

TDM2MOVES

A TRAVEL DEMAND MODEL APPLICATION
TO GENERATE TRAVEL ACTIVITY INPUT
DATA FOR THE MOVES MODEL

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II. TDM2MOVES - description

- ▣ Travel demand model application (CUBE)
- ▣ Post process following traffic assignment
- ▣ **Creates CSV input for MOVES (42 files)**
 - Speed profile
 - VMT by vehicle type
 - Ramp percentage
 - Road type distribution
- ▣ **Creates travel activity summary (24 files)**
- ▣ Run time: 47 sec

III. TDM2MOVES - data inputs

- ▣ HPMS factors
 - Adjust model results to HPMS
 - ▣ For the base year: $HPMS_f = HPMS_{vmt} / MODEL_{vmt}$
 - By county and facility
- ▣ AADT factors
 - By county, facility, and season
- ▣ VMT mix (vehicle type activity percentage)
 - By county, facility, and year

AADT & HPMS Factors Look-up Table

A	HPMSF	aadtF_SM	aadtF_WT	HPMSR	aadtR_SM	aadtR_WT	HPMSL	aadtL_SM	aadtL_WT	HPMSA	aadtA_SM	aadtA_WT
1	0.983	1.042	0.955	0.983	1.042	0.955	2.966	1.016	0.972	1.120	1.016	0.972
2	1.043	1.042	0.955	1.043	1.042	0.955	2.886	1.016	0.972	1.051	1.016	0.972
3	0.928	1.010	0.989	0.928	1.010	0.989	2.769	1.018	0.972	0.979	1.018	0.972
4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	1.013	1.042	0.955	1.013	1.042	0.955	3.978	1.016	0.972	0.957	1.016	0.972
6	0.867	1.010	0.989	0.867	1.010	0.989	3.132	1.018	0.972	0.901	1.018	0.972
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Note – Column “A” denotes county or city geographic area.

Sample Look-up Table for Arterial VMT Mix Factors

A	YEAR	VEH_11	VEH_21	VEH_31	VEH_32	VEH_41	VEH_42	VEH_43	VEH_51	VEH_52	VEH_53	VEH_54	VEH_61	VEH_62
1	2010	0.00572	0.41117	0.34416	0.11799	0.00255	0.00079	0.00288	0.00110	0.03584	0.00484	0.00216	0.02950	0.04131
2	2010	0.00619	0.44451	0.34937	0.11978	0.00156	0.00049	0.00177	0.00077	0.02513	0.00339	0.00151	0.01897	0.02656
3	2010	0.00622	0.44709	0.36227	0.12420	0.00125	0.00039	0.00141	0.00061	0.01999	0.00270	0.00120	0.01361	0.01906
4	2010	0.00594	0.42691	0.34782	0.11924	0.00164	0.00051	0.00186	0.00087	0.02838	0.00383	0.00171	0.02553	0.03575
1	2020	0.00500	0.35940	0.38436	0.12731	0.00269	0.00075	0.00299	0.00107	0.03668	0.00540	0.00224	0.02921	0.04290
2	2020	0.00543	0.39029	0.39194	0.12982	0.00166	0.00047	0.00184	0.00075	0.02584	0.00380	0.00158	0.01887	0.02771
3	2020	0.00546	0.39214	0.40598	0.13447	0.00132	0.00037	0.00147	0.00060	0.02054	0.00302	0.00126	0.01352	0.01986
4	2020	0.00521	0.37392	0.38925	0.12893	0.00174	0.00049	0.00193	0.00085	0.02911	0.00429	0.00178	0.02533	0.03720
1	2030	0.00453	0.32509	0.41015	0.13044	0.00292	0.00079	0.00320	0.00114	0.03933	0.00585	0.00244	0.02998	0.04414
2	2030	0.00494	0.35456	0.42005	0.13359	0.00181	0.00049	0.00198	0.00080	0.02782	0.00414	0.00172	0.01945	0.02864
3	2030	0.00496	0.35625	0.43511	0.13838	0.00144	0.00039	0.00158	0.00064	0.02212	0.00329	0.00137	0.01394	0.02052
4	2030	0.00472	0.33896	0.41627	0.13239	0.00189	0.00051	0.00207	0.00090	0.03128	0.00466	0.00194	0.02605	0.03836

Note – Column “A” denotes county geographic area.

