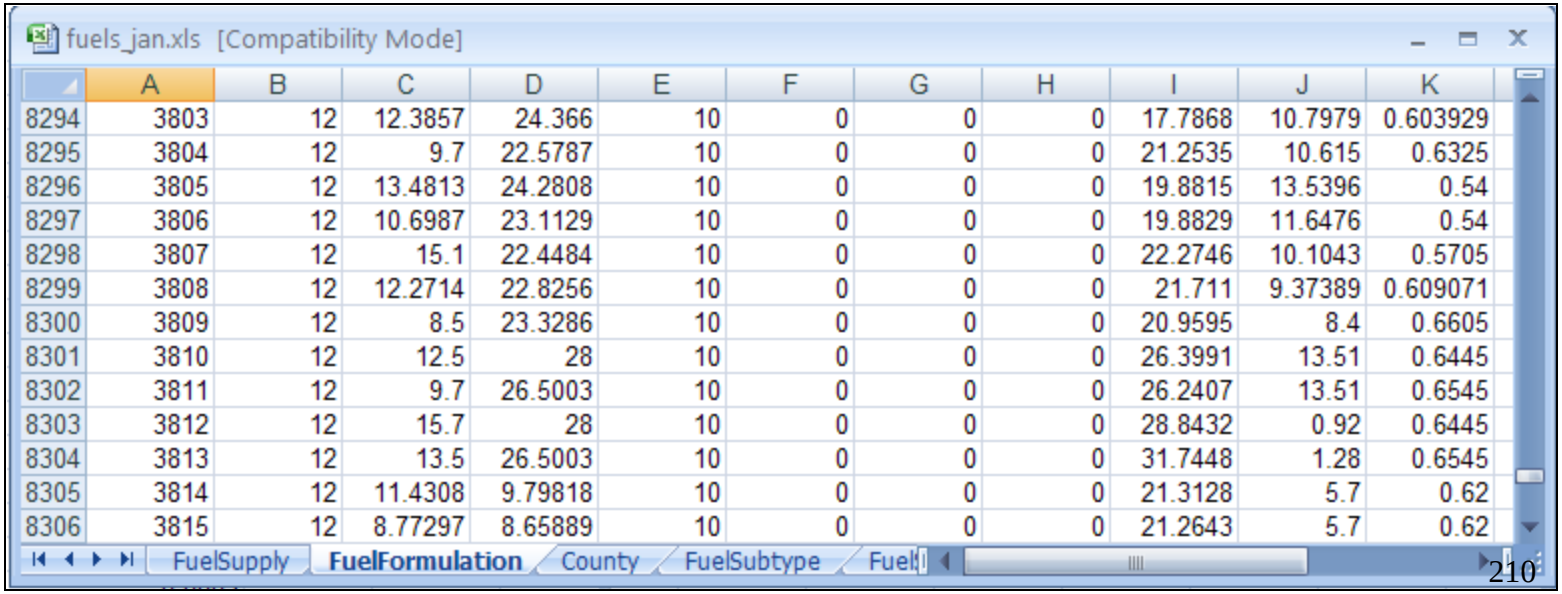
Fuels Input (fuel_jan.xls)

MOVES Default Fuel Supply and Fuel Formulation Used


fuels_jan.xls [Compatibility Mode]

	A	B	C	D	E	F	G	H	I
1	countyID	fuelYearID	monthGrou	fuelFormul	marketSha	marketShareCV			
2	26161	2012	1	20011	1	0.5			
3	26161	2012	1	3807	1	0.5			
4									
5									
6									
7									
8									
9									
10									
11									

FuelSupply | FuelFormulation | County | Fue


fuels_jan.xls [Compatibility Mode]

	A	B	C	D	E	F	G	H	I	J	K
8294	3803	12	12.3857	24.366	10	0	0	0	17.7868	10.7979	0.603929
8295	3804	12	9.7	22.5787	10	0	0	0	21.2535	10.615	0.6325
8296	3805	12	13.4813	24.2808	10	0	0	0	19.8815	13.5396	0.54
8297	3806	12	10.6987	23.1129	10	0	0	0	19.8829	11.6476	0.54
8298	3807	12	15.1	22.4484	10	0	0	0	22.2746	10.1043	0.5705
8299	3808	12	12.2714	22.8256	10	0	0	0	21.711	9.37389	0.609071
8300	3809	12	8.5	23.3286	10	0	0	0	20.9595	8.4	0.6605
8301	3810	12	12.5	28	10	0	0	0	26.3991	13.51	0.6445
8302	3811	12	9.7	26.5003	10	0	0	0	26.2407	13.51	0.6545
8303	3812	12	15.7	28	10	0	0	0	28.8432	0.92	0.6445
8304	3813	12	13.5	26.5003	10	0	0	0	31.7448	1.28	0.6545
8305	3814	12	11.4308	9.79818	10	0	0	0	21.3128	5.7	0.62
8306	3815	12	8.77297	8.65889	10	0	0	0	21.2643	5.7	0.62

FuelSupply | FuelFormulation | County | FuelSubtype | Fuel

Age Distribution Input (agedist.xls)

Provided by MPO

Local Data for Transit Buses (sourcetype 42) Obtained from Bus Roster

agedist.xls [Compatibility Mode]

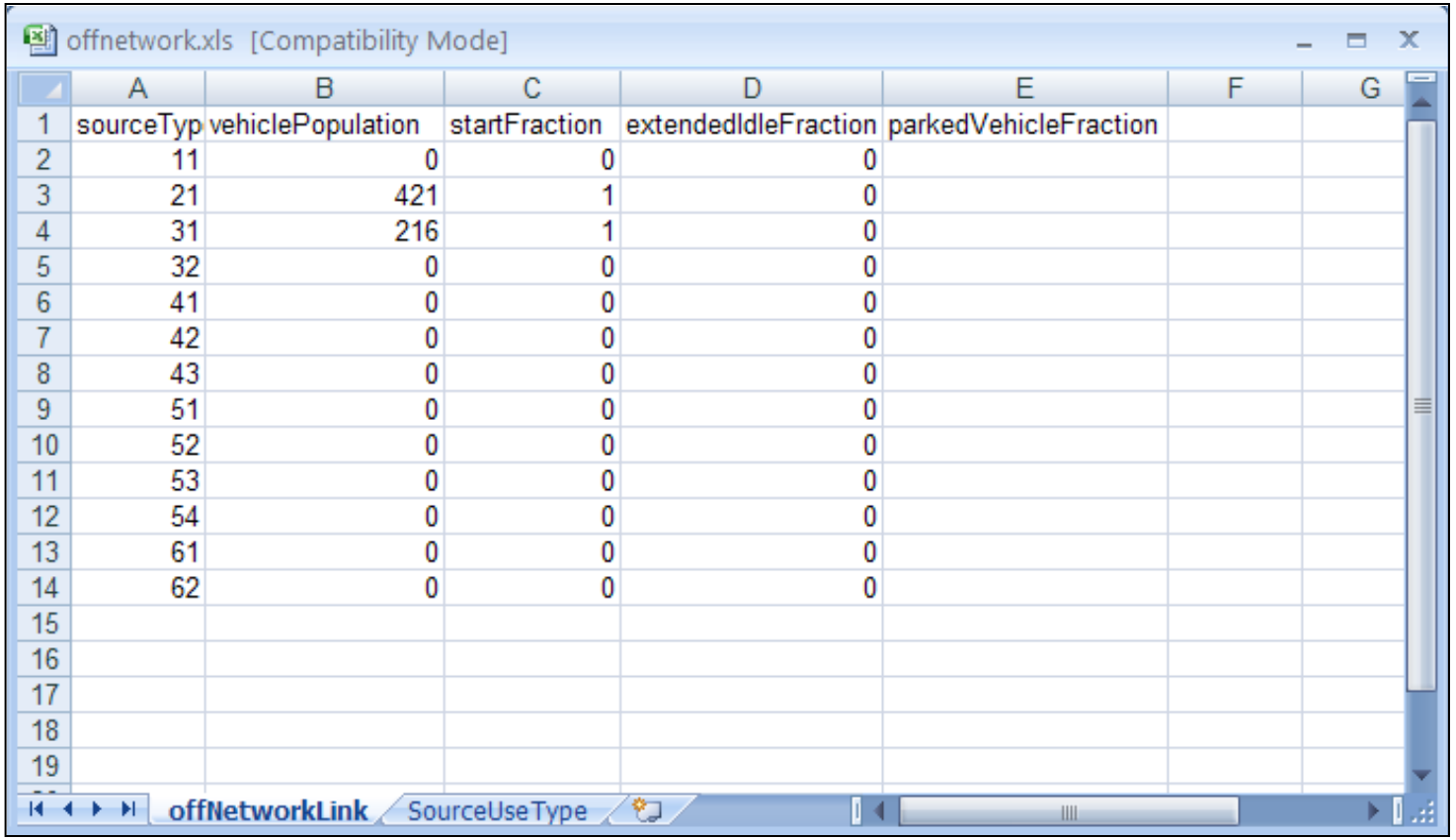
	A	B	C	D	E	F	G	H
1	sourceTyp	yearID	ageID	ageFraction				
2	11	2020	0	0.071362				
3	11	2020	1	0.071075				
4	11	2020	2	0.071147				
5	11	2020	3	0.070357				
6	11	2020	4	0.068521				
7	11	2020	5	0.065452				
8	11	2020	6	0.064117				
9	11	2020	7	0.061838				
10	11	2020	8	0.058894				
11	11	2020	9	0.054936				
12	11	2020	10	0.047725				
13	11	2020	11	0.042259				
14	11	2020	12	0.037962				
15	11	2020	13	0.033661				
16	11	2020	14	0.030885				
17	11	2020	15	0.028874				
18	11	2020	16	0.024984				
19	11	2020	17	0.021669				
20	11	2020	18	0.015195				
21	11	2020	19	0.011895				
22	11	2020	20	0.009375				
23	11	2020	21	0.00763				
24	11	2020	22	0.006016				
25	11	2020	23	0.004323				
26	11	2020	24	0.003227				
27	11	2020	25	0.002695				
28	11	2020	26	0.002217				
29	11	2020	27	0.002197				
30	11	2020	28	0.002242				
31	11	2020	29	0.001777				
32	11	2020	30	0.005492				

