Technical Memorandum
Northeast Ohio (AMATS, NOACA, Ashtabula)
2008 8-hr Ozone NAAQS
SIP Inventory
Mobile Source Emissions (VOC and NOx)

February 2016

By AMATS, NOACA and ODOT

In Coordination with the Ohio Environmental Protection Agency

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1. Overview

This memorandum is intended to document the USEPA MOVES based mobile source air quality analyses performed by the Ohio Department of Transportation (ODOT) for the Akron Metropolitan Area Transportation Study (AMATS) and Ashtabula county areas, and by ODOT and the the Northeast Ohio Areawide Coordinating Agency for the counties of Cuyahoga, Geauga, Lake, Lorain and Medina in its area. These analyses were conducted in support of Ohio EPA's intent to submit a redesignation request and maintenance State Implementation Plan (SIP) 2008 8-hr Ozone NAAQS.

The designated maintenance area in northeast Ohio for the 2008 8-hr Ozone NAAQS includes the counties of Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit; and Ashtabula.

The inventories include county based, annual totals of Volatile Organic Compounds (VOC's) and Oxides of Nitrogen (NO_X) for the years 2011, 2014, 2020, and 2030.

Latest Planning Assumptions

These ozone inventory runs meet the latest planning assumption requirement as the area remains under the grace period for using MOVES2010 in lieu of MOVES2014. As discussed in Section 2 of this report, the travel forecast modeling processes used to develop vehicle miles of travel (VMT) for the AMATS and NOACA areas is calibrated using the latest population and land use data available and are validated using corresponding traffic count data. Currently, the travel demand models are validated to year 2005.

U.S. EPA's MOVES2010a is used for all mobile source emission analyses with MOVES input and output needs being established at various interagency consultation meetings and e-mails in January 2016 (See **Appendix A**). It was also established that annual emission estimates would be based on a single-season approach. The emissions estimates are expressed in tons per day.

Finally, the regional emissions analysis includes emissions for Volatile Organic Compounds (VOCs), and Oxides of Nitrogen (NO_X).

On Road Mobile Source Emissions Inventory Summary

Tables 1 to 4 present a summary of emissions by county as well as the entire maintenance area for VOCs, and NOx for calendar years 2011, 2014, 2020, and 2030. They also include annual VMT totals. The remainder of this document focuses on the assumptions behind the analyses.

Table 1 – Northeast Ohio On-Road Mobile Source Emissions

2011			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Annual VMT**
Ashtabula	2.882	6.347	1,151,284,460
Cuyahoga	27.0357	50.7256	10,360,221,320
Geauga	4.7616	7.4586	934,179,175
Lake	5.9439	11.9748	2,113,224,440
Lorain	7.804	14.1127	2,543,628,790
Medina	5.4096	14.5906	2,251,931,740
Portage	4.479	9.957	1,875,030,185
Summit	13.607	29.192	5,804,227,445
TOTAL	**71.9228**	**144.3583**	**27,033,727,555**

Table 2 – Northeast Ohio On-Road Mobile Source Emissions

2014			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Annual VMT**
Ashtabula	2.089	4.216	1,179,937,325
Cuyahoga	17.8405	31.7193	10,390,750,650
Geauga	2.0266	3.7346	967,442,355
Lake	4.2963	8.0452	2,160,408,355
Lorain	5.6908	10.2934	2,603,862,550
Medina	3.9525	10.3258	2,325,138,330
Portage	3.384	6.774	1,923,587,960
Summit	10.074	19.451	5,974,651,785
TOTAL	**49.3537**	**94.5593**	**27,525,779,310**

Table 3 – Northeast Ohio On-Road Mobile Source Emissions

2020			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Annual VMT**
Ashtabula	1.384	2.282	1,240,812,755
Cuyahoga	12.1821	17.6512	10,363,284,400
Geauga	1.4463	2.1987	992,075,110
Lake	2.85	4.7055	2,201,333,250
Lorain	3.7867	5.7605	2,641,533,105
Medina	2.7786	5.8476	2,441,471,495
Portage	2.388	3.931	2,147,158,490
Summit	6.958	11.153	6,459,328,715
TOTAL	**33.77**	**53.52**	**28,486,997,320**

Table 4 – Northeast Ohio On-Road Mobile Source Emissions

2030 Maintenance			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Annual VMT**
Ashtabula	1.061	1.563	1,317,124,035
Cuyahoga	9.3709	12.01	10,488,856,080
Geauga	1.1096	1.5927	1,065,782,115
Lake	2.1542	3.2489	2,343,033,550
Lorain	2.8572	3.8609	2,806,675,895
Medina	2.2225	4.3048	2,657,765,020
Portage	1.996	2.900	2,321,683,605
Summit	6.014	8.618	6,888,537,325
TOTAL	**26.78**	**38.10**	**29,889,457,625**

2. Urban Travel Demand Models

NOACA maintains a PC-based regional travel demand forecasting model on the Citilabs CUBE platform for use in its urban transportation planning process. This model employs the traditional four step modeling process to project existing and future traffic volumes and travel patterns on the regional transportation networks. The four step process consists of trip generation, trip distribution, mode split, and route assignment. Output from the model is link-by-link directional volumes for four time periods: AM peak, Midday, PM peak, and Night and is added together to create 24-hour traffic volumes for the existing or future regional transportation networks. ODOT ran NOACA's model for this effort.

The Ohio Department of Transportation (ODOT) holds the transportation model for the AMATS area. AMATS prepares and submits networks for its planning area to ODOT. ODOT prepares networks for Ashtabula County. ODOT's modeling is also run on a PC-based CUBE platform.

These models are uniquely suited to perform emission analyses. The modeling process identifies growth in vehicle miles of travel and changes in regional travel patterns resulting from the projects that are proposed in these areas' transportation plans and programs.