IV. TDM2MOVES – methodology

(continued)

- ▣ Link level calculations
 - Speed profile
 - ▣ (determine speed bin and tally VHT)
 - VMT by vehicle type
 - Ramp percentage
 - Road type distribution

TDM2MOVES Files Created

- ▣ MV_VMTxVeh_SL2030_sm.csv *
- ▣ MV_Ramp_SL2030.csv
- ▣ MV_Road_SL2030_sm.csv*
- ▣ MV_Speed_SL2030.csv
- ▣ hpmsVMTxBinS_SL2030.csv*
- ▣ Summary_SL2030.csv

**Note – “S” and “sm” denote summer season files. Winter season files are also created and denoted with “W” and “wt”.*

V. Emission Calculations

look-up tables

- ▣ Run MOVES: emission rates
 - Rates lookup table: by speed bin & facility
 - Can be reused
- ▣ VMT summary: by speed bin & facility
- ▣ Spreadsheet: $\text{Emissions} = \text{rates} * \text{VMT}$

Sample MOVES Emission Rates

Modified as Excel lookup table

Index	County	yearID	monthID	dayID	hourID	linkID	pollutantID	processID	roadTypeID	avgSpeedBinID	ratePerDistance
SL_2008_NOx_RunEx_A_1	SL	2008	1	5	1	490350501	NOx	RunEx	A	1	4.46209
SL_2008_NOx_RunEx_A_2	SL	2008	1	5	1	490350502	NOx	RunEx	A	2	2.64693
SL_2008_NOx_RunEx_A_3	SL	2008	1	5	1	490350503	NOx	RunEx	A	3	1.86211
SL_2008_NOx_RunEx_A_4	SL	2008	1	5	1	490350504	NOx	RunEx	A	4	1.65442
SL_2008_NOx_RunEx_A_5	SL	2008	1	5	1	490350505	NOx	RunEx	A	5	1.53544
SL_2008_NOx_RunEx_A_6	SL	2008	1	5	1	490350506	NOx	RunEx	A	6	1.45602
SL_2008_NOx_RunEx_A_7	SL	2008	1	5	1	490350507	NOx	RunEx	A	7	1.38056
SL_2008_NOx_RunEx_A_8	SL	2008	1	5	1	490350508	NOx	RunEx	A	8	1.3413
SL_2008_NOx_RunEx_A_9	SL	2008	1	5	1	490350509	NOx	RunEx	A	9	1.36536
SL_2008_NOx_RunEx_A_10	SL	2008	1	5	1	490350510	NOx	RunEx	A	10	1.38655
SL_2008_NOx_RunEx_A_11	SL	2008	1	5	1	490350511	NOx	RunEx	A	11	1.40248
SL_2008_NOx_RunEx_A_12	SL	2008	1	5	1	490350512	NOx	RunEx	A	12	1.41631
SL_2008_NOx_RunEx_A_13	SL	2008	1	5	1	490350513	NOx	RunEx	A	13	1.43723
SL_2008_NOx_RunEx_A_14	SL	2008	1	5	1	490350514	NOx	RunEx	A	14	1.48416
SL_2008_NOx_RunEx_A_15	SL	2008	1	5	1	490350515	NOx	RunEx	A	15	1.53439
SL_2008_NOx_RunEx_A_16	SL	2008	1	5	1	490350516	NOx	RunEx	A	16	1.56722

Note: This table can be reused for instantaneous emission calculations.

VMT Totals by Speed Bin and Road Type

(Lookup table: can be used with emission rate table)

Index	Speed Bin	RMP_VMT	FWY_VMT	ART_VMT	LCL_VMT
SL2030W_1	1	-	-	3,502	-
SL2030W_2	2	26,998	-	69,880	-
SL2030W_3	3	134,794	3,014	106,573	2,768,581
SL2030W_4	4	157,030	14,219	269,776	3,823,279
SL2030W_5	5	184,980	50,063	897,561	-
SL2030W_6	6	30,442	92,124	2,721,698	-
SL2030W_7	7	3,649	209,723	4,048,567	-
SL2030W_8	8	-	611,216	3,282,539	-
SL2030W_9	9	-	466,449	2,027,823	-
SL2030W_10	10	-	467,461	640,145	-
SL2030W_11	11	-	926,352	289,876	-
SL2030W_12	12	-	1,539,872	97,369	-
SL2030W_13	13	-	1,734,102	-	-
SL2030W_14	14	-	9,322,568	-	-
SL2030W_15	15	-	694,546	-	-
SL2030W_16	16	-	203,144	-	-

