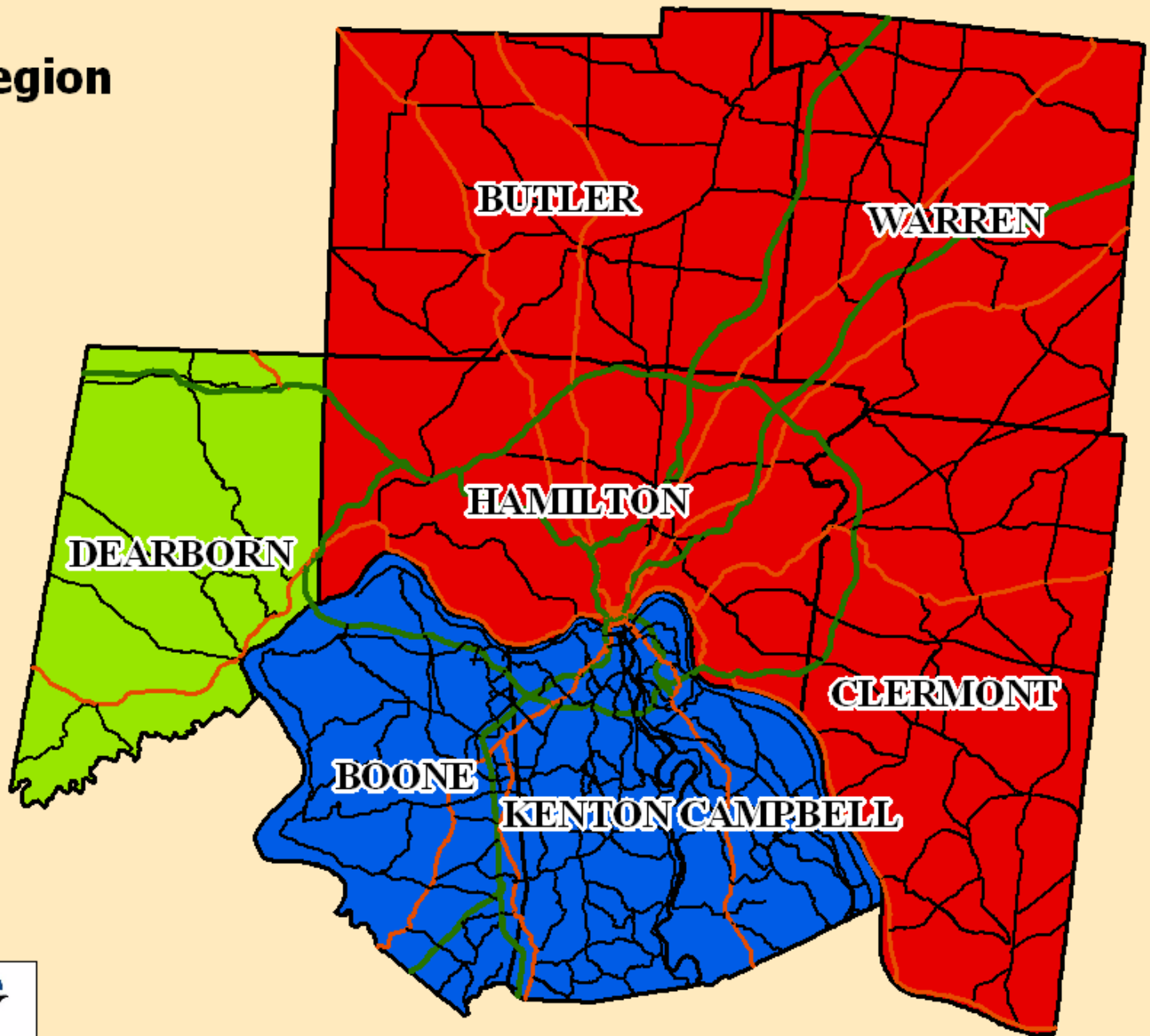


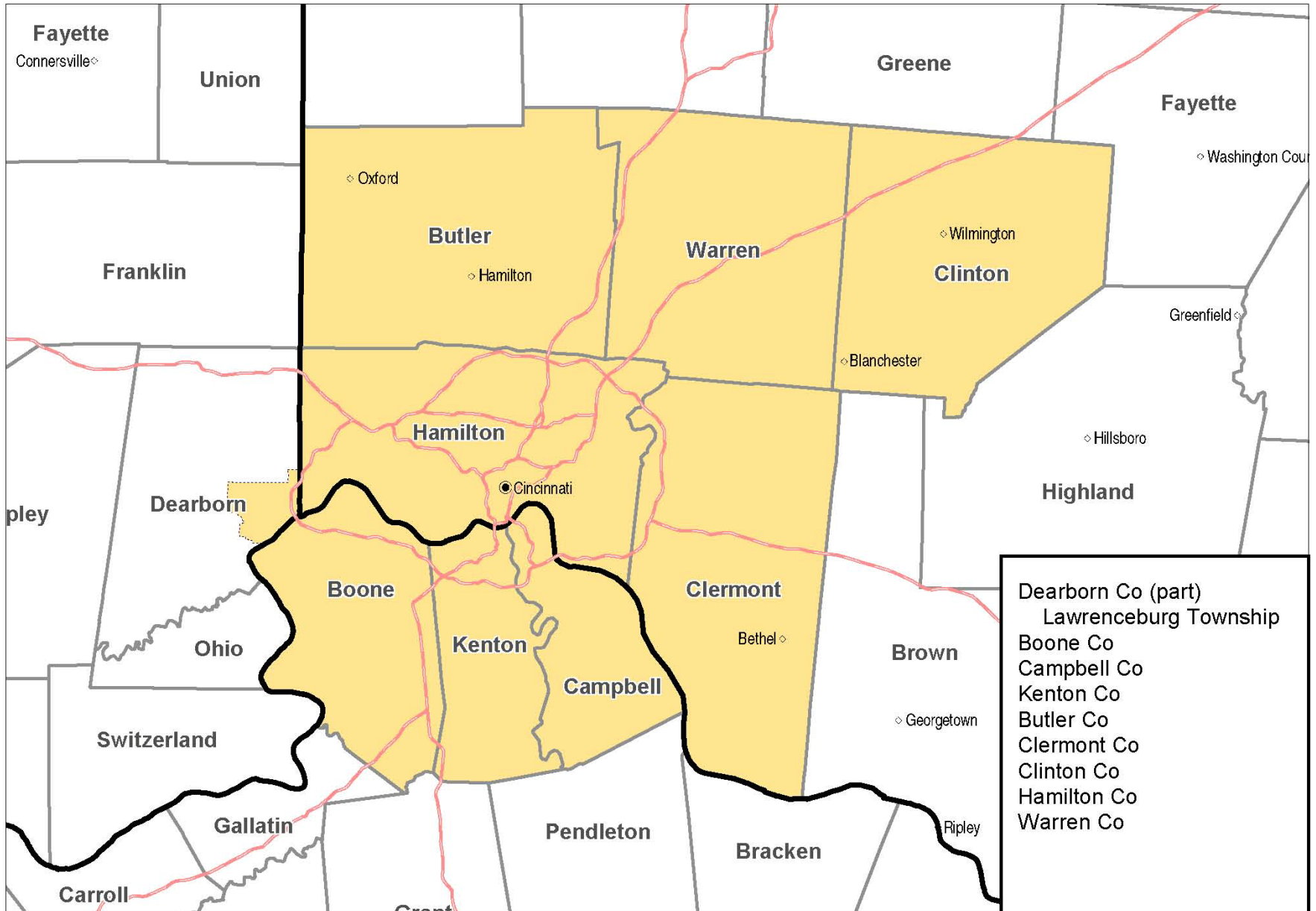
MOVES Post-Processing

Indiana MPO Conference
September 15, 2010

OKI Region



Cincinnati-Hamilton, OH-KY-IN 8-hour Ozone Nonattainment Area



Boundaries and locations are for illustrative purposes only. This is not a regulatory document.

Advantage of Using Rates

- Use same rates across multiple counties
- Adjust only transportation system inputs (new travel model run)
 - VMT, Average speed, Road type
- Rerun MOVES on standard cycle (i.e. every 4 years) or when new analysis year required
- Use rates for project level analysis
- Disadvantage – data overload!

Emission Rate Tables

- **Rate per Distance**
 - Running exhaust, brakewear, tirewear
 - Grams per mile (unit setting in runspec)
 - Rate for each hour, source (vehicle) type, road type, speed bin, pollutant and process
- **Rate per Vehicle**
 - Start and idle exhaust
 - Grams per vehicle population
 - Rate for each hour, vehicle type, pollutant and process
- **Rate per Profile**
 - Evaporative emissions when vehicles are stationary (VOC's and hydrocarbons only)
 - Grams per vehicle population
 - Rate for each hour, vehicle type, pollutant and process

Using Rate Tables

- MOVES native format is SQL
- Use MS Access, SQL Query browser or other database
- Access advantages
 - Widely available
 - Easily imports/exports to excel
 - Don't need to learn SQL commands (although helpful)
 - Import SQL tables directly with ODBC connection

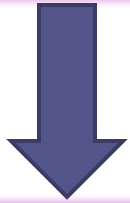
PM2.5 SIP Revision for Cincinnati Nonattainment Area