Landuse and Socio-economic Data

The areas' socio-economic model variables reflect the current and expected future regional land uses as best known to staff.

Socio-economic variables were developed for all areas based on 2000 Census data and 2030 county-level Ohio Department of Development population projections. Minor adjustments to 2005 data have been made in an effort to have this data correspond to 2005 estimates released by the US Census Bureau.

Until new 2010 Census based projections are developed by the Ohio Department of Development (ODOD), the current data represents the best available for this effort.

3. Emission Factor Generation

Using MOVES, emission factor files were generated for 2011, 2014, 2020, and 2030. Assumptions for these runs include an I/M program in all but Ashtabula Township. Programs and corresponding MOVES parameters were developed in consultation with OEPA.

Technical Details

Table 5 summarizes the settings used in the MOVES run specification file and the MOVES County-Data Manager. All inputs for the region's analyses are included in the CD provided to Ohio EPA as part of this document submittal. Further information about specific inputs that are not using default values is also discussed below.

Table 5 – MOVES Inputs

RunSpec Parameter Settings	
MOVES Version	2010/08/26
Scale	County
MOVES Modeling Technique	Emission Factor Method Rates per Distance Rates per Vehicle
Time Span	Time Aggregation: Hour 1 Month representing average annual temperatures All hours of day selected 16 speed bins Weekdays only
Geographic Bounds	Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage and Summit Counties
Vehicles/Equipment	All related source types, gasoline and diesel; CNG-Transit Buses for base year 2002 & attainment year 2006
Road Type	All road types including off-network
Pollutants and Processes	Total Gaseous Hydrocarbons, Non-Methane Hydrocarbons, Volitile Organic Compounds, NO_x
Strategies	Alternative Vehicle Fuels and Technologies for interim year 2012, and maintenance year 2020 to offset impact of CNG
General Output	Units = grams, joules and miles
Output Emissions	Time = hour, Location =county, on-road emission rates by road type and source use type.
Advance Performance	None
County Data Manager Sources	
Source Type Population	Combination of local and default data Local BMV Vehicle Registration Total Local BMV population for motorcycle (11), moped (11), bus (41, 42,43), mobile home (54), house vehicle (54) MOVES default fractions for the rest (21,31,32,51,52,53,61,62)

	Future year growth rate based on TFM's household growth rates.
Vehicle Type VMT	Travel Demand Forecast Model's daily VMT EPA annual VMT converter Hourly VMT fractions - ODOT Hourly Percentage
I/M Program	I/M program information supplied by Ohio EPA
Fuel Formulation	Default
Fuel Supply	Default
Metereology Data	Local data obtained from NOAA National Climatic Data Center. Data will consist of monthly high and low temperatures and daily relative humidity for 2006.
Ramp Fraction	Travel Demand Forecast Model
Road Type Distribution	ODOT's 2006 DVMT by FC
Age Distribution	Local data ODOT from 2009 motor vehicle registration The same age distribution will be used for all analysis years
Average Speed Distribution	Default as a place holder
Zone Activity	Default with necessary modification as prescribed in MOVES userguide.

Temperature and Relative Humidity

Temperatures used for the single season approach are representative of 12 months in 2006 based on NOAA data from the National Climate Data Center website. The month of July was used as the representative month. Data for Cleveland Hopkins International Airport (CLE) was used for NOACA's area. Data for Akron-Canton Airport (CAK) was used for AMATS and Ashtabula Areas. To get the correct fomat for MOVES, the data was entered into a spreadsheet provided by EPA which was designed to convert Mobile6 data to MOVES. The average annual hourly temperature and relative humidity distribution profile for Cuyahoga, Lake, Lorain, and Medina Counties can be seen in Table 6a. Table 6b portrays the data for Portage and Summit Counties; and Ashtabula.

Table 6a – Temperature and Relative Humidity Data for NOACA portion of area

Hour	Average Temperature	Average Relative Humidity
1	71.0	77.0
2	70.0	79.0
3	69.0	81.0
4	68.0	82.0
5	68.0	83.0
6	68.0	83.0
7	71.0	78.0
8	74.0	72.0
9	77.0	65.0
10	80.0	60.0
11	81.0	56.0
12	82.0	55.0
13	82.0	54.0
14	83.0	51.0
15	83.0	50.0
16	83.0	50.0
17	82.0	51.0
18	82.0	52.0
19	80.0	56.0
20	78.0	60.0
21	75.0	66.0
22	74.0	69.0
23	72.0	73.0
24	71.0	76.0

Table 6b – Temperature and Relative Humidity Data for AMATS portion of area

Hour	Average Temperature	Average Relative Humidity
1	44.90333333	76
2	43.77166667	78
3	42.8825	79
4	42.23583333	81
5	41.75083333	82
6	41.185	83
7	40.7	82
8	41.10416667	79
9	43.52916667	74
10	47.40916667	71
11	51.37	68
12	54.765	63
13	57.75583333	61
14	59.3725	58
15	59.93833333	56
16	60.1	55
17	59.69583333	57
18	58.56416667	60
19	56.62416667	65
20	54.11833333	69
21	51.6125	71
22	49.43	73
23	47.89416667	74

Ramp Fraction

Ramp fractions were derived using the base year travel demand model VHT fractions. Ramp fractions can be seen in Table 7. Base year fractions were kept the same for future years.

