Technical Memorandum
Northeast Ohio (AMATS, NOACA, Ashtabula)
1997 8-hr Ozone NAAQS Maintenance SIP Inventory
Mobile Source Emissions (VOC and NOx)

September 2012

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 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 update State Implementation Plan (SIP) maintenance budgets for the 1997 8-hr Ozone NAAQS.

The designated maintenance area in northeast Ohio for the 1997 8-hr Ozone NAAQS includes the counties of Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, and Summit; and Ashtabula. Ohio EPA intends to submit a SIP update to USEPA using the Motor Vehicle Emission Simulator (MOVES).

The inventories include county based, annual totals of Volatile Organic Compounds (VOC's) and Oxides of Nitrogen (NO_X) for the base year 2002, attainment year 2006, the interim budget year 2012, and the maintenance budget year 2020.

Latest Planning Assumptions

These ozone inventory runs meet the latest planning assumption requirement. 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 most recent emissions software, MOVES, is used for all mobile source emission analyses with MOVES input and output needs being established at various interagency consultation meetings and e-mails between January 2012 and April 2012 (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 2002, 2006, 2012, and 2020. They also include average summer day VMT's. The remainder of this document focuses on the assumptions behind the analyses.

Table 1 – Northeast Ohio On-Road Mobile Source Emissions

2002 Base			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Daily VMT (miles/day)**
Ashtabula	5.00	11.29	3,178,599
Cuyahoga	62.92	128.84	29,297,006
Geauga	6.06	13.47	2,567,692
Lake	13.28	29.59	5,738,319
Lorain	16.56	34.23	6,972,908
Medina	12.34	36.39	5,888,243
Portage	8.26	17.17	4,782,788
Summit	30.58	60.43	15,788,738
TOTAL	**155.00**	**331.42**	**74,214,293**

Table 2 – Northeast Ohio On-Road Mobile Source Emissions

2006 Attainment			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Daily VMT (miles/day)**
Ashtabula	4.17	9.04	3,075,258
Cuyahoga	48.61	104.67	29,378,875
Geauga	5.10	11.85	2,698,563
Lake	10.87	25.93	5,889,045
Lorain	13.59	29.89	7,088,351
Medina	10.52	32.52	6,165,358
Portage	6.95	14.83	5,186,076
Summit	21.78	45.49	16,213,278
TOTAL	**121.59**	**274.21**	**75,694,804**

Table 3 – Northeast Ohio On-Road Mobile Source Emissions

2012 Interim			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Daily VMT (miles/day)**
Ashtabula	2.59	5.20	3,120,712
Cuyahoga	26.65	61.07	31,395,908
Geauga	2.88	7.63	2,796,371
Lake	6.33	16.62	6,329,046
Lorain	8.02	19.15	7,294,998
Medina	6.51	21.53	6,268,845
Portage	4.39	8.81	5,108,060
Summit	13.53	24.57	15,612,531
TOTAL	**70.90**	**164.56**	**77,926,471**

Table 4 – Northeast Ohio On-Road Mobile Source Emissions

2020 Maintenance			
COUNTY	**VOC (tons/day)**	**NOx (tons/day)**	**Daily VMT (miles/day)**
Ashtabula	1.38	2.28	3,335,613
Cuyahoga	13.60	33.73	35,342,881
Geauga	1.74	5.37	3,090,956
Lake	3.42	10.62	7,227,239
Lorain	4.28	12.01	8,238,155
Medina	3.73	14.98	7,564,982
Portage	2.37	3.89	5,499,263
Summit	7.02	11.35	16,443,663
TOTAL	**37.55**	**94.22**	**86,742,752**

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.

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.

Detailed information about NOACA's travel demand forecast model can be found here: **http://www.noaca.org/traveldemandmemo.pdf**

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 base year 2002, attainment year 2006, interim year 2012, and maintenance year 2020. 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 for the base year 2002 & attainment year 2006. 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 – 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 – 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 – 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 – 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.