- **PM2.5 Annual Standard Redesignation**
- **Opted for MOVES to avoid future conformity problem (MOVES conformity vs. MOBILE budget)**
- **2 separate budgets (KY, OH/IN combined)**
- **Annual PM2.5, SO₂, NO_x**
- **Analysis Years = 2005, 2008, 2011, 2015, 2018, 2021.**
- **2015 and 2021 to become new budget years**
- **MOVES portion submitted to states Aug. 2010**

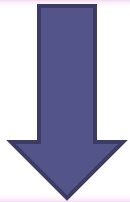
Cincinnati PM2.5 SIP Inventory

- 24 rate tables for PM2.5 SIP: 2 domains, 6 analysis years, 2 types of rates (distance and vehicle, no evaporative)
- Run union query (append) for each rate type
- Sum rates for all processes within pollutant type
 - Result - 1 rate per distance table and 1 rate per vehicle table
- rateperdistance table = 2.4 m records,
ratepervehicle table = 20k records

05rateperdistance
08rateperdistance
11rateperdistance
15rateperdistance
18rateperdistance
21rateperdistance



Union Query



Sum processes
within pollutant
and make 1
rateperdistance
table

05ratepervehicle
08ratepervehicle
11ratepervehicle
15ratepervehicle
18ratepervehicle
21ratepervehicle



Union Query



Sum processes
within pollutant
and make 1
ratepervehicle
table

Distance-Based Emissions : Create VMT Table

- **Table of VMT by state (domain) and analysis year; from OKI Travel Demand Model**
 - **daily, summer, annual**
- **Distribute VMT by hour, vehicle type, road type and speed bin.**

VMT Distribution	Source
Hourly	24-hour traffic counts. By road type
Road type (5 types)	Travel Demand Model – By state, year, sourcetype. Identical distribution for all vehicle types except default for combination trucks. Off-network (roadtype 1 = 0)
Average Speed (16 bins)	Travel Demand Model – By state, year, road type, hour
Vehicle (source) type (13 types)	MOVES default national run for representative county. Source type VMT/Total VMT.

Calculate Distance-based Emissions

- **Design Access Query**
 - join fields from Distributed VMT table and rateperdistance table to get matching rates
 - Join on state, year, hour, vehicle type, road type and speed bin fields.
- **Sum emissions by budget area, year, hour, and vehicle type**

Calculate Distance Based Emissions

VMT Table

Make Distributed VMT Table Query: * vehicle type fraction *
hour fraction * road type fraction * speed bin fraction

Distributed VMT Table

Emissions Query: Distributed VMT * matching emissions
rate from rateperdistance table

Sum Emissions by budget area,
year, hour, and vehicle type

Vehicle-based Emissions

- Table of vehicle population by state, year
- Access Query: Join to ratepervehicle table
 - Join on state, year, hour, vehicle type
 - Multiply by vehicle type population fraction and matching emission rate
 - MOVES builds the start fraction into the rates

Calculate Vehicle Based Emissions

Vehicle Population Table



```
graph TD; A[Vehicle Population Table] --> B["Emissions Query: Vehicle Population by budget area/year * vehicle type fraction * matching emissions rate from ratepervehicle table"]
```

Emissions Query: Vehicle Population by budget area/year * vehicle type fraction * matching emissions rate from ratepervehicle table

Generate Emissions Report

- **Access query: Sum distance emissions and vehicle emissions, convert to tons**
- **Access report: Group by budget area, year and pollutant**

Table 1. Mobile Source Emissions for the Cincinnati PM2.5 Nonattainment Area (tons)