Table 7 – Ramp Fractions

County	roadTypeID	roadDesc	rampFraction
Ashtabula	2	Rural Restricted Access	0.010
	4	Urban Restricted Access	0.180
Cuyahoga	2	Rural Restricted Access	0
	4	Urban Restricted Access	0.116
Geauga	2	Rural Restricted Access	0.061
	4	Urban Restricted Access	0.061
Lake	2	Rural Restricted Access	0.092
	4	Urban Restricted Access	0.092
Lorain	2	Rural Restricted Access	0.107
	4	Urban Restricted Access	0.107
Medina	2	Rural Restricted Access	0.058
	4	Urban Restricted Access	0.058
Portage	2	Rural Restricted Access	0.010
	4	Urban Restricted Access	0.180
Summit	2	Rural Restricted Access	0.010
	4	Urban Restricted Access	0.009

Source Type Population

Source type population is based on a combination of local and MOVES default data. Local data was obtained from ODPS Bureau of Motor Vehicles Motor Vehicle Registrations by county and vehicle type. The MOVES default source type population data was obtained from the national level MOVES inventory runs for each county.

OBMV's vehicle registration data was used as a control total for all source type population and a sub total for Intercity Bus (41), Transit Bus (42), and School Bus (43). The same data was also used to assign source type population of Motorcycle (11) and Motor Home (54). For the rest of source types 21, 31, 32, 51, 52, 53, 61 and 62, the fraction of each source type from the MOVES default data was used and adjusted to match up the control total for source type population. Future year source type growth rate is based on travel demand model's annual household growth rate from year 2005 to year 2022 for corresponding analysis years. Table 8 shows source type population for the analyzed counties in 2006.

Table 8 – Sample Source Type Population for year 2006

sourceTypeID	sourceTypeName	Cuyahoga	Geauga	Lake	Lorain	Medina	Portage	Summit	Ashtabula
11	Motorcycle	25,638	3,931	8,082	10,893	7,097	7,194	16,874	3,645
21	Passenger Car	561,351	50,481	118,570	146,537	87,913	84,557	269,462	46,126
31	Passenger Truck	367,186	35,709	78,318	97,335	60,304	60,467	185,435	33,208
32	Light Commercial Truck	122,671	11,930	26,165	32,518	20,146	2,425	7,436	1,332
41	Intercity Bus	377	14	65	32	16	33	135	62
42	Transit Bus	208	8	36	17	9	17	71	33
43	School Bus	2,595	95	446	217	113	199	826	381
51	Refuse truck	307	47	72	91	72	64	150	37
52	Single Unit Short-haul Truck	17,525	2,669	4,094	5,177	4,114	2,664	6,179	1,516
53	Single Unit Long-haul Truck	1,894	288	442	559	445	340	789	193
54	Motor Home	4,916	1,385	2,100	4,399	2,628	2,549	4,687	177
61	Comb Short-haul Truck	3,781	496	1,058	1,098	1,358	1,289	2,229	727
62	Comb Long-haul Truck	4,073	535	1,139	1,182	1,463	1,483	2,564	836

I/M Program

I/M program information was supplied by Ohio EPA. The I/M program was applied to all analysis years for every geography with the exception of Ashtabula County. The I/M program MOVES inputs reflect:

1) ASM 2525 Phase-in Cutpoints, for model years up to 1995
2) Evaporative Gas Cap Check, for model years up to 1995
3) Evaporative System OBD Check, for model years 1996 & newer
4) Exhaust OBD Check, for model years 1996 & newer

The compliance rate and failure rates are obtained from Ohio EPA and compliance factors are calculated. These are applied to Cuyahoga, Geauga, Lake, Lorain, Medina, Portage & Summit counties and for all model years.

Vehicle Age Distribution

Vehicle age distribution information was derived using ODPS vehicle registration data (2009). The data was given to OEPA who supplied a VIN decoder that allowed ODOT to create correctly formatted MOVES inputs. A different age distribution file is used for each county. Table 9 provides a sample distribution for Cuyahoga County. The distributions for other areas can be found in the electronic input submittals. The same age distributions were used for all analysis years.

Table 9 – Sample Vehicle Age Distribution for Cuyahoga County

yearid	sourcetypeid	ageid	ageFraction
2006	11	30	0.106925
2006	11	29	0.018783
2006	11	28	0.026115
2006	11	27	0.014845
2006	11	26	0.011632
2006	11	25	0.01317
2006	11	24	0.014596
2006	11	23	0.00998
2006	11	22	0.007536
2006	11	21	0.009369
2006	11	20	0.009074
2006	11	19	0.008758
2006	11	18	0.010636
2006	11	17	0.013827
2006	11	16	0.017312
2006	11	15	0.021
2006	11	14	0.02272
2006	11	13	0.021951
2006	11	12	0.02582
2006	11	11	0.03761
2006	11	10	0.044965
2006	11	9	0.05413
2006	11	8	0.060081
2006	11	7	0.075515
2006	11	6	0.063725
2006	11	5	0.066418
2006	11	4	0.076963
2006	11	3	0.068658
2006	11	2	0.044852
2006	11	1	0.021362
2006	11	0	0.001675
2006	21	30	0.031927
2006	21	29	0.001002
2006	21	28	0.001082
2006	21	27	0.001608
2006	21	26	0.002483
2006	21	25	0.003053
2006	21	24	0.003691
2006	21	23	0.005082
2006	21	22	0.006714
2006	21	21	0.010246
2006	21	20	0.013223
2006	21	19	0.017294
2006	21	18	0.023152
2006	21	17	0.028475
2006	21	16	0.034352
2006	21	15	0.044328
2006	21	14	0.040195
2006	21	13	0.048119
2006	21	12	0.050547
2006	21	11	0.056333
2006	21	10	0.057401
2006	21	9	0.054497
2006	21	8	0.058427
2006	21	7	0.059745
2006	21	6	0.059884
2006	21	5	0.060329
2006	21	4	0.058016
2006	21	3	0.060513
2006	21	2	0.05262
2006	21	1	0.04119
2006	21	0	0.014472
2006	31	30	0.002999
2006	31	29	0.000209
2006	31	28	0.000285
2006	31	27	0.000524
2006	31	26	0.000797
2006	31	25	0.001189
2006	31	24	0.001723
2006	31	23	0.002477
2006	31	22	0.003177
2006	31	21	0.00491
2006	31	20	0.006233
2006	31	19	0.008686
2006	31	18	0.011764
2006	31	17	0.02159
2006	31	16	0.026281
2006	31	15	0.03281