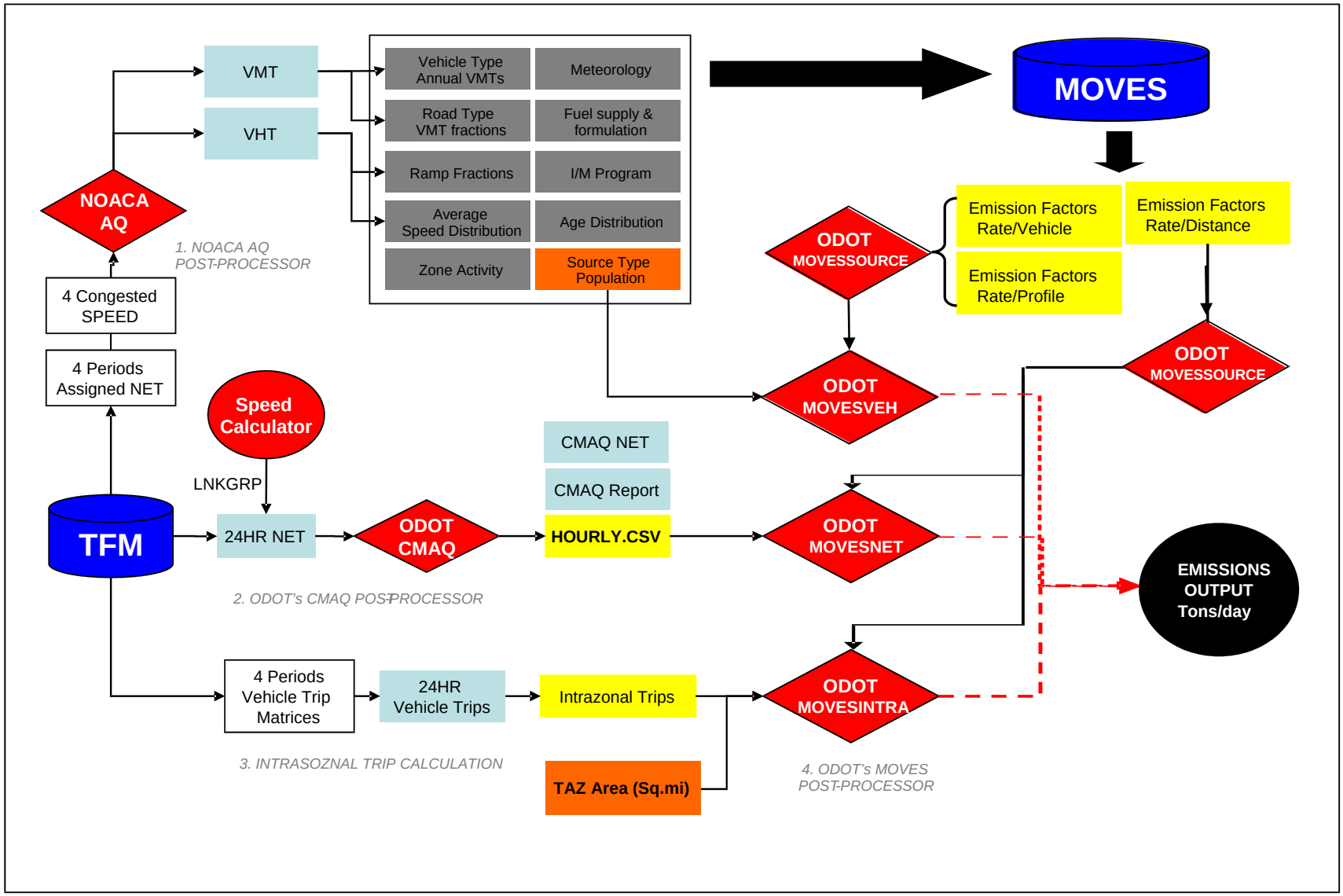

Figure 4 – Emission Calculation Process

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: Brunello, Nino [mailto:Nino.Brunello@dot.state.oh.us]
Sent: Friday, April 20, 2012 7:57 AM
To: B Davis
Cc: V Nemalapuri; E Kang
Subject: RE: Ozone Summer Day Factors