sourceTypeAgeDistribution | AgeCatego

Modeling Off-Network Activity

- MOVES can only model one off-network link per run
  - Our project has two distinct parking areas with an identical fleet, but varying number of starts
- A work-around option is to input a place-holder number of starts
  - Ensure that fleet mix (i.e., ratio of source types) and soak-time distribution is identical for all parking areas
- Results will be used to derive a grams/start value
  - Can be applied to any number of starts
  - Discussed following tomorrow's AERMOD module

Off-network Input (offnetwork.xls)



offnetwork.xls [Compatibility Mode]

	A	B	C	D	E	F	G
1	sourceTyp	vehiclePopulation	startFraction	extendedIdleFraction	parkedVehicleFraction		
2	11	0	0	0			
3	21	421	1	0			
4	31	216	1	0			
5	32	0	0	0			
6	41	0	0	0			
7	42	0	0	0			
8	43	0	0	0			
9	51	0	0	0			
10	52	0	0	0			
11	53	0	0	0			
12	54	0	0	0			
13	61	0	0	0			
14	62	0	0	0			
15							
16							
17							
18							
19							

offNetworkLink SourceUseType

Expected use of park-and-ride facility (ratio of source types 21 vs. 31 correct, but numbers are only a placeholder… actual grams/start emission rates will be calculated in a post-processing step)

Deriving OpMode Distribution from Traffic Data

Expected use of park-and-ride facility

traffic_data.xlsx

	A	B	C	D	E	F
1	opmode bin	description	fraction PM peak hour	fraction all other hours		
2	101	Soak Time < 6 minutes	0.05	0.05		
3	102	6 minutes <= Soak Time < 30 minutes	0	0		
4	103	30 minutes <= Soak Time < 60 minutes	0	0		
5	104	60 minutes <= Soak Time < 90 minutes	0	0		
6	105	90 minutes <= Soak Time < 120 minutes	0	0		
7	106	120 minutes <= Soak Time < 360 minutes	0	0.05		
8	107	360 minutes <= Soak Time < 720 minutes	0.95	0.8		
9	108	720 minutes <= Soak Time	0	0.1		
10						
11						
12						
13						
14						

Traffic Data | Fleet Mix | Bus Roster | Bus Age Distribution | Soak D

OpMode Distribution Input (opmode.xls)

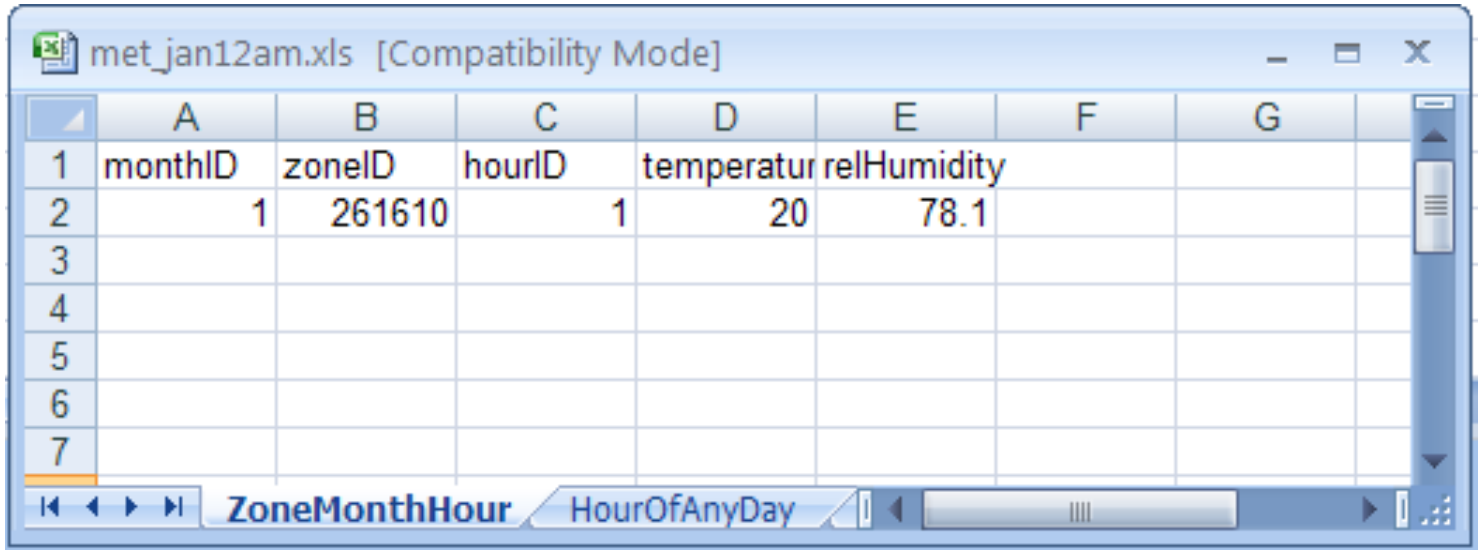
opmode.xls [Compatibility Mode]