2006	31	14	0.031973
2006	31	13	0.036449
2006	31	12	0.043884
2006	31	11	0.049373
2006	31	10	0.053384
2006	31	9	0.052496
2006	31	8	0.068594
2006	31	7	0.073487
2006	31	6	0.079743
2006	31	5	0.092016
2006	31	4	0.082702
2006	31	3	0.07979
2006	31	2	0.07549
2006	31	1	0.04345
2006	31	0	0.011516
2006	32	30	0.006296
2006	32	29	0.000508
2006	32	28	0.000914
2006	32	27	0.001219
2006	32	26	0.002844
2006	32	25	0.002945
2006	32	24	0.002945
2006	32	23	0.004367
2006	32	22	0.005078
2006	32	21	0.008531
2006	32	20	0.010358
2006	32	19	0.009851
2006	32	18	0.014522
2006	32	17	0.024576
2006	32	16	0.03727
2006	32	15	0.054737
2006	32	14	0.036458
2006	32	13	0.043668
2006	32	12	0.041637
2006	32	11	0.048746
2006	32	10	0.055753
2006	32	9	0.040317
2006	32	8	0.038997
2006	32	7	0.03788
2006	32	6	0.029349
2006	32	5	0.029958
2006	32	4	0.086016
2006	32	3	0.091398
2006	32	2	0.13923
2006	32	1	0.063166
2006	32	0	0.030466
2006	41	30	0.002855
2006	41	29	0.001428
2006	41	28	0.001428
2006	41	27	0.001428
2006	41	26	0.000714
2006	41	25	0.00571
2006	41	24	0
2006	41	23	0.003569
2006	41	22	0.009279
2006	41	21	0.003569
2006	41	20	0.007852
2006	41	19	0.010707
2006	41	18	0.017131
2006	41	17	0.009993
2006	41	16	0.009279
2006	41	15	0.0207
2006	41	14	0.019986
2006	41	13	0.0207
2006	41	12	0.024982
2006	41	11	0.042827
2006	41	10	0.071378
2006	41	9	0.06424
2006	41	8	0.059957
2006	41	7	0.097787
2006	41	6	0.114918
2006	41	5	0.063526
2006	41	4	0.114918
2006	41	3	0.086367
2006	41	2	0.044254
2006	41	1	0.068522
2006	41	0	0
2006	42	30	0.010638
2006	42	29	0
2006	42	28	0
2006	42	27	0
2006	42	26	0.005319

2006	42	25	0
2006	42	24	0
2006	42	23	0
2006	42	22	0
2006	42	21	0.005319
2006	42	20	0
2006	42	19	0
2006	42	18	0
2006	42	17	0
2006	42	16	0.021277
2006	42	15	0.005319
2006	42	14	0.010638
2006	42	13	0.005319
2006	42	12	0.047872
2006	42	11	0.079787
2006	42	10	0.026596
2006	42	9	0.058511
2006	42	8	0.079787
2006	42	7	0.079787
2006	42	6	0.079787
2006	42	5	0.074468
2006	42	4	0.170213
2006	42	3	0.074468
2006	42	2	0.12766
2006	42	1	0.037234
2006	42	0	0
2006	43	30	0.000585
2006	43	29	0
2006	43	28	0
2006	43	27	0.001171
2006	43	26	0.001171
2006	43	25	0.005855
2006	43	24	0.002342
2006	43	23	0.007611
2006	43	22	0.008197
2006	43	21	0.005855
2006	43	20	0.008197
2006	43	19	0.014052
2006	43	18	0.007611
2006	43	17	0.009368
2006	43	16	0.009953
2006	43	15	0.011124
2006	43	14	0.010539
2006	43	13	0.044496
2006	43	12	0.050937
2006	43	11	0.088993
2006	43	10	0.104801
2006	43	9	0.067916
2006	43	8	0.100703
2006	43	7	0.058548
2006	43	6	0.050351
2006	43	5	0.052693
2006	43	4	0.052693
2006	43	3	0.0726
2006	43	2	0.049766
2006	43	1	0.059719
2006	43	0	0.042155
2006	51	30	0.014851
2006	51	29	0.002475
2006	51	28	0
2006	51	27	0
2006	51	26	0
2006	51	25	0.002475
2006	51	24	0.00495
2006	51	23	0.012376
2006	51	22	0
2006	51	21	0.00495
2006	51	20	0.00495
2006	51	19	0.00495
2006	51	18	0.007426
2006	51	17	0.012376
2006	51	16	0.024752
2006	51	15	0.066832
2006	51	14	0.044554
2006	51	13	0.027228
2006	51	12	0.044554
2006	51	11	0.027228
2006	51	10	0.044554
2006	51	9	0.044554
2006	51	8	0.059406
2006	51	7	0.09901
2006	51	6	0.032178