Yes, there is a way to adjust only the VMT. The Cube application GUI offers a growth factor selection of either 1.00 or 1.08. The application then generates a script to be executed where the adjustment factor is a variable. That variable can overwritten or hard-coded in the script.

~~~~~~
Nino Brunello, P.E.
Modeling & Forecasting Section
Division of Planning
Ohio Department of Transportation
(614) 752-5742

From: B Davis [mailto:BDavis@mpo.noaca.org]
Sent: Thursday, April 19, 2012 3:22 PM
To: Durham, William F; krodi@eastgatecog.org; Brunello, Nino; PJividen@AkronOhio.gov; CBaker@akronohio.gov; Jeff Dutton; NGILL@morpc.org; aramirez@mvrpc.org; Saleem Salameh; tmazur@lacrpc.com; smapel@lcounty.com; randy.durst@movrc.org; sschmid@clarkcountyohio.gov; mikepap@bhjmpc.org; David Gedeon; rsharma@belomar.org
Cc: Dines, Jennifer; Morris.Patricia@epamail.epa.gov; Moore, Dave; Byram, Mark; John Getchey; Lisa Pompeo
Subject: RE: Ozone Summer Day Factors

NOACA concurs with the adjustment.

Any chance there is a way to adjust VMT without adjusting vehicle population? Excess evaporative emissions don't belong in the photochemical grid models that are often one use for the outputs of these analyses. I guess the grid modelers could reduce evaporatives by 8% before they plug them in.

Bill Davis
NOACA
(216)-241-2414, Ext. 251

From: Durham, William F [mailto:William.F.Durham@wv.gov]
Sent: Thursday, April 19, 2012 2:48 PM
To: Kathleen Rodi; Brunello, Nino; PJividen@AkronOhio.gov; CBaker@akronohio.gov; Jeff Dutton; B Davis; NGILL@morpc.org; aramirez@mvrpc.org; Saleem Salameh; tmazur@lacrpc.com; smapel@lcounty.com; randy.durst@movrc.org; sschmid@clarkcountyohio.gov; mikepap@bhjmpc.org; David Gedeon; rsharma@belomar.org
Cc: Dines, Jennifer; Morris.Patricia@epamail.epa.gov; Moore, Dave; Byram, Mark; John Getchey; Lisa Pompeo
Subject: RE: Ozone Summer Day Factors

Nino:
I don't object to factoring the vehicle population up, but I'm not sure the factor should be as high as the one historically used for VMT. The vehicle pop characterizes the vehicles operating in the domain, which relates to starts and diurnal/evap emissions. Factoring the vehicle pop up does seem to capture the increases in actual summer starts
but it may also artificially inflate the evap emissions. That may be O.K. as long as we're conscious of it.
Fred
From: Kathleen Rodi [mailto:krodi@eastgatecog.org]
Sent: Thursday, April 19, 2012 2:40 PM
~~~~~~

To: Brunello, Nino; PJividen@AkronOhio.gov; CBaker@akronohio.gov; Jeff Dutton; Bill Davis; Nick Gill (NGILL@morpc.org); aramirez@mvrpc.org; Saleem Salameh; Lima (tmazur@lacrpc.com); smapel@lcounty.com; 'randy.durst@movrc.org' (randy.durst@movrc.org); sschmid@clarkcountyohio.gov; mikepap@bhjmpc.org; David Gedeon; rsharma@belomar.org
Cc: Durham, William F; Dines, Jennifer; Patricia Morris (Morris.Patricia@epamail.epa.gov) (Morris.Patricia@epamail.epa.gov); Moore, Dave; Byram, Mark; John Getchey; Lisa Pompeo
Subject: RE: Ozone Summer Day Factors