	A	B	C	D	E	F	G
1	sourceTypeID	hourDayID	linkID	polProcessID	opModeID	opModeFraction	
2	11	15	75	9102	101	0.05	
3	11	15	75	9102	106	0.05	
4	11	15	75	9102	107	0.8	
5	11	15	75	9102	108	0.1	
6	11	15	75	11002	101	0.05	
7	11	15	75	11002	106	0.05	
8	11	15	75	11002	107	0.8	
9	11	15	75	11002	108	0.1	
10	11	15	75	11016	101	0.05	
11	11	15	75	11016	106	0.05	
12	11	15	75	11016	107	0.8	
13	11	15	75	11016	108	0.1	
14	11	15	75	11102	101	0.05	
15	11	15	75	11102	106	0.05	
16	11	15	75	11102	107	0.8	
17	11	15	75	11102	108	0.1	
18	11	15	75	11116	101	0.05	
19	11	15	75	11116	106	0.05	
20	11	15	75	11116	107	0.8	
21	11	15	75	11116	108	0.1	
22	11	15	75	11202	101	0.05	
23	11	15	75	11202	106	0.05	
24	11	15	75	11202	107	0.8	
25	11	15	75	11202	108	0.1	
26	11	15	75	11216	101	0.05	
27	11	15	75	11216	106	0.05	
28	11	15	75	11216	107	0.8	
29	11	15	75	11216	108	0.1	
30	11	15	75	11502	101	0.05	

opModeDistribution | HourDay | Operati

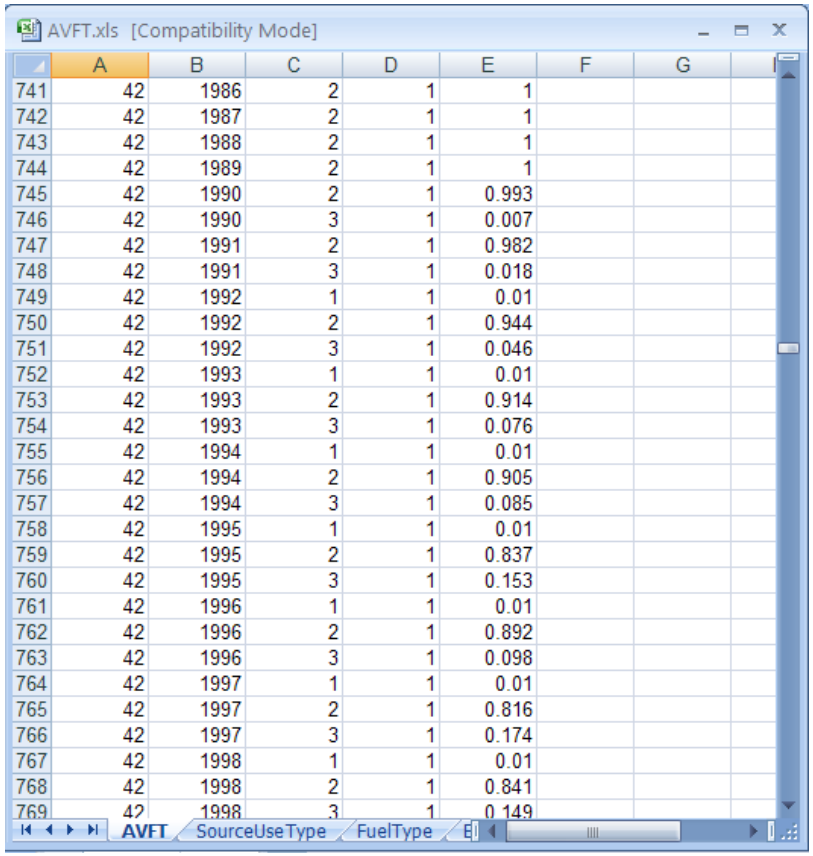
Single file contains all four hourly scenarios (12 a.m., 6 a.m., 12 p.m., 6 p.m.)

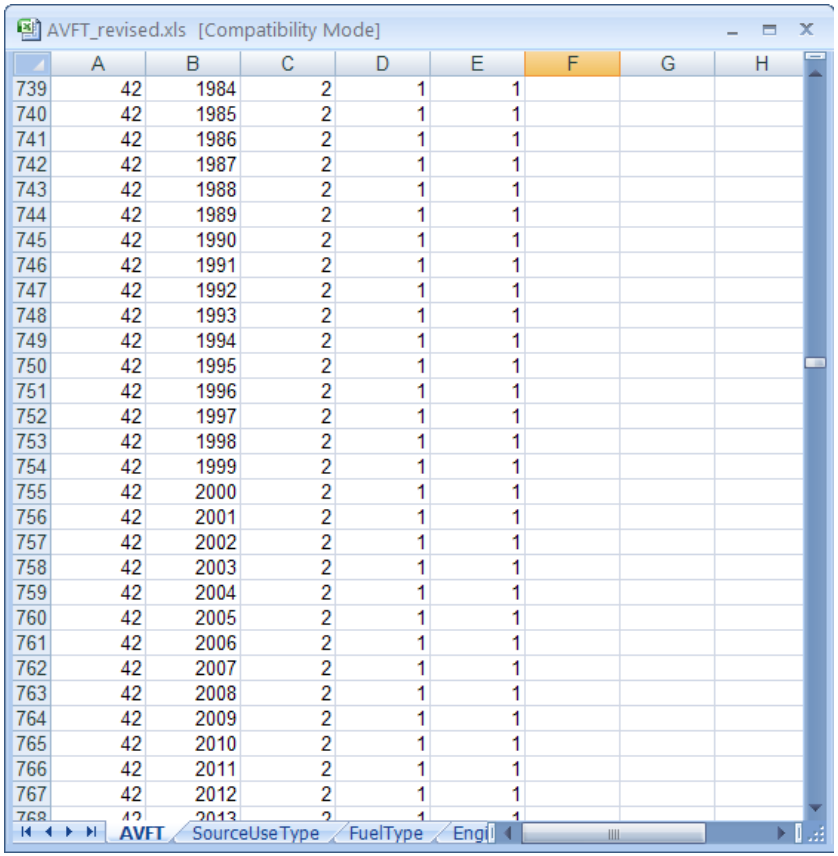
Meteorology Input (met_jan12am.xls)



Temperature and humidity data taken from nearby met station (same dataset used for air quality analysis)