VI. Other MOVES Adaptations

Daily VMT Inputs

▣ **MOVES = Annual**

▣ **Conformity = Daily**



Daily VMT Inputs

- ▣ Modify default database
 - MOVESdb_21010515
- ▣ Save modified database
 - UtahDailyMOVESdb_21010515
- ▣ Set modified database as default
 - MOVES gui: *Settings/Configure MOVES*
- ▣ **Another webinar?**

Daily VMT Inputs

Modified MOVES tables

■ Monthvmfraction

- design month = 1
- all others = 0

■ Dayvmtfractions

- design month:
 - roadTypeID = 1-5, 32, 52
 - dayID = 5
 - dayVMTFraction = 1
- all other days = 0

■ Hourvmtfraction

- all dayID (2) = 0
- all dayID (5) = MOVES default

■ Monthofanyyear

- all noOfDays = 1

■ Dayofanyweek

- noOfRealDays for weekend = 0
- noOfRealDays for Weekdays=7

V. Other MOVES Adaptations

New Road Type For Local Roads

- ▣ *THIS IS OPTIONAL!*
- ▣ Local Roads = residential streets
- ▣ Less truck activity on locals
- ▣ Mobile6 separated local roads
- ▣ MOVES combines locals with arterials
 - Truck activity on local roads exaggerated
- ▣ **Another webinar?**

Summary

- ▣ Automated MOVES inputs from TDM
- ▣ Daily scale for VMT inputs
- ▣ Created additional road type (local)

The End

Questions?

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Overview

- I. WFRC travel model characteristics
- II. TDM2MOVES - description
- III. TDM2MOVES - data inputs
- IV. TDM2MOVES - methodology
- V. Emission calculations: *look-up tables*
- VI. Other MOVES adaptations
 - a. Daily VMT inputs
 - b. New road type for Local Roads

I. WFRC Travel Model Characteristics

- ▣ Population
 - 2010 2.2M
 - 2040 3.5M
- ▣ Four counties
 - distinct I/M programs
- ▣ Six non-attainment areas (+2 for O₃)
- ▣ Two pollution seasons
- ▣ Four time periods (*AM, midday, PM, evening*)
- ▣ TDM zones – 3,400
- ▣ TDM links – 21,000

IV. TDM2MOVES – methodology

- ▣ Link level calculations
- ▣ Aggregate & sort results
- ▣ Generate files
 - MOVES inputs
 - VMT summary

Calculation: Road Distribution

$$\text{Veh}_n \text{PctFwy}_w = \frac{(\text{rampVMT} + \text{fwyVMT}) * \text{HPMSf} * \text{AADTf}_w * \text{mixF}_n}{\text{TotalVMT}_w \{\text{for veh}_n\}}$$

And likewise for Arterials, Locals, and Total VMT.....

Where:

RampVMT, *fwyVMT*, *artVMT*, and *locVMT* is the modeled VMT for freeways, ramps, arterials, and local roads respectively,

mixF_n, *mixA_n*, and *mixL_n* is the percentage of VMT on freeways/ramps, arterials, and local roads respectively for vehicle type “n” (MOVES types 10, 20, 30, 40, 50, 60),

HPMSf, *HPMSa*, *HPMSl* is the HPMS adjustment factor for freeways/ramps, arterials, and local roads respectively, and

AADTf_w, *AADTa_w*, and *AADTl_w* is the winter AADT factor for freeways/ramps, arterials, and local roads respectively.

IV. TDM2MOVES – methodology

(continued)

- ▣ **Aggregate calculations**
 - **By time period**
 - **By speed bin**
 - **By facility type**
 - **By city (*non-attainment only*)**
 - **By county**
 - **By season (*VMT & Road type*)**
- ▣ **Print Resulting Files**
 - **“MV” prefix for MOVES inputs**
 - **Year, county, season, file type**
 - **CSV format**
 - **Summary files with “lookup” index**

Calculation: Speed Profile

For the AM time period:

$$P_{fwyVHT_AMbin_x} = fwyVHT_AMbin_x / \{[SUM]fwyVHT_AM\}$$

and,

$$P_{artVHT_AMbin_x} = artVHT_AMbin_x / \{[SUM]artVHT_AM\}$$

and,

$$P_{locVHT_AMbin_x} = locVHT_AMbin_x / \{[SUM]locVHT_AM\}$$

Repeat for midday (MD), PM peak (PM) & evening (EV)