We concur with the adjustment.
Kathleen

From: Brunello, Nino [mailto:Nino.Brunello@dot.state.oh.us]
Sent: Thursday, April 19, 2012 2:30 PM
To: PJividen@AkronOhio.gov; CBaker@akronohio.gov; Jeff Dutton; Bill Davis; Nick Gill (NGILL@morpc.org); aramirez@mvrpc.org; Saleem Salameh; Lima (tmazur@lacrpc.com); smapel@lcounty.com; 'randy.durst@movrc.org' (randy.durst@movrc.org); sschmid@clarkcountyohio.gov; mikepap@bhjmpc.org; David Gedeon; rsharma@belomar.org; Kathleen Rodi
Cc: Fred Durham; Dines, Jennifer; Patricia Morris (Morris.Patricia@epamail.epa.gov) (Morris.Patricia@epamail.epa.gov); Moore, Dave; Byram, Mark
Subject: FW: Ozone Summer Day Factors

All:

After discussions with ODOT, OEPA, WVDEP, and USEPA, we are of the opinion that there needs to be an additional seasonal factor for summer when calculating ozone pollutants.

There is currently an adjustment for increasing average daily VMT (+ 8%) which was used in previously when using Moblie6 to generate emission factors. With MOVES, there is a vehicle component used in addition to VMT, so there needs to be an adjustment from average number of vehicles to the number of vehicles in summer day. We propose to use the same 8% increase.

We need to have an inter-agency agreement on this, and would prefer to do it via email (to make it easier on all of us). Please respond with your approval and/or questions.

Thanks,

Nino Brunello, P.E.
Modeling & Forecasting Section
Division of Planning
Ohio Department of Transportation
(614) 752-5742

From: Dines, Jennifer
Sent: Thursday, April 12, 2012 9:04 AM
To: Brunello, Nino; Durham, William F
Cc: Moore, Dave
Subject: RE: Ozone Summer Day Factors

Nino and Fred, talked to Pat and she agrees that BOTH VMT and number of vehicles should have the 1.08 factor applied.

Pat suggested we should have consultation on this. I told her ODOT is taking the lead on this project and I'd let Dave know……..she says email is fine.

Thanks,

Jennifer Dines
Manager, State Implementation Plan and Rulemaking Section
Division of Air Pollution Control
Ohio Environmental Protection Agency
Wk (614) 644-3696
Fax (614) 644-3681

From: Brunello, Nino
Sent: Monday, April 09, 2012 12:59 PM
To: Dines, Jennifer; Durham, William F
Subject: RE: Ozone Summer Day Factors

Jennifer/Fred,

There is another item that needs to be discussed. Since we now calculate emission rates for both VMT and number of vehicles, does there need to be a summer adjustment factors for vehicles as well? This was not done with MOBILE, so we have nothing to follow. If I had to guess, I would think that there would be an increase, but I couldn't guess as to how many or what factor to use. Maybe just use 1.08 in absence of anything better? Thoughts?

~~~~~~

Nino Brunello, P.E.
Modeling & Forecasting Section
Division of Planning
Ohio Department of Transportation
(614) 752-5742

From: Durham, William F [mailto:William.F.Durham@wv.gov]
Sent: Friday, April 06, 2012 8:50 AM
To: Brunello, Nino
Cc: Dines, Jennifer
Subject: Ozone Summer Day Factors

Nino:
I spoke with Jenn this morning and outlined the issue of Summer day VMT v. Average daily VMT.
We agreed that Pat Morris may be able to shed some light on the question.
Jenn & my calendars are open next Mon. and Tues. afternoon. Please give me a call & I'll patch Jenn in.
Fred

****

From: E Kang
Sent: Tuesday, February 21, 2012 12:10 PM
To: R Eckner; B Davis; G Grano
Cc: V Nemalapuri
Subject: Using truck vmts for MOVES post-processing

Needs for truck model improvement and validation followed by truck counts can be discussed in two different context: SIP/Conformity and freight planning.

1) OZONE SIP
~~~~~~

During a conference call with Nino last Friday, he notified us that ODOT's MOVES post-processors are able to handle Vehicle class VMTs in two ways: 1) separate Auto and Truck VMTs, 2) combined VMTs as we did for PM SIP.