2006	51	5	0.071782
2006	51	4	0.128713
2006	51	3	0.071782
2006	51	2	0.094059
2006	51	1	0.04703
2006	51	0	0
2006	52	30	0.014851
2006	52	29	0.002475
2006	52	28	0
2006	52	27	0
2006	52	26	0
2006	52	25	0.002475
2006	52	24	0.00495
2006	52	23	0.012376
2006	52	22	0
2006	52	21	0.00495
2006	52	20	0.00495
2006	52	19	0.00495
2006	52	18	0.007426
2006	52	17	0.012376
2006	52	16	0.024752
2006	52	15	0.066832
2006	52	14	0.044554
2006	52	13	0.027228
2006	52	12	0.044554
2006	52	11	0.027228
2006	52	10	0.044554
2006	52	9	0.044554
2006	52	8	0.059406
2006	52	7	0.09901
2006	52	6	0.032178
2006	52	5	0.071782
2006	52	4	0.128713
2006	52	3	0.071782
2006	52	2	0.094059
2006	52	1	0.04703
2006	52	0	0
2006	53	30	0.096774
2006	53	29	0
2006	53	28	0
2006	53	27	0
2006	53	26	0.064516
2006	53	25	0.032258
2006	53	24	0.032258
2006	53	23	0.032258
2006	53	22	0.064516
2006	53	21	0.032258
2006	53	20	0.064516
2006	53	19	0.032258
2006	53	18	0
2006	53	17	0.032258
2006	53	16	0.064516
2006	53	15	0.032258
2006	53	14	0.193548
2006	53	13	0.096774
2006	53	12	0.064516
2006	53	11	0
2006	53	10	0
2006	53	9	0
2006	53	8	0
2006	53	7	0
2006	53	6	0.032258
2006	53	5	0
2006	53	4	0
2006	53	3	0
2006	53	2	0
2006	53	1	0
2006	53	0	0.032258
2006	54	30	0.155541
2006	54	29	0.007973
2006	54	28	0.012568
2006	54	27	0.014595
2006	54	26	0.023378
2006	54	25	0.021622
2006	54	24	0.02473
2006	54	23	0.024865
2006	54	22	0.026486
2006	54	21	0.028514
2006	54	20	0.023649
2006	54	19	0.017838
2006	54	18	0.023514
2006	54	17	0.027568

2006	54	16	0.032432
2006	54	15	0.037838
2006	54	14	0.032973
2006	54	13	0.034054
2006	54	12	0.036351
2006	54	11	0.045
2006	54	10	0.045811
2006	54	9	0.032297
2006	54	8	0.034595
2006	54	7	0.037027
2006	54	6	0.038378
2006	54	5	0.039054
2006	54	4	0.039595
2006	54	3	0.034595
2006	54	2	0.028784
2006	54	1	0.014865
2006	54	0	0.003514
2006	61	30	0.026394
2006	61	29	0.001795
2006	61	28	0.001969
2006	61	27	0.0027
2006	61	26	0.004162
2006	61	25	0.005771
2006	61	24	0.007714
2006	61	23	0.007951
2006	61	22	0.01355
2006	61	21	0.017698
2006	61	20	0.017692
2006	61	19	0.018667
2006	61	18	0.023951
2006	61	17	0.030517
2006	61	16	0.044041
2006	61	15	0.043611
2006	61	14	0.038558
2006	61	13	0.047786
2006	61	12	0.044426
2006	61	11	0.056475
2006	61	10	0.062624
2006	61	9	0.052544
2006	61	8	0.054525
2006	61	7	0.065875
2006	61	6	0.064946
2006	61	5	0.065997
2006	61	4	0.06129
2006	61	3	0.052723
2006	61	2	0.042316
2006	61	1	0.018436
2006	61	0	0.003296
2006	62	30	0.001821
2006	62	29	0
2006	62	28	0
2006	62	27	0.00091
2006	62	26	0.000759
2006	62	25	0.002731
2006	62	24	0.001517
2006	62	23	0.001972
2006	62	22	0.00349
2006	62	21	0.005159
2006	62	20	0.0044
2006	62	19	0.003945
2006	62	18	0.007131
2006	62	17	0.016083
2006	62	16	0.021393
2006	62	15	0.028827
2006	62	14	0.034593
2006	62	13	0.025338
2006	62	12	0.059172
2006	62	11	0.080413
2006	62	10	0.107419
2006	62	9	0.075861
2006	62	8	0.04582
2006	62	7	0.047944
2006	62	6	0.099833
2006	62	5	0.090882
2006	62	4	0.057047
2006	62	3	0.112729
2006	62	2	0.017145
2006	62	1	0.038993
2006	62	0	0.006676

Road Type Distribution

Road type distribution is based on the ODOT's 2006 daily vehicle miles of travel (DVMT) by functional classification (FC). These inputs vary by county. A sample road type distribution input for Cuyahoga County can be seen in Table 10. Cuyahoga County does not contain rural road types 2 and 3. The distributions for other areas can be found in the electronic input submittals.

Table 10 – Sample Road Type Distribution for Cuyahoga County

sourceTypeID	roadTypeID	roadTypeVMTFraction
11	1	0
11	2	0
11	3	0
11	4	0.47072
11	5	0.52928
21	1	0
21	2	0
21	3	0
21	4	0.47072
21	5	0.52928
31	1	0
31	2	0
31	3	0
31	4	0.47072
31	5	0.52928
32	1	0
32	2	0
32	3	0
32	4	0.47072
32	5	0.52928
41	1	0
41	2	0
41	3	0
41	4	0.47072
41	5	0.52928
42	1	0
42	2	0
42	3	0
42	4	0.47072
42	5	0.52928
43	1	0
43	2	0
43	3	0
43	4	0.47072
43	5	0.52928
51	1	0
51	2	0
51	3	0
51	4	0.47072
51	5	0.52928
52	1	0
52	2	0
52	3	0
52	4	0.47072
52	5	0.52928
53	1	0
53	2	0
53	3	0
53	4	0.47072
53	5	0.52928
54	1	0
54	2	0
54	3	0
54	4	0.47072
54	5	0.52928
61	1	0
61	2	0
61	3	0
61	4	0.47072
61	5	0.52928
62	1	0
62	2	0
62	3	0
62	4	0.47072
62	5	0.52928

Vehicle Type VMT and VMT Fractions

VMT by MOVES vehicle types is subdivided into four sections namely HPMS base year VMT, monthly VMT fractions, daily VMT fractions and hourly VMT fractions. For NOACA's counties, HPMS base year VMT was derived by using the converter tool, US EPA's AADVMT Calculator_HPMS.xls. The converter takes average annual daily VMT (AADVMT) and generates MOVES input data based on default factors. AADVMT is computed by using total daily VMT obtained from travel demand model and fractioning it with the MOVES default distance travelled by each source type to come up vehicle type VMTs. The same method was used to generate data for other analysis years.