Where:

$P_{fwyVHT_AMbin_x}$, $P_{artVHT_AMbin_x}$, and $P_{locVHT_AMbin_x}$ are the percentage of VHT in speed bin “x” for freeways, arterials, and local roads respectively,

$fwyVHT_AMbin_x$, $artVHT_AMbin_x$ and $locVHT_AMbin_x$ are the VHT on freeway, arterial and local road class links with operating speeds in the range of bin_x, and

$[SUM]fwyVHT_AM$, $[SUM]artVHT_AM$ and $[SUM]locVHT_AM$ are the totals respectively of all freeway, arterial and local road VHT for all speed ranges.

Calculation: VMT by Vehicle Type

$$VMT_{wtVeh_n} = (rampVMT + fwyVMT) * mixF_n * HPMSf * AADTf_{wt} + artVMT * mixA_n * HPMSa * AADTa_{wt} + locVMT * mixL_n * HPMSl * AADTl_{wt}$$

Where:

VMT_{wtVeh_n} is the winter VMT for vehicle type “n” (MOVES types 10, 20, 30, 40, 50, 60),

$RampVMT$, $fwyVMT$, $artVMT$, and $locVMT$ is the modeled VMT for freeways, ramps, arterials, and local roads respectively,

$mixF_n$, $mixA_n$, and $mixL_n$ is the percentage of VMT on freeways/ramps, arterials, and local roads respectively for vehicle type “n” (MOVES types 10, 20, 30, 40, 50, 60),

$HPMSf$, $HPMSa$, $HPMSl$ is the HPMS adjustment factor for freeways/ramps, arterials, and local roads respectively, and

$AADTf_{wt}$, $AADTa_{wt}$, and $AADTl_{wt}$ is the winter AADT factor for freeways/ramps, arterials, and local roads respectively.

Calculation: Ramp Percentage

$$\mathit{RampPCT} = \mathit{rampVHT} / (\mathit{rampVHT} + \mathit{fwyVHT})$$

Subject to EPA Review.

Where:

RampPCT is the ramp VHT as a percentage of total ramp and freeway VHT,

rampVHT is the VHT on ramps, and

fwyVHT is the VHT on freeways.

MOVES Input File Example: Speed Profile By Vehicle, Road, Hour, Day, & Speed Bin Salt Lake County 2030

sourceTypeID	roadTypeID	hourDayID	avgSpeedBinID	avgSpeedFraction
21	5	85	1	0.0079
21	5	85	2	0.0963
21	5	85	3	0.0108
21	5	85	4	0.0153
21	5	85	5	0.0453
21	5	85	6	0.1969
21	5	85	7	0.2776
21	5	85	8	0.2057
21	5	85	9	0.103
21	5	85	10	0.0282
21	5	85	11	0.0081
21	5	85	12	0.0048
21	5	85	13	0
21	5	85	14	0
21	5	85	15	0
21	5	85	16	0
21	5	95	1	0
21	5	95	2	0.0037
21	5	95	3	0.0061
21	5	95	4	0.0073
21	5	95	5	0.0674
21	5	95	6	0.2075
21	5	95	7	0.3132
21	5	95	8	0.2022
21	5	95	9	0.1388
21	5	95	10	0.0338
21	5	95	11	0.0153
21	5	95	12	0.0046
21	5	95	13	0
21	5	95	14	0
21	5	95	15	0
21	5	95	16	0

MOVES Input File Example:
VMT By Vehicle Type
Salt Lake County 2030 Winter

HPMSVtypeID	yearID	HPMSBaseYearVMT	baseYearOffNetVMT
10	2030	187661	0
20	2030	13482605	0
30	2030	22174384	0
40	2030	83189	0
50	2030	742200	0
60	2030	1249629	0