In terms of using separate VMTs, Nino asked me the confidence level of truck vmts from model and suggested to test both ways. This will be the first time to test Truck VMTs with a purpose .

From: V Nemalapuri
Sent: Tuesday, February 07, 2012 10:16 AM
To: nino.brunello@dot.state.oh.us
Cc: B Davis; G Grano; E Kang
Subject: FW: 8-Hour Ozone SIP Budget Revisions

Good Morning Nino,

We need to get started on ozone SIP budget revisions as mentioned in Dave Moore's email. How about a kick off meeting? Let me know your availability.

Thanks,
Vijay Krishna Nemalapuri
Northeast Ohio Areawide Coordinating Agency (NOACA)
1299 Superior Ave., Cleveland OH 44114
(216) 241-2414 x321
vnemalapuri@mpo.noaca.org

From: Moore, Dave [mailto:Dave.Moore1@dot.state.oh.us]
Sent: Monday, January 30, 2012 9:18 AM
To: aramirez@mvrpc.org; Andy Reser ; B Davis; Bob Muransky ; Curtis Baker ; Jeff Dutton ; krodi@eastgatecog.org; Lamar Daniel; Leigh Oesterling ; mhill@lcounty.com1; mikepap@bhjmpc.org; Nick Gill ; Phyllis Jividen ; Randy Durst; Saleem Salameh (ssalameh@intelos.net); sschmid@clarkcountyohio.gov; Thom Mazur ; henry@tmacog.org
Cc: Dines, Jennifer; Oesterling, Leigh; Byram, Mark; Brunello, Nino; Giaimo, Greg; Phinney, Scott; Granato, Sam; Anderson, Rebekah
Subject: 8-Hour Ozone SIP Budget Revisions

All,

The current Ohio Ozone SIP budgets were developed using US EPA's MOBILE software. Effective March 2, 2012 US EPA's AQ software of record will be MOVES. Post March 2nd all new SIP and Transportation Conformity actions will be required to use MOVES. In order to assure ongoing positive Ohio MPO T-Plan/TIP conformity actions, the Ohio Ozone SIP budgets need updated to reflect MOVES outputs.

Updating the Ozone SIP budgets to MOVES requires new MOVES based mobile emission inventories for the SIP attainment year and budget years, consistent with the attached pdf. Please contact your ODOT CO travel demand modeling liaison to coordinate needed transportation network, modeling runs, and emission factor post processing to establish these new SIP mobile emission inventories. Our goal is to submit the new inventories and documentation to OEPA on or before April 1, 2012.

We have a working agreement with OEPA to establish SIP budgets, assuming sufficient safety margin is available, at 15% above the emission inventory. As you are developing the new MOVES based budget year inventories, it may be a good idea to compare the resulting inventories plus 15% to MOVES based T-Plan interim and horizon year emissions as a check to assure positive future year conformity findings.

Thanks
DM

****

-----Original Message-----
From: Moore, Dave [mailto:Dave.Moore1@dot.state.oh.us]
Sent: Friday, January 06, 2012 1:30 PM
To: Byram, Mark; Brunello, Nino; Giaimo, Greg; Granato, Sam; Dines, Jennifer; aramirez@mvrpc.org; Andy Reser ; B Davis; Bob Muransky ; Curtis Baker ; Jeff Dutton ; krodi@eastgatecog.org; Lamar Daniel; Leigh Oesterling ; mhill@lcounty.com1; mikepap@bhjmpc.org; Nick Gill ; Phyllis Jividen ; Randy Durst; Saleem Salameh (ssalameh@intelos.net); sschmid@clarkcountyohio.gov; Thom Mazur ; henry@tmacog.org
Subject: FW: Ozone SIP updates

All,

See Pat Morris' message below regarding updating the Ohio Ozone SIP MOBILE based budgets to MOVES. Recall that MOVES is required to be used for SIP development and conformity determinations, effective March 2, 2012. A number of Ohio MPOs have quadrennial T-Plan/conformity determinations due in August, 2012. The existing Ozone SIP budgets need updated (US EPA Approval) to MOVES prior to initiating the conformity process on the Plan Updates.