ODOT uses weigh in motion (WIM) data to develop inputs for the counties it models. The inputs for each geographic area can be seen in the supplied input files. Sample HPMS VMT for 2006 is provided in Table 11.

Table 11 – Sample Yearly HPMS VMT for 2006

HPMS VType ID	Cuyahoga	Geauga	Lake	Lorain
10	36,279,066	3,579,545	7,368,124	8,813,331
20	5,393,830,829	465,757,651	1,063,615,481	1,285,052,331
30	3,355,271,802	313,217,056	667,810,586	811,206,625
40	13,433,997	2,917,998	3,199,949	4,083,872
50	207,639,389	30,311,606	45,080,548	55,677,744
60	308,438,715	38,801,503	79,624,414	81,166,499

HPMS VType ID	Medina	Portage	Summit	Ashtabula
10	8,039,568	7,033,066	22,040,247	4,172,818
20	1,054,314,702	1,254,291,780	3,930,704,234	744,189,232
30	687,173,536	387,008,969	1,212,810,142	229,617,950
40	5,307,954	3,955,747	12,396,534	2,347,001
50	60,452,301	29,243,117	91,642,188	17,350,359
60	136,727,415	69,428,531	217,575,389	41,192,939

Output Emission Factors

Table 12 shows the first record in a MOVES sample output (rate per distance) emission file for year 2006. For any given month, day of week, hour of the day, pollutant, and process; the rate per distance varies by road type, and speed bin. Rates per distance emissions are applied to link and intrazonal VMT.

Table 12 – Sample Emission File (Rate per Distance) for year 2006

Heading:	MOVESScenarioID	MOVESRunID	yearID	monthID	dayID	hourID
Record:	Cuyahoga	1	2006	7	5	1
Heading:	linkID	pollutantID	processID	sourceTypeID	SCC	fuelTypeID
Record:	9.9E+08	87	11	54		0
Heading:	modelYearID	roadTypeID	avgSpeedBinID	temperature	relHumidity	ratePerDistance
Record:	0	5	3	68	82	0.02331

Table 13 shows the first record in a MOVES sample output (rate per vehicle) emission file for year 2006. The rate per vehicle varies for any combinations of month, day of week, hour of the day, pollutant, and process. Rates per vehicle emissions are applied to the vehicle souce type population.

Table 13 – Sample Emission File (Rate per Vehicle) for year 2006

Heading:	MOVESScenarioID	MOVESRunID	yearID	monthID	dayID
Record:	Cuyahoga	1	2006	7	5
Heading:	hourID	zoneID	pollutantID	processID	sourceTypeID
Record:	1	990180	1	2	11
Heading:	SCC	fuelTypeID	modelYearID	temperature	ratePerVehicle
Record:		0	0	71	0.002892

Table 14 shows the first record in a MOVES sample output (rate per profile) emission file for year 2006. The rate per vehicle varies for any combinations of month, day of week, hour of the day, pollutant, and process. Rates per vehicle emissions are applied to the vehicle source type population.

Table 14 – Sample Emission File (Rate per Profile) for year 2006

Heading:	MOVESScenarioID	MOVESRunID	yearID	monthID	dayID
Record:	Cuyahoga	1	9.9E+09	2006	5
Heading:	hourID	pollutantID	processID	sourceTypeID	SCC
Record:	1	12	11		
Heading:	fuelTypeID	modelYearID	temperature	ratePerVehicle	
Record:	0	0	71	0.008215	

All output files are available in the electronic submittal.

4. Post Processing

Total emissions were computed with the aid of several custom programs by ODOT. The process uses data on daily and directional traffic distributions as well as more up to date volume/delay functions from the 2000 Highway Capacity Manual (HCM). This process, described below and illustrated in Figure 4, also uses rewritten code able to handle the newer model network formats and MOVES generated emission factors.

First step (movessource.exe) aggregates the emission factors. Rate per profile and rate per vehicle files are combined during this process. The resultant emission factor files contain emission factors broadly classified into total vehicles, cars and trucks by pollutant, by average speed, road type and hour of day.

The second step in the the process involves running ODOT postcms.exe to calculate hourly link volumes based on the percentage of the daily volume (travel demand model output) determined by a link's facility and area type. Link speeds from the travel demand model are not used in the analysis. The speeds are estimated as a post-process to the model based on HCM methods using a link's volume-to-capacity ratio and link group code. The daily to hourly volume conversion percentages and speed tables can be seen in **Appendix B.**

The third step (movesnet.exe) uses a combination of the MOVES emission factors and the hourly link volumes that are output of the postcms.exe program. The hourly volumes are multiplied by the MOVES emission factor for the corresponding hour of day, speed bin, and roadtype to calculate emissions for every network link for each hour. The final link on road vehicle emissions for the area is the sum of all individual link-hour emissions.

The fourth step, (movesveh.exe), calculates vehicle-based emissions for each source type for each hour of the day. The vehicle source type is based on a combination of local and default data. The final vehicle emissions for each county are the sum of all individual hourly emissions for all vehicle types.

Intrazonal trips do not get loaded onto the network, so the fifth step in the process requires a separate method to account for those trips that use local roads to travel within a zone. The movesintra.exe program uses intrazonal trips to estimate VMT using the area in square miles and intrazonal trips of each zone. The zone is assumed circular and the radius of the circle is used as the average trip length for these intrazonal trips. Intrazonal emissions are then calculated by combining MOVES generated emissions with estimated intrazonal VMT. The emission rates are the same as those used to calculated link based emissions.