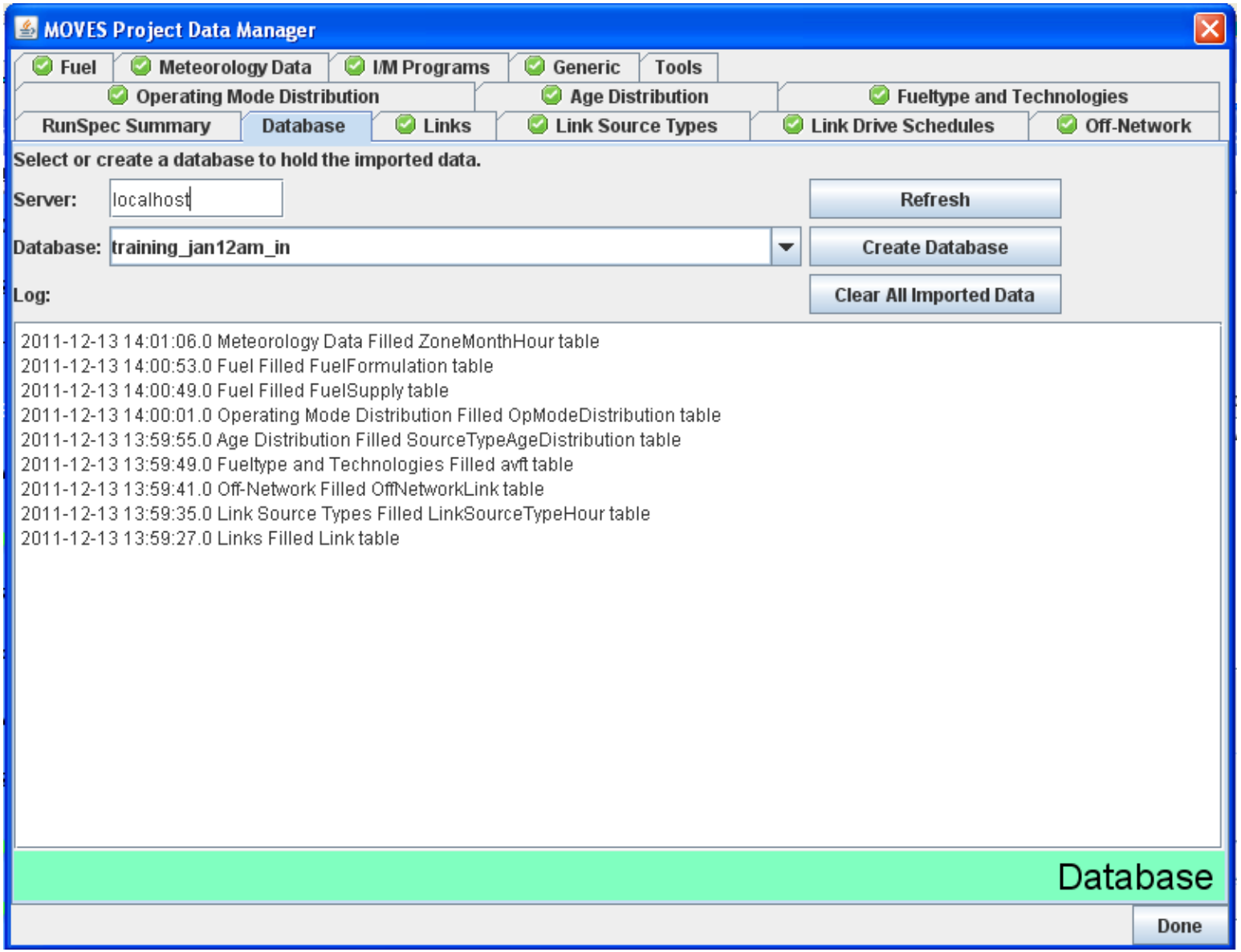
FuelType and Technology Input



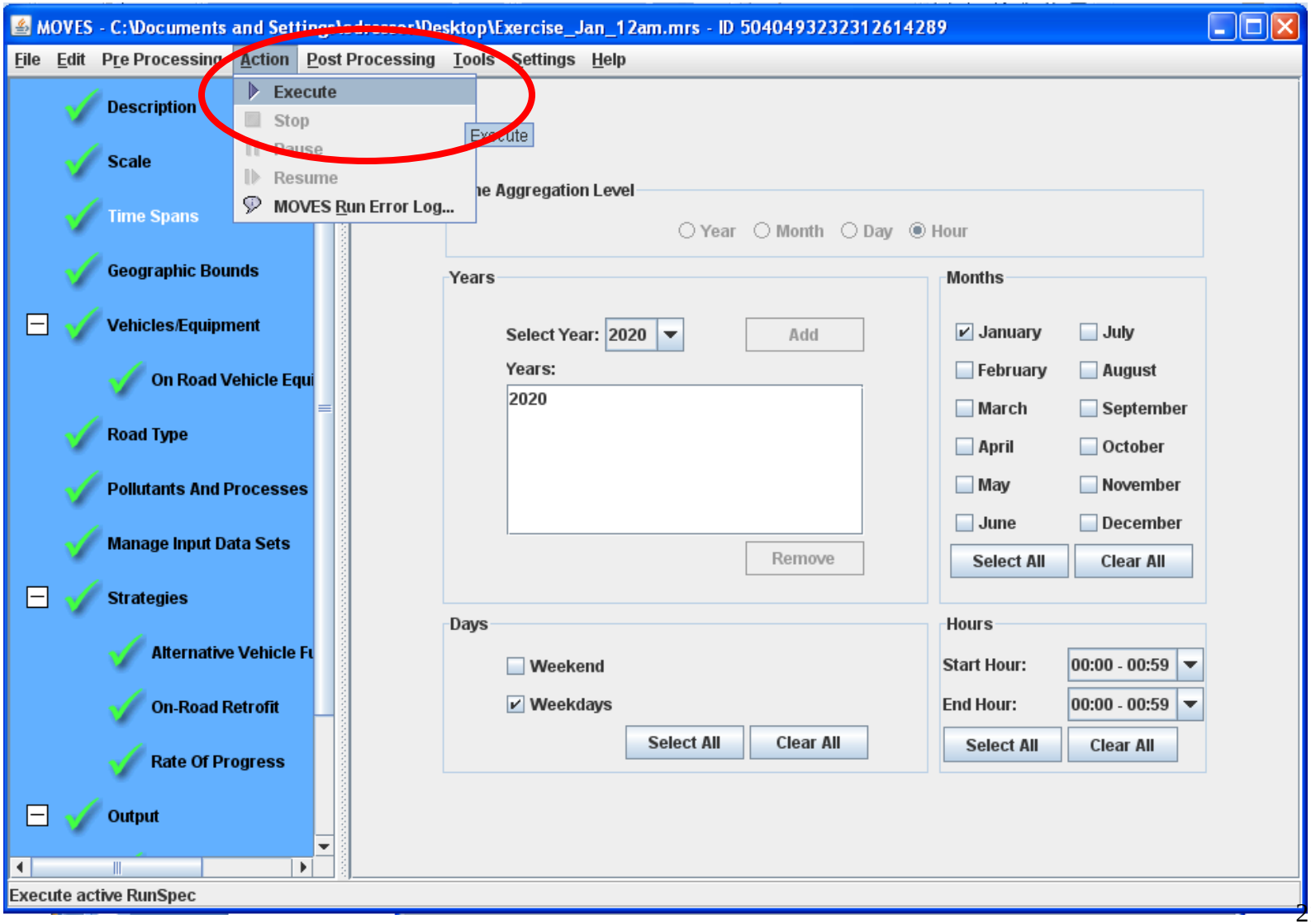


For transit buses (sourcetype 42), all model years – a fraction of 1 is entered for diesel fuel (fuel type 2 in column C) and all other fuel types are deleted