In order to provide sufficient lead time for OEPA and US EPA to complete their respective SIP Update processes and still provide plenty of time for the MPO conformity process, we collectively need get going, yesterday.

Thanks
DM

-----Original Message-----
From: Patricia Morris [mailto:Morris.Patricia@epamail.epa.gov]
Sent: Thursday, January 05, 2012 11:18 AM
To: Moore, Dave; Dines, Jennifer
Subject: Ozone SIP updates

Dave and Jen,

Something that was helpful to Indiana was a table of years that need to be updated for each of the Indiana ozone areas.
I can put together a table for the Ohio areas too.

There are several ways to update the ozone SIPs with MOVES budgets. One is to simply replace the MOBILE6 budgets with MOVES budgets in the old approved maintenance plan SIP. This requires that the monitored attainment year in the SIP and the budget years are modeled and replaced with MOVES emissions. For example, I have looked at Canton's approved ozone SIP (it is on the OEPA website) and 2004 is the attainment year in the SIP and 2009 and 2018 are budget years. These are the years that would need new MOVES emissions numbers. You need to have the 2004 attainment year included so that safety margin can be allocated to the budget years.

Question 7 of the Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes (PDF) (17 pp, 148K, EPA-420-B-09-046, December 2009) gives details of what needs to be addressed in the SIP revision.
This type of a revision could be processed at our office in about 90 days from formal submission.

Another option is do the the full 8-year maintenance plan update required by the Clean Air Act. Eight years after formal redesignation to attainment, a new maintenance plan is needed to extend the maintenance time frame out another 10 years. This update would not only update the earlier budgets with MOVES but would provide for 10 more years of maintenance. It would need to examine and project point and area source emissions. OAQPS has guidance on maintenance plan updates.
This type of submittal would take up to 18 months to process at our office.

I will start work on putting together a table of all the Ohio ozone areas and the years in the approved ozone maintenance plan, for each area, that will need to be modeled for the update to MOVES.

Pat

Patricia Morris
Environmental Scientist
USEPA Region 5
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Appendix B
Post Processing Default Distributions

HOUR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PCTADT																								
URB FWY	0.9	0.6	0.5	0.6	0.9	2.2	5.2	7.3	6.4	5.2	4.9	5.1	5.3	5.5	6.1	7.2	8.0	7.9	5.8	4.2	3.4	2.9	2.2	1.5
URB ART	0.7	0.4	0.3	0.3	0.6	1.5	3.5	5.7	5.5	5.1	5.3	6.2	6.5	6.4	6.8	7.6	8.2	8.1	6.2	4.8	4.0	3.0	1.9	1.3
RUR FWY	1.4	1.1	0.9	1.0	1.3	2.2	3.7	5.2	5.4	5.4	5.6	5.6	5.7	6.0	6.5	7.1	7.5	7.0	5.6	4.5	3.8	3.2	2.5	2.0
RUR ART	0.8	0.5	0.4	0.5	1.0	2.4	4.8	6.2	5.5	5.3	5.5	5.8	6.0	6.0	6.7	7.6	8.1	7.7	5.6	4.2	3.5	2.8	1.9	1.3
PCTADT TRK																								
URB FWY	2.1	1.9	1.8	2.0	2.4	3.0	3.9	4.6	5.3	6.0	6.3	6.4	6.4	6.4	6.3	5.8	5.2	4.6	4.1	3.7	3.4	3.1	2.8	2.4
URB ART	1.1	0.9	1.0	1.2	1.6	2.3	3.9	5.9	6.9	6.7	7.1	7.6	7.4	7.2	7.4	7.2	6.0	5.0	3.7	2.8	2.3	1.9	1.5	1.3
RUR FWY	2.6	2.2	2.1	2.3	2.6	3.1	3.5	4.0	4.5	5.1	5.6	5.8	5.8	5.8	5.8	5.6	5.3	4.9	4.6	4.3	4.0	3.8	3.5	3.1
RUR ART	1.5	1.3	1.4	1.6	2.2	3.0	4.2	5.3	6.1	6.7	7.0	7.1	7.0	6.9	6.8	6.3	5.5	4.6	3.8	3.1	2.6	2.3	2.1	1.7
PCTDIR																								
URB FWY	38	40	40	46	56	64	70	70	68	62	58	52	52	52	50	46	38	38	46	52	46	42	42	40
URB ART	44	46	44	48	54	62	66	68	64	56	54	52	50	50	50	46	40	38	46	52	48	46	46	46
RUR FWY	44	46	48	54	60	68	68	64	58	54	52	50	50	52	52	48	42	40	44	48	48	44	46	44
RUR ART	40	42	44	48	58	66	72	68	60	56	54	50	50	50	50	46	40	38	46	50	46	44	44	44