MOVES Input File Example:
Ramp Fraction
Salt Lake County 2030

roadTypeID	rampFraction
2	0
4	0.121

MOVES Input File Example: Road Type Distribution By Vehicle Type

Salt Lake County 2030

sourceTypeID	roadTypeID	roadTypeVMTFraction
21	1	0
21	2	0
21	3	0
21	32	0
21	4	0.4552
21	5	0.382
21	52	0.1629
31	1	0
31	2	0
31	3	0
31	32	0
31	4	0.4332
31	5	0.3739
31	52	0.1929
41	1	0
41	2	0
41	3	0
41	32	0
41	4	0.3813
41	5	0.5925
41	52	0.0261
51	1	0
51	2	0
51	3	0
51	32	0
51	4	0.3999
51	5	0.534
51	52	0.0661
61	1	0
61	2	0
61	3	0
61	32	0
61	4	0.5726
61	5	0.3986
61	52	0.0287

Note - new road types created for rural local (32) and urban local (52) (optional)

Also note the difference in local road percentage for passenger cars (16.2%) and heavy trucks (2.8%)

Index for Emission Rate Look Up Tables

Sample

SL_2008_NOx_RunEx_A_1

County – Year – Pollutant – Process – Road Type – Speed Bin

Summary File

Index	VMT_model	VHT_model	HPMS factor	VMT-hpms	VMT-hpms Summer	VMT-hpms Winter	VHT-hpms	speed	delay
SL2030_TOTAL	36,023,953	1,064,396	--	38,713,875	39,274,242	37,919,914	1,364,039	33.84	130,203
SL2030_RMP	586,073	42,357	0.928	543,876	549,315	537,894	39,308	13.84	17,302
SL2030_FWY	17,797,989	307,661	0.928	16,516,534	16,681,699	16,334,852	285,509	57.85	40,196
SL2030_ART	15,190,722	524,520	0.979	14,871,717	15,139,408	14,455,309	513,505	28.96	72,622
SL2030_LCL	2,449,169	189,858	2.769	6,781,749	6,903,820	6,591,860	525,717	12.9	82
SL2030_AM	6,514,744	189,566	--	6,879,696	6,977,031	6,743,377	235,064	34.37	28,215
SL2030_MD	11,993,167	338,500	--	13,007,727	13,198,164	12,736,377	447,489	35.43	20,292
SL2030_PM	9,594,447	331,859	--	10,302,134	10,452,605	10,087,978	408,488	28.91	80,836
SL2030_EV	7,921,596	204,471	--	8,524,319	8,646,442	8,352,182	272,999	38.74	861
SL2030_RMP_AM	99,533	7,281	0.928	92,367	93,290	91,351	6,757	13.67	3,026
SL2030_RMP_MD	200,685	14,657	0.928	186,236	188,098	184,188	13,602	13.69	6,076
SL2030_RMP_PM	142,691	13,546	0.928	132,418	133,742	130,961	12,571	10.53	7,441
SL2030_RMP_EV	143,164	6,873	0.928	132,856	134,184	131,394	6,378	20.83	760
SL2030_FWY_AM	3,469,958	61,925	0.928	3,220,121	3,252,322	3,184,699	57,467	56.03	9,881
SL2030_FWY_MD	5,685,897	90,201	0.928	5,276,512	5,329,277	5,218,470	83,707	63.04	4,567
SL2030_FWY_PM	4,567,242	94,320	0.928	4,238,400	4,280,784	4,191,778	87,529	48.42	25,746
SL2030_FWY_EV	4,074,893	61,215	0.928	3,781,500	3,819,315	3,739,904	56,808	66.57	2
SL2030_ART_AM	2,563,239	90,746	0.979	2,509,411	2,554,580	2,439,147	88,840	28.25	15,295
SL2030_ART_MD	5,231,371	165,796	0.979	5,121,512	5,213,699	4,978,110	162,314	31.55	9,619
SL2030_ART_PM	4,242,404	174,217	0.979	4,153,314	4,228,073	4,037,021	170,559	24.35	47,628
SL2030_ART_EV	3,153,709	93,760	0.979	3,087,481	3,143,055	3,001,031	91,791	33.64	81
SL2030_LCL_AM	382,014	29,614	2.769	1,057,798	1,076,838	1,028,179	82,000	12.9	13
SL2030_LCL_MD	875,214	67,846	2.769	2,423,467	2,467,089	2,355,610	187,866	12.9	30
SL2030_LCL_pm	642,110	49,776	2.769	1,778,002	1,810,006	1,728,218	137,830	12.9	22
SL2030_LCL_EV	549,831	42,623	2.769	1,522,482	1,549,887	1,479,853	118,022	12.9	18