All Files Imported



Execute Jan 12 a.m. RunSpec

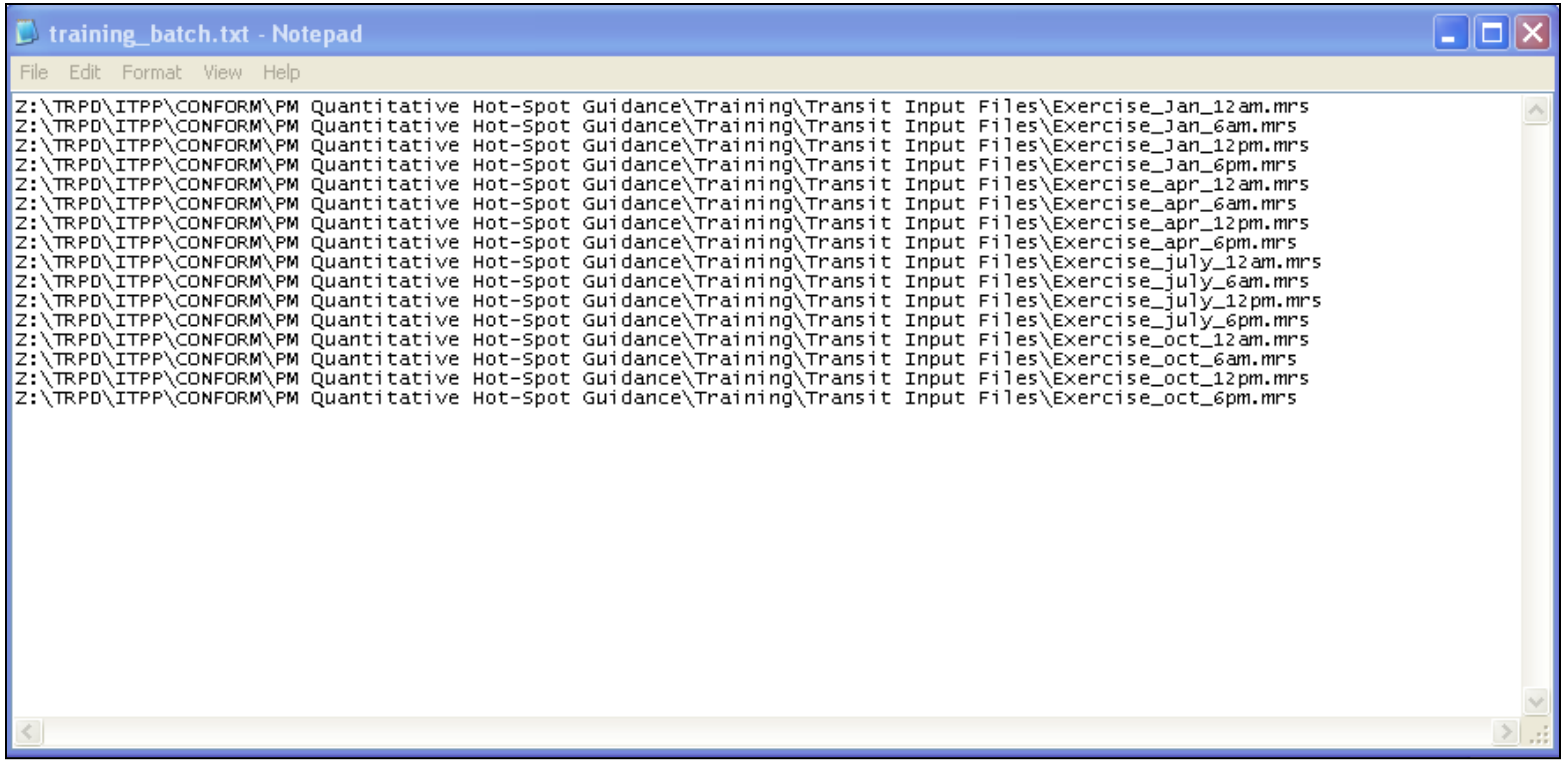


Completing the MOVES Analysis

- All 16 Runs are created through the same steps:
  1. RunSpec created (use same RunSpec saved under new name)
     - Only month and hour will vary
     - Should have same output database (Transit_Exercise_Out)
  2. Input files imported
     - Meteorology and Link (off-peak vs. peak) will vary by hour
     - Fuels will vary by quarter
  3. MOVES executed

Optional: Using a Batch File to Automate the Runs – Step 1

Once all RunSpecs are created and Input Databases are populated… user can create batch text file listing location of each RunSpec



Optional: Using a Batch File to Automate the Runs – Step 2

- Navigate to MOVES folder in Command Prompt, such as C:\EPA\MOVES\MOVESGHGSOURCE\
- Type

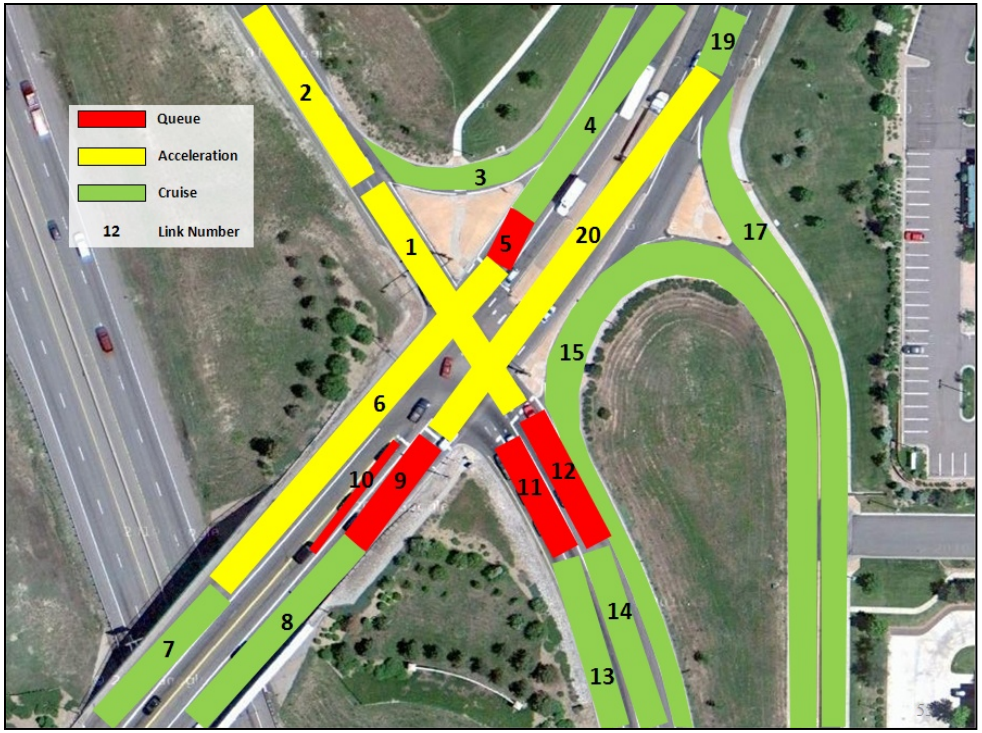
  setenv.bat
- Hit return
- Then type

  java -Xmx300m gov.epa.otaq.moves.master.commandline.MOVESCommandLine -rl "C:\Documents and Settings\cdresser\Desktop\training.batch.txt“

Note: replace file name above “C:\Documents and Settings\cdresser\Desktop\training.batch.txt” with the location of your batch text file

MOVES will execute all 16 RunSpecs and place the results in the output database “Transit_Exercise_Out”

How Do I Develop Traffic Data for MOVES?



General Tips for Developing Traffic Data

- Develop traffic data by using appropriate methods based on best practices
  - » Some resources are available through FHWA's Travel Model Improvement Program (TMIP)
  - » Methodologies for computing intersection control delay provided in the Highway Capacity Manual (HCM) 2010
  - » Coordinate early with traffic analysts to use and/or adjust existing data for PM hot-spot analyses

- Project sponsor should document traffic data sets, their sources, key assumptions, and methods used to develop build/no-build scenario inputs

Note: The following slides include approaches for dividing up links based on best practices, but there may be other best practice approaches

Guidance Reference:

Section 4.2.1

Developing Traffic Data for MOVES Highway Links

Tips for Highway Links

1. Use Network Schematic

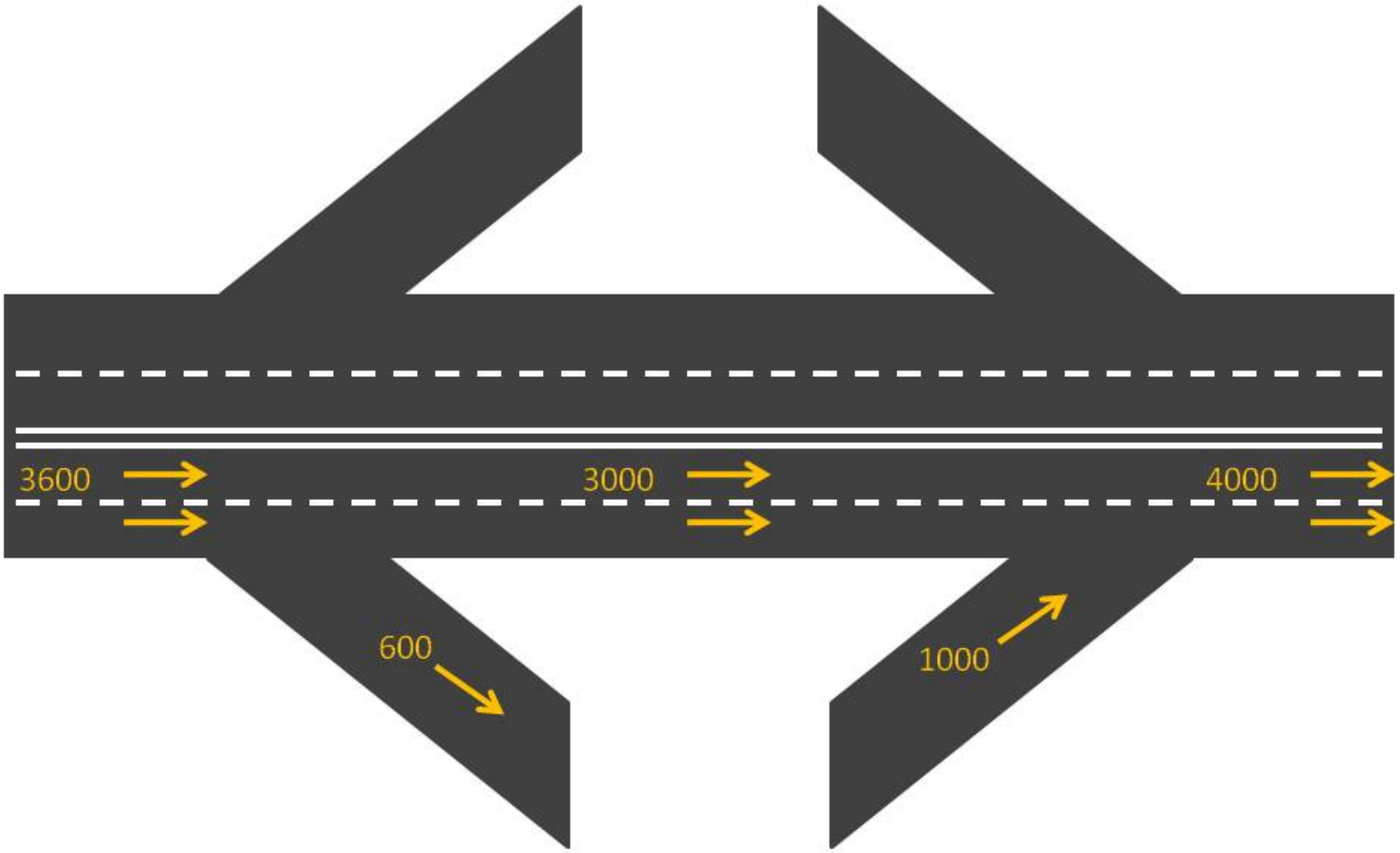
- Shows volumes and number of lanes
  - » May be consolidated with arterial network
- Volumes at each interchange should be balanced
  - » Consider other changes, such as vehicle mix (e.g., major freight terminal at interchange)