LOS E VC	0	0.625	1.25	1.875	2.5	3.125	3.75	4.375	5	5.625	6.25	6.875	7.5	8.125	8.75	9.375	10	10.625	11.25	11.875	12.5	13.125	13.75	14.375
SPEEDVC																								
curve1	75	75	75	75	75	75	74.9	74.8	74.6	74.2	73.5	72.3	70.5	67.8	64.2	59.5	54	47.7	41.2	34.9	28.9	23.7	19.2	15.5
curve2	70	70	70	70	70	70	70	69.9	69.8	69.6	69.2	68.4	67.1	65.1	62.2	58.2	53	47	40.5	33.9	27.7	22.2	17.6	13.8
curve3	65	65	65	65	65	65	65	65	65	64.9	64.8	64.4	63.8	62.6	60.5	57	52	45.4	37.8	29.9	22.7	16.7	12.1	8.6
curve4	60	60	60	60	60	60	60	60	60	59.9	59.8	59.6	59.1	58.2	56.7	54.3	50.8	46.1	40.3	33.8	27.3	21.3	16.2	12.2
curve5	55	55	55	55	55	55	55	55	55	55	55	54.9	54.7	54.3	53.6	52.3	50	46.5	41.5	35.3	28.5	21.9	16.1	11.5
curve6	60	60	60	60	60	60	60	60	59.9	59.8	59.7	59.4	59.1	58.5	57.7	56.5	55	53.1	50.7	47.9	44.7	41.1	37.3	33.4
curve7	55	55	55	55	55	55	55	55	54.9	54.9	54.7	54.5	54.2	53.8	53.1	52.2	50.9	49.3	47.3	44.9	42.1	39	35.7	32.2
curve8	50	50	50	50	50	50	50	50	49.9	49.9	49.8	49.6	49.4	49	48.5	47.7	46.7	45.4	43.8	41.8	39.5	36.8	33.9	30.9