The final step is to summarize link, vehicle, and intrazonal emissions for each county, pollutant, and analyzed year. Summary emissions for each pollutant, county, and scenario year in northeast Ohio were previously displayed in tables 1-4.

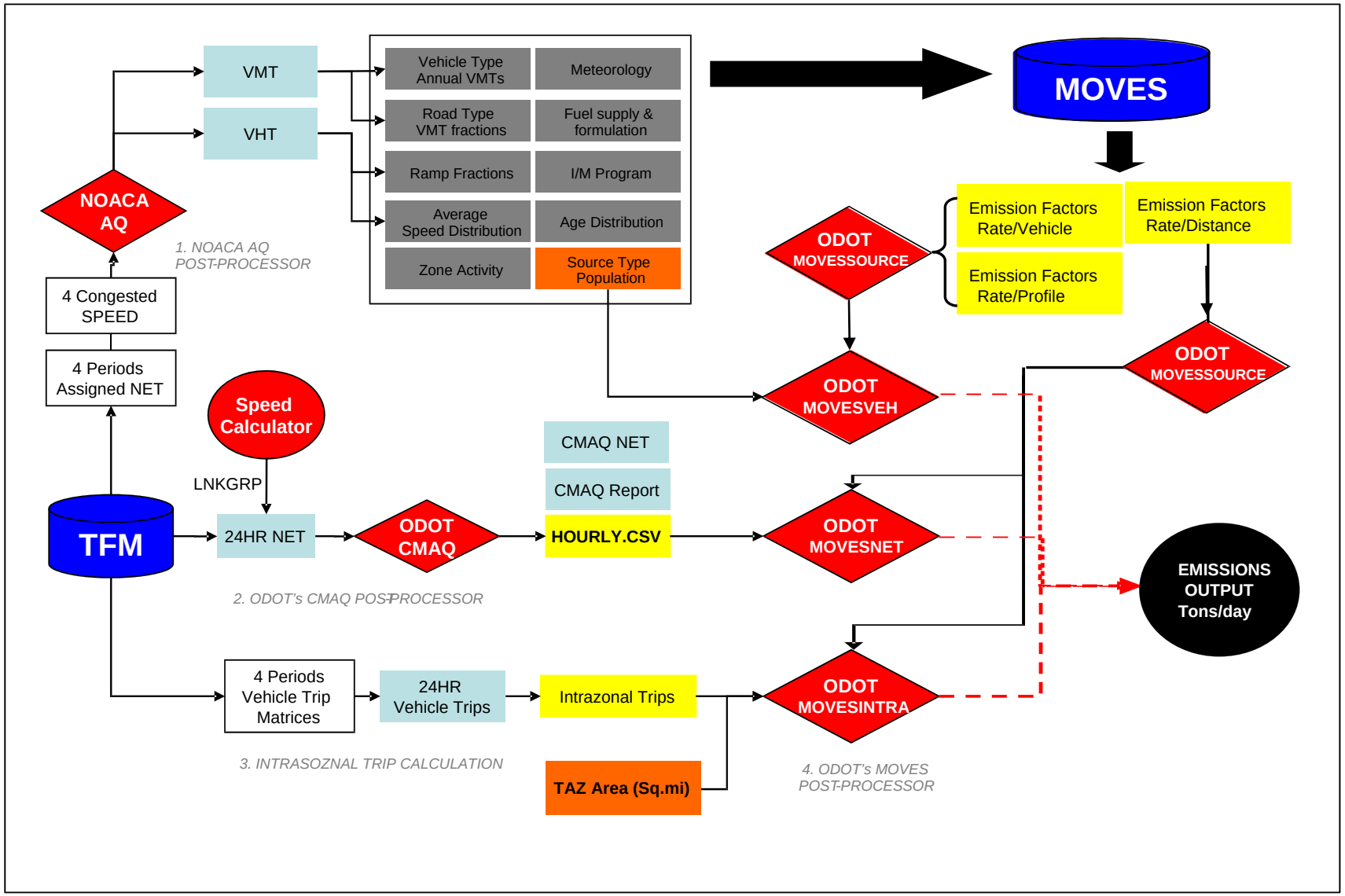

Figure 4 – Emission Calculation Process

5. Multiple MPO Coordination Issues

AMATS, NOACA, ODOT, and OEPA have a long history of working together in air quality issues. All parties have had an opportunity to review and approve this summary document.

Appendix A

Interagency Consultation Documentation

From: Van Vlerah, Jennifer
Sent: Wednesday, January 20, 2016 1:31 PM
To: Moore, David; Byram, Mark; 'Granato, Samuel'; Brunello, Antonino; '(vnemalapuri@mpo.noaca.org)'; 'Bill Davis (bdavis@mpo.noaca.org)'; 'E Kang (ekang@mpo.noaca.org)'; 'cbaker@akronohio.gov'; 'Oesterling, Leigh'; 'cparasa@morpc.org'; 'mhill@lcounty.com'; 'ngill@morpc.org'; 'smapel@lcounty.com'; 'Phyllis Jividen (Pjividen@akronohio.gov)'; Maietta, Anthony (maietta.anthony@epa.gov); 'aprater@akronohio.gov'; Fetty Davis, Erica; Beekman, Christopher; 'Svingen, Eric'; 'Doty, Edward'; 'Liljegren, Jennifer'; 'D'Agostino, Kathleen'; 'Aburano, Douglas'; 'Blakley, Pamela'
Cc: Fetty Davis, Erica; Beekman, Christopher
Subject: RE: Interagency Consultation - 2008 Ozone Redesignations for Columbus and Cleveland Areas

Please forgive me if I do not have everyone that was on the call on this email…please route as needed.