Tips for Highway Links

2. Define Distinct Links

- Use points with changes in volume
  - » For example, at ramps, have three (or more) links
    - – Freeway before
    - – Freeway after
    - – Ramp
- Segments with different characteristics
  - » E.g., high occupancy vehicle (HOV) or bus lane
- Segments with different operations
  - » Ramp may have portion with speed changes and portion with steady speed, or lane additions, or drops

Example: Highway Links



Tips for Highway Links

3. Define Cruise Links

- Such links would occur on the freeway
- Speeds will vary with changes in volumes
- When average speed option is used:
  - » Average speed equal to cruise speed
  - » Simplifying assumptions in this approach:
    - – No restrictions on cruise (e.g., capacity)
    - – Limited vehicle interference by vehicle type

Tips for Highway Links

4. Define Ramp Links

- Use vehicle activity options discussed later for acceleration and deceleration links
  - » Estimate distance and average speed
    - – Distance of link will typically be based on geometry of ramp (Might not begin or end at stopped condition)
    - – Operations might vary along length of ramp (e.g. deceleration, then cruise, then acceleration)
  - » Might use link drive schedule for typical ramp operations

Highway Links from Example Analysis

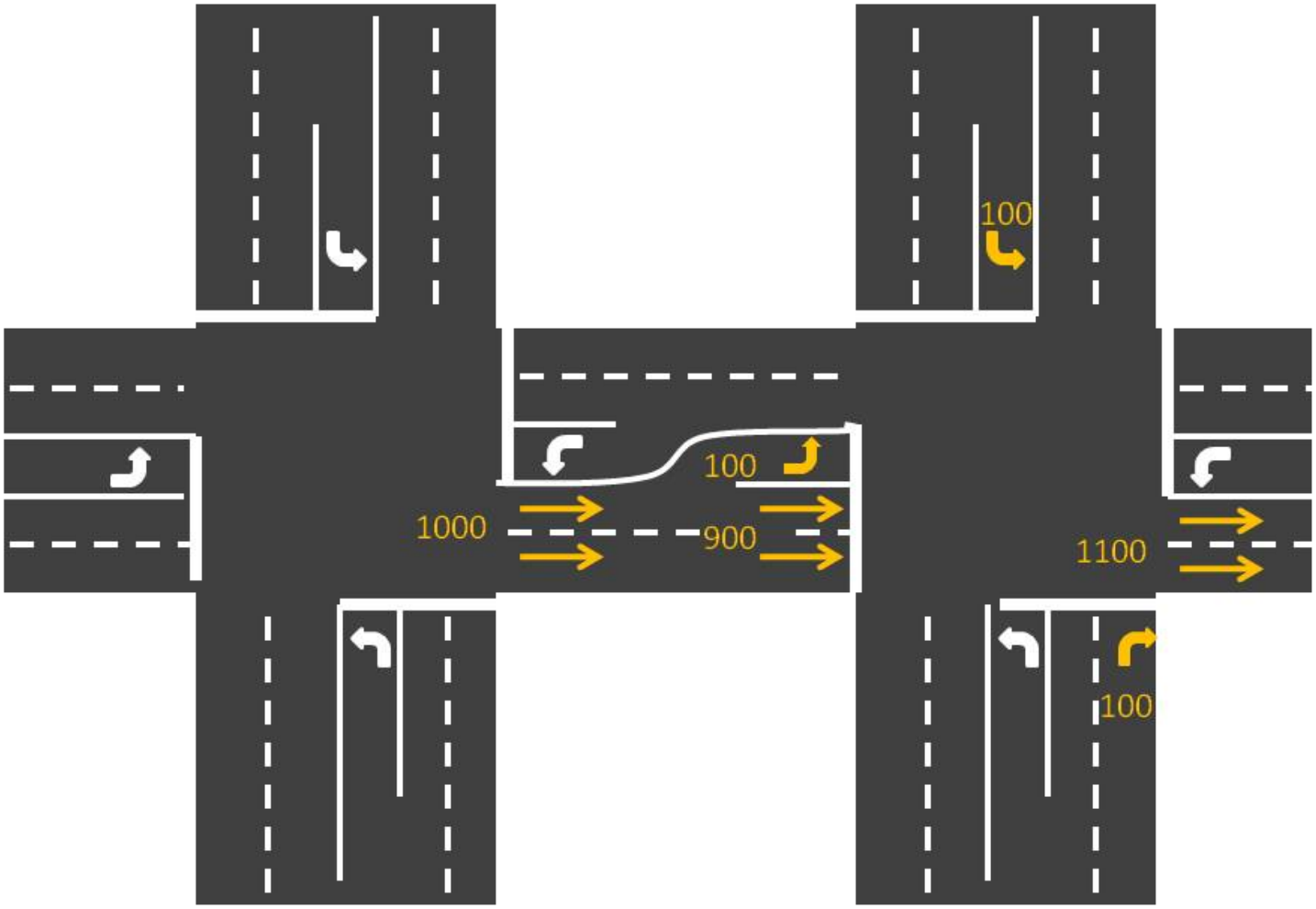
Developing Traffic Data for MOVES Intersection Links

Tips for Intersection Links

1. Turn Movement Schematic

- Intersection approach volumes
  - » How many vehicles for each movement
- Intersection departure volumes
  - » How many vehicles from each approach
- Need for all intersections, all time periods analyzed

Example: Intersection Links



Tips for Intersection Links

2. Traffic Analysis (Operational Details)

- Define the network in segments for:
  - » Queue (includes deceleration, cruise, and idle)
  - » Cruise
  - » Acceleration

- For each link, determine:
  - » Link Length
  - » Average Speed
  - » Road Grade