Year	Pollutant Name	DailyEmissions	AnnualEmissions
Kentucky Portion of NA Area			
2005	Vehicle Population: 364,081	Daily VMT: 9,621,110	Annual VMT: 3,289,109,202
	Oxides of Nitrogen	39.10	13,496.54
	Primary Exhaust PM2.5 - Total	1.36	466.23
	Primary PM2.5 - Brakewear Particulate	0.16	54.04
	Primary PM2.5 - Tirewear Particulate	0.05	17.52
	Sulfur Dioxide (SO2)	0.12	41.46
2008	Vehicle Population: 375,873	Daily VMT: 9,991,179	Annual VMT: 3,425,339,505
	Oxides of Nitrogen	37.91	13,114.20
	Primary Exhaust PM2.5 - Total	1.64	562.84
	Primary PM2.5 - Brakewear Particulate	0.18	62.10
	Primary PM2.5 - Tirewear Particulate	0.06	20.70
	Sulfur Dioxide (SO2)	0.12	42.74
2011	Vehicle Population: 381,911	Daily VMT: 10,490,143	Annual VMT: 3,587,796,186
	Oxides of Nitrogen	29.33	10,141.52
	Primary Exhaust PM2.5 - Total	1.19	407.74
	Primary PM2.5 - Brakewear Particulate	0.20	68.38
	Primary PM2.5 - Tirewear Particulate	0.07	22.68
	Sulfur Dioxide (SO2)	0.13	45.36
2015	Vehicle Population: 394,278	Daily VMT: 11,495,496	Annual VMT: 3,931,385,741
	Oxides of Nitrogen	20.18	6,996.21
	Primary Exhaust PM2.5 - Total	0.78	267.30
	Primary PM2.5 - Brakewear Particulate	0.23	77.94
	Primary PM2.5 - Tirewear Particulate	0.08	25.88
	Sulfur Dioxide (SO2)	0.15	50.50
2018	Vehicle Population: 403,817	Daily VMT: 12,173,549	Annual VMT: 4,163,203,435
	Oxides of Nitrogen	15.78	5,480.81
	Primary Exhaust PM2.5 - Total	0.59	202.15
	Primary PM2.5 - Brakewear Particulate	0.27	91.15
	Primary PM2.5 - Tirewear Particulate	0.09	30.09
	Sulfur Dioxide (SO2)	0.16	56.28
2021	Vehicle Population: 413,587	Daily VMT: 12,534,236	Annual VMT: 4,286,834,360
	Oxides of Nitrogen	12.75	4,435.96
	Primary Exhaust PM2.5 - Total	0.43	146.79
	Primary PM2.5 - Brakewear Particulate	0.28	96.84
	Primary PM2.5 - Tirewear Particulate	0.09	31.74
	Sulfur Dioxide (SO2)	0.17	58.63

Ohio/Indiana Portion of NA Area

2005 Vehicle Population: 1,754,582 Daily VMT: 39,564,030 Annual VMT: 13,541,324,003

Oxides of Nitrogen	168.89	58,423.36
Primary Exhaust PM2.5 - Total	5.74	1,979.63
Primary PM2.5 - Brakewear Particulate	0.65	223.20
Primary PM2.5 - Tirewear Particulate	0.20	69.67
Sulfur Dioxide (SO2)	0.48	165.35

2008 Vehicle Population: 1,811,406 Daily VMT: 40,858,751 Annual VMT: 14,015,754,874

Oxides of Nitrogen	148.02	51,357.02
Primary Exhaust PM2.5 - Total	4.85	1,675.04
Primary PM2.5 - Brakewear Particulate	0.80	273.84
Primary PM2.5 - Tirewear Particulate	0.25	85.37
Sulfur Dioxide (SO2)	0.54	185.13

2011 Vehicle Population: 1,840,505 Daily VMT: 42,044,841 Annual VMT: 14,383,526,419

Oxides of Nitrogen	135.95	47,061.53
Primary Exhaust PM2.5 - Total	5.54	1,904.61
Primary PM2.5 - Brakewear Particulate	0.85	290.00
Primary PM2.5 - Tirewear Particulate	0.27	91.52
Sulfur Dioxide (SO2)	0.53	182.01

2015 Vehicle Population: 1,900,111 Daily VMT: 43,316,281 Annual VMT: 14,830,453,053

Oxides of Nitrogen	89.45	31,064.21
Primary Exhaust PM2.5 - Total	3.57	1,227.86
Primary PM2.5 - Brakewear Particulate	0.82	280.25
Primary PM2.5 - Tirewear Particulate	0.26	90.54
Sulfur Dioxide (SO2)	0.53	182.69

2018 Vehicle Population: 1,946,080 Daily VMT: 45,314,292 Annual VMT: 15,513,701,656

Oxides of Nitrogen	70.34	24,451.43
Primary Exhaust PM2.5 - Total	2.78	958.57
Primary PM2.5 - Brakewear Particulate	0.90	307.39
Primary PM2.5 - Tirewear Particulate	0.29	99.03
Sulfur Dioxide (SO2)	0.57	195.09

2021 Vehicle Population: 1,993,161 Daily VMT: 46,689,707 Annual VMT: 15,521,916,278

Oxides of Nitrogen	55.50	18,911.05
Primary Exhaust PM2.5 - Total	2.10	705.30
Primary PM2.5 - Brakewear Particulate	0.96	320.17
Primary PM2.5 - Tirewear Particulate	0.31	102.89
Sulfur Dioxide (SO2)	0.60	199.14

Lessons

- Watch out for multiple runs stored in MOVES rate tables; Only use max RunID #.
- Improve processing speed. When distributing VMT, remove records where $VMT = 0$ (i.e. any fraction = 0)
- Include calculated VMT and vehicle type population in report – should match original.

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