curve9	45	45	45	45	45	45	45	45	45	44.9	44.8	44.7	44.4	44.1	43.6	43	42.1	40.9	39.4	37.6	35.5	33.1
30.5	27.8																					
curve10	50	50	50	50	49.9	49.8	49.7	49.4	49	48.4	47.5	46.5	45.1	43.5	41.7	39.6	37.3	34.9	32.4	29.8	27.3	24.9
22.6	20.4																					
curve11	50	50	50	50	50	49.9	49.7	49.4	48.9	48	46.7	44.9	42.5	39.6	36.2	32.6	28.7	25	21.4	18.2	15.3	12.9
10.8	9																					
curve12	50	50	50	50	50	49.9	49.8	49.6	49.1	48.2	46.8	44.5	41.4	37.5	32.9	28	23.1	18.7	14.9	11.8	9.2	7.2
5.7	4.5																					
curve13	40	40	40	40	40	40	39.9	39.8	39.5	39.2	38.6	37.8	36.7	35.3	33.5	31.4	29	26.4	23.7	21.1	18.5	16.1
13.9	12																					
curve14	40	40	40	40	40	39.9	39.8	39.6	39.1	38.5	37.5	36.1	34.3	32.1	29.4	26.5	23.5	20.5	17.7	15.1	12.8	10.7
9	7.6																					
curve15	40	40	40	40	40	39.9	39.7	39.4	38.8	37.9	36.5	34.7	32.3	29.5	26.4	23.2	20	17	14.3	11.9	9.9	8.2
6.8	5.6																					
curve16	35	35	35	35	35	34.9	34.8	34.5	34	33.2	32.1	30.5	28.5	26.1	23.5	20.6	17.9	15.2	12.8	10.7	8.9	7.4
6.1	5.1																					
curve17	35	35	35	35	35	34.9	34.7	34.4	33.9	33.1	32	30.3	28.3	25.8	23.1	20.3	17.5	14.9	12.5	10.4	8.6	7.2
5.9	4.9																					
curve18	35	35	35	35	35	34.9	34.6	34.2	33.5	32.4	30.9	28.8	26.3	23.4	20.4	17.4	14.6	12.1	9.9	8.1	6.6	5.4
4.4	3.6																					
curve19	30	30	30	30	30	29.9	29.8	29.5	29	28.2	27.1	25.6	23.7	21.5	19.1	16.6	14.2	12	10	8.3	6.8	5.6
4.6	3.8																					
curve20	30	30	30	30	30	29.9	29.7	29.4	28.9	28.1	26.9	25.3	23.4	21.1	18.6	16.1	13.6	11.4	9.5	7.8	6.4	5.3
4.3	3.6																					
curve21	30	30	30	30	30	29.9	29.7	29.3	28.7	27.7	26.2	24.4	22.1	19.6	17	14.4	12	9.9	8.1	6.6	5.4	4.4
3.6	2.9																					

VC RATIO TO LOS CONVERSION (VALUE SHOWN IS LOWER LIMIT FOR THAT LOS)(URBAN ROADS USE SPEED BREAKS BELOW FOR LOS DETERMINATION) (ALL USE THE BASE VC'S TO DETERMINE EXCEEDANCE)

	BASE	RUR2	FWY
A	0.00	0.00	0.00
B	0.30	0.00	0.25
C	0.50	0.10	0.40
D	0.70	0.30	0.60
E	0.90	0.50	0.80
F	1.00	1.00	1.00
F+	1.10	1.10	1.10
F++	1.30	1.30	1.30

SPEED VC RATIO BREAKS FOR URBAN STREETS (HIGHEST SPEED FOR GIVEN LOS & FF SPEED)

FFS	B	C	D	E	F
>47	42.	34.	27.	21.	16.
>37	35.	28.	22.	17.	13.
>32	30.	24.	18.	14.	10.
<33	25.	19.	13.	9.	7.

LEVEL OF SERVICE THRESHOLD BY AREA

NUM	LOS	DEFINITION
1	F	CINCINNATI,CLEVELAND,COLUMBUS CENTRAL MPO COUNTIES (CUY,FRA,HAM)
2	E	OTHER TMA MPOS (AKRON,CANTON,DAYTON,TOLEDO,YOUNGSTOWN + NON-CENTRAL COUNTIES FROM 1)
3	E	OTHER MPOS & PARTS OF AREAS 1 & 2 OUTSIDE URBANIZED AREA
4	E	RURAL NON MPO COUNTIES

PEAK SPREADING MODEL INFO (SET MAX ITERATIONS TO 0 TO DISABLE PEAK SPREADING)
MAX VC RATIO FWY: 1.30
MAX VC RATIO ART: 1.30
MAX ITERATIONS : 1000

TRUCK PCE: 2.0

AQ SEASON FACTOR: 1.08

MODEL CLASS PARAMETERS (MAX 4 CLASSES, HOURS 0-23 W/ NO OVERLAP IN CLASS, ALLOCATE ENTIRE CLASS AS TRUCK(1) OR NOT(0))

CLS TRK	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLS BEG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLS END	23	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLS NUM	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0