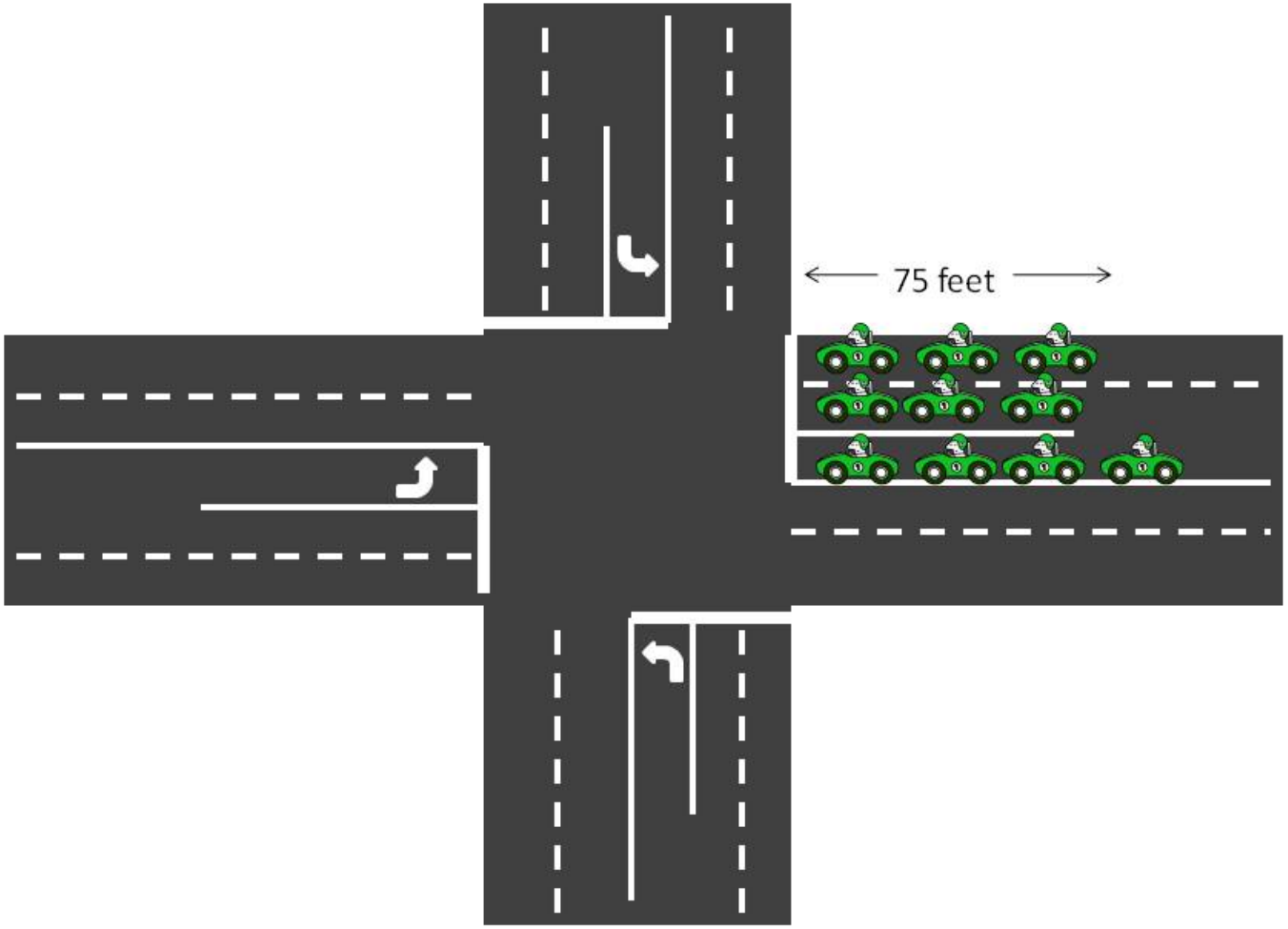
Note: This approach for dividing up links is only one possible option when using the average speed activity option in MOVES. Using other approaches with the average speed option, or using other activity options (such as link drive schedule) may require a different definition of links.

Tips for Intersection Links

3. Define Queue Links

- Assume the queue begins at stop bar
  - » Builds backward from there
- Average speed = distance / total time;
  - » Speed should account for both idling (red-light) and cruise (green-light)
- For side-by-side queues:
  - » If similar length, create one approach
  - » If different, create two approaches

Example: Intersection Links



Tips for Intersection Links

4. Define Acceleration Links

- Assume the acceleration begins at stop bar
  - » Builds forward from there

- Calculate the length of the link from:

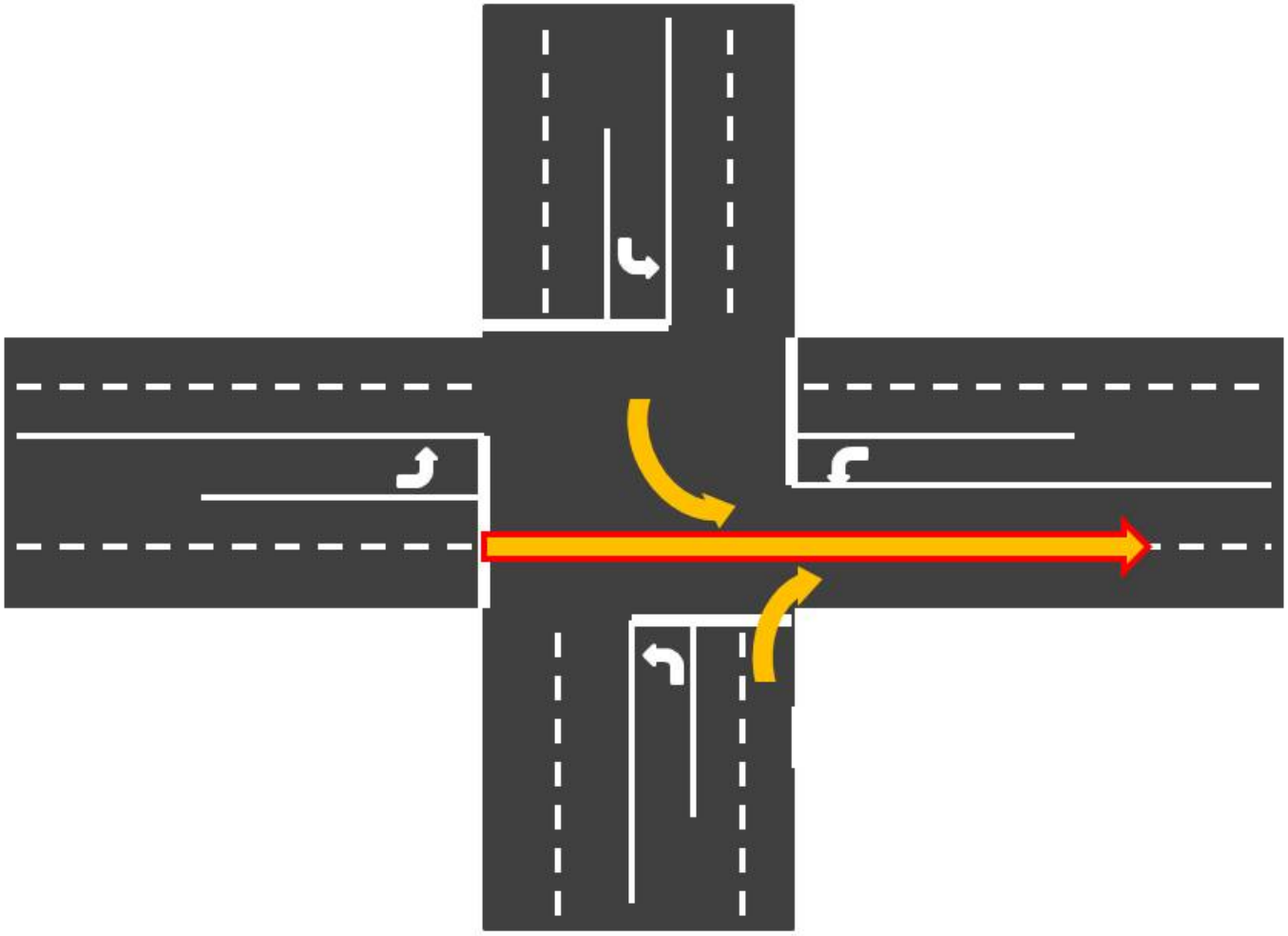
$$d = v_o * t + 0.5 * a * t^2$$

$$t = (v_i - v_o) / a$$

- Average speed = distance / total time;
  - » Speed should account for cruise (green-light) and acceleration from a stop (red-light)

Note: Add related turning movement volumes to through movement for departure volume