We concluded our IAC call in record time…15 minutes! Representatives from NOACA, ODOT, OEPA, USEPA, and FHA were on the call. MORPC and LCATS were not on the call. Nick from MORPC did call me right after our call ended and I filled him in. If you can provide feedback on the minutes by COB 1/17/16 that would be appreciated.

The counties each agency is responsible for regarding the modeling:
Cleveland:
Cuyahoga, Geauga, Lake, Lorain and Medina counties: NOACA
Ashtabula county: ODOT
Summit and Portage counties: AMATS

Columbus:
Franklin, Delaware, Licking, Fairfield, Madison, and Knox counties: MORPC
LCATS doesn't model

ODOT (Nino) will perform MOVES runs to provide emissions factors to NOACA, AMATS and MORPC (MPOs). The MPOS will use the emissions factors in combination with the travel demand model to produce emissions in tons per summer day (TSD). The process will be documented by the MPOs in a report to be submitted to OEPA along with 2 disk of the modeling files for each area.

I am assuming ODOT (Nino) will be responsible for both the ODOT and MPO steps above for Ashtabula County? Therefore, Nino will need to coordinate with NOACA and AMATS in providing the emissions for the final write-up.

Here is the pollutant and year needs for each county:

VOC, NOx (TSD)
2011, 2014, 2020, 2030. 2020 and 2030 will be budget years. We will once again try to accommodate a 15% safety margin for mobile budgets. Once all sector emissions are analyzed, OEPA will notify everyone via email of the results and ability to accommodate the 15%.

I am proposing the following timeline:

ODOT delivery of data to MPOs: 2/5/16 (3.5 weeks)
MPO deliver to OEPA: 2/26/16 (3 weeks)

Thanks for your participation, Jennifer

Jennifer Van Vlerah
Manager, SIP, Inventory and Rulemaking
Ohio EPA Division of Air Pollution Control
614-644-3696

From: Van Vlerah, Jennifer
Sent: Friday, January 15, 2016 8:22 AM
To: Moore, David; Byram, Mark; 'Granato, Samuel'; Brunello, Antonino; '(vnemalapuri@mpo.noaca.org)'; 'Bill Davis (bdavis@mpo.noaca.org)'; 'E Kang (ekang@mpo.noaca.org)'; 'cbaker@akronohio.gov'; 'Oesterling, Leigh'; 'cparasa@morpc.org'; 'mhill@lcounty.com'; 'ngill@morpc.org'; 'smapel@lcounty.com'; 'Phyllis Jividen (Pjividen@akronohio.gov)'; Maietta, Anthony (maietta.anthony@epa.gov); 'aprater@akronohio.gov'; Fetty Davis, Erica; Beekman, Christopher; Svingen, Eric; Doty, Edward; Liljegren, Jennifer; D'Agostino, Kathleen; Aburano, Douglas; Blakley, Pamela
Cc: Fetty Davis, Erica; Beekman, Christopher
Subject: RE: Interagency Consultation - 2008 Ozone Redesignations for Columbus and Cleveland Areas

Looks like most everybody except NOACA has responded and the only day that works for everyone is January 20 at 1pm EST. So I am hoping this will work for them also and we can do them together since we will cover the same information.

I have a bridge line that only holds 18 so if you can all gather at your respective agencies as much as possible when you call in that will ensure nobody is left out.

The number is 614-387-7405.

I have also made a correction to the email below which will serve as a rough agenda. If anyone wants to email me other topics they would like to cover in advance I'll include them.

Thanks much, Jen

Jennifer Van Vlerah
Manager, SIP, Inventory and Rulemaking
Ohio EPA Division of Air Pollution Control
614-644-3696

From: Van Vlerah, Jennifer
Sent: Thursday, January 14, 2016 1:27 PM

To: Moore, David; Byram, Mark; Granato, Samuel; Brunello, Antonino; (vnemalapuri@mpo.noaca.org); Bill Davis (bdavis@mpo.noaca.org); E Kang (ekang@mpo.noaca.org); 'cbaker@akronohio.gov'; Oesterling, Leigh; 'cparasa@morpc.org'; 'mhill@lcounty.com'; 'ngill@morpc.org'; 'smapel@lcounty.com'; 'Phyllis Jividen (Pjividen@akronohio.gov)'; Maietta, Anthony (maietta.anthony@epa.gov)
Cc: Fetty Davis, Erica; Beekman, Christopher
Subject: Interagency Consultation - 2008 Ozone Redesignations for Columbus and Cleveland Areas

Hello IAC contacts,

We are wrapping up development of our redesignation request and maintenance plan for the 2008 ozone standard for the Cincinnati area. We now would like to move on to preparing documents for Columbus and Cleveland areas. It is important we have all redesignations in under the 2008 ozone standard with sufficient time for USEPA to approve them prior to USEPA making designations under the newer 2015 ozone standard (Oct 2017). We will need assistance in mobile emissions inventories and projections for these areas.

Here is a summary of the counties with the MPOs/Agencies I believe modeled each county last time. Please correct me if I am wrong! And please let me know if I should add/remove anyone from this distribution list.

Cleveland:
Cuyahoga, Geauga, Lake, Lorain and Medina counties: NOACA
Ashtabula county: ODOT
Summit and Portage counties: AMATS (data goes to Nino at ODOT for extrapolating data for Air Quality)

Columbus:
Franklin, Delaware, Licking, Fairfield, Madison, and Knox counties: MORPC
LCATS, ODOT doesn't model

Here is the pollutant and year needs for each county:

VOC, NOx
2011, 2014, 2020, 2030

I have also attached the write-up from OKI for the Cincinnati area. We will need something similar for your areas also. We also need two disks with all the modeling files once finalized.

We will once again try to accommodate a 15% safety margin for mobile budgets.

Thanks much, Jennifer

Jennifer Van Vlerah
Manager, SIP, Inventory and Rulemaking
Ohio EPA Division of Air Pollution Control
614-644-3696