Example: Intersection Links

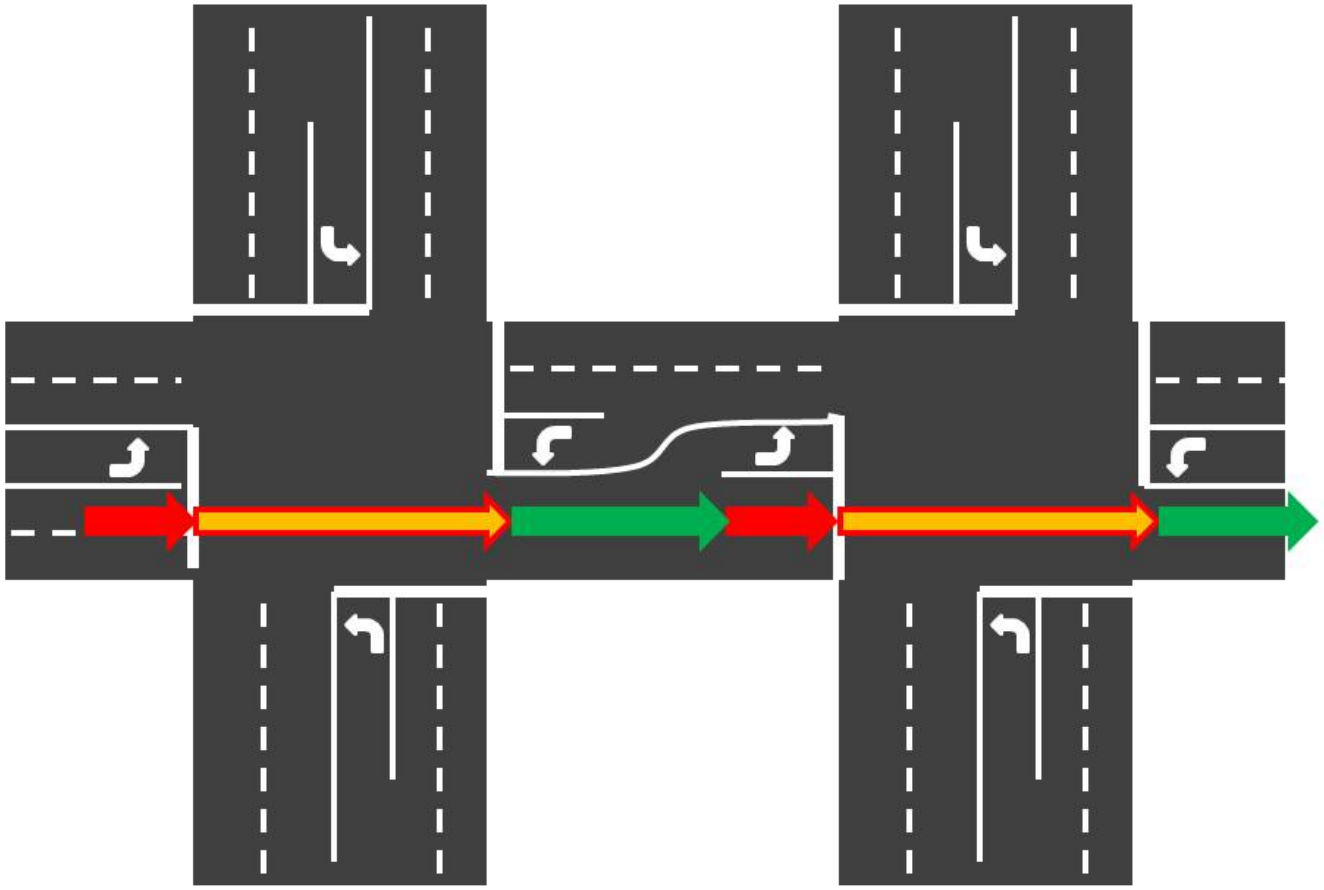


Tips for Intersection Links

5. Define Cruise Links

- Length from end of acceleration link to the back end of the next queue link
- Average speed is equal to cruise speed
- Simplifying assumptions in this approach:
  - » No restrictions on cruise (e.g., capacity)
  - » Uniform acceleration
  - » Limited vehicle interference by vehicle type

Example: Intersection Links



Queue Link

Accel Link

Cruise Link

Tips for Intersection Links

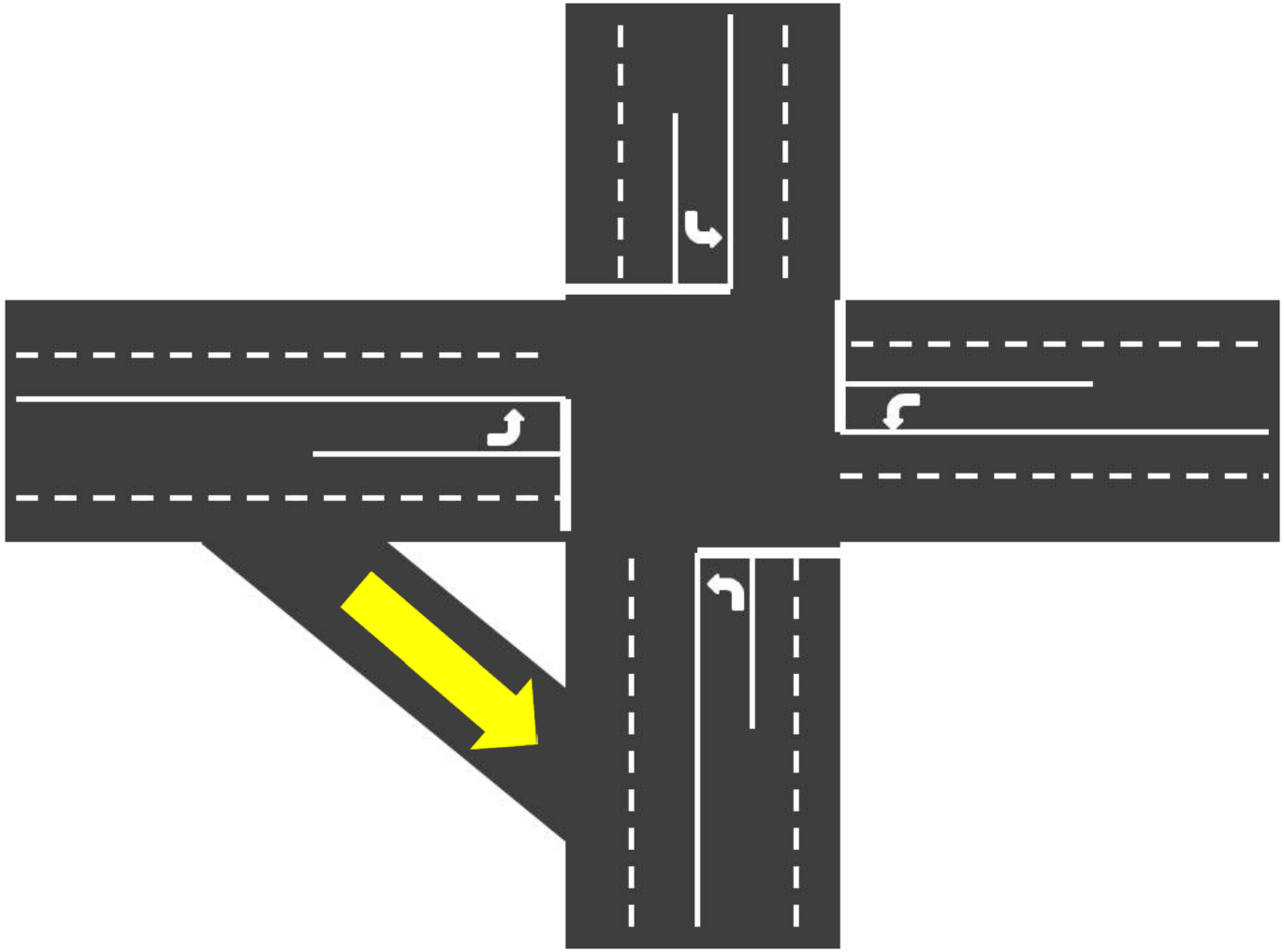
6. Define Special Links

- Some roadway segments may differ from these generalized link categories

- For example, channelized right turn may have deceleration into turn, and acceleration out of it
  - » Simplifying assumption: treat as cruise link but use a lower speed

- Need to evaluate what is reasonable approach

Example: Intersection Links



End of Module 2

Questions?