

APPENDIX H

Bus Emissions Estimation

MEMORANDUM

October 7, 2010

To: Files
From: Erin Morrow, MWCOG/DTP
Subject: Transit and School Bus Emissions

Background

For the development of the HDV percentage in the VMT mix for Mobile6.2, staff divided the vehicle class into trucks and buses, with the further breakdown of buses into transit bus and school bus categories. This memo discusses the collection of information from regional transit providers and the development of ozone season NOx and VOC, winter CO, and PM_{2.5} precursor NOx and direct PM_{2.5} emissions estimates for transit and school buses for various analysis years.

Approach

Data Collection

In order to obtain current regional transit data, staff developed a questionnaire for transit providers and school bus operators in the region. The technique of emailing and then conducting follow-up phone calls produced a high response rate. Staff used response data to complete table a table showing daily VMT with average operating speed, by provider (Table 1).

Fleet Age Distribution

Using 2008 VIN data, staff developed regional school bus and transit bus age distributions (shown in Tables 2A and 2B respectively) and diesel sales fractions which were used in the Mobile6.2 model to develop emissions rates. A detailed description of this process can be found in a June 9, 2009 memo from Daivamani Sivasailam in the VIN Decoder Project Files. For simplification purposes, because the number of buses other than diesel is statistically insignificant, the fleet will be input to the Mobil6.2 model as 100 percent diesel. Emissions for buses that are not diesel (e.g. CNG buses) are accounted for using TERM analysis.

VMT Estimates

The annual VMT from the survey was divided by the number of service days for each provider to calculate a daily VMT. To account for bus VMT for providers in the region for which no survey data was received, staff estimated VMT by using data from providers with similar service type. In many cases, where VMT data was not provided, total number of buses was provided, making the estimate process more accurate. In Table 1B, estimated VMT values are shown in italics. Daily school bus VMT represents a school day in May.

The resulting daily 2001 VMT from the survey, including estimation values from providers for which no data was received, is 277,000 for transit buses (compared to 180,000 in the FY03-08 TIP), and 489,900 for school buses.

For estimating bus VMT for the future, staff used the HDBS (school bus) and HDBT (transit bus) values in the "National Average Vehicle Miles Traveled Fractions by Vehicle Class" table from EPA's *Technical Guidance on the use of Mobile 6 for Emission Inventory Preparation* to modify current data. This is shown as Table 3.

Emission Estimates

Using the survey data, staff created transit bus and school bus emission tables. In the tables, the daily VMT was adjusted from the base (survey) year (2001) using the method described above. The fleet age distributions as an input to the Mobile6.2 model to produce emission factors for each pollutant, by speed. Factors for PM_{2.5} pollutants were prepared for each of 3 seasons (Season 1: January-April, Season 2: May-September, Season 3: October-December) Using the appropriate emission factor, based on the average operating speed for each provider, staff calculated each pollutant's emissions for transit buses and school buses for each analysis year. Table 4 shows a one-year sample of bus emission factors. Tables 5A-5F show a one-year sample of transit and school bus emissions for each of the pollutants analyzed.

TABLE 1
2001 Bus
Operating Statistics

Service	Contact	Average Speed	Daily VMT
	Name		
Metrobus	Lora Byala	10	123,299
Fairfax Connector	Andy Szakos	15	18,036
PRTC Omnalink	Tim Roseboom	15	4038
Alexandria DASH	Cindy Modell	13	3,454
City of Fairfax CUE	Alex Verzosa	15	1,483
Arlington Co. ART	Jim Maslanka	16	794
Loudoun Transportation Assc.	Mark McGregor	15	4,532
Mont. Co. Ride-On	Phil McLaughlin	14.5	35,616
PG Co. The Bus	Frank Bell	15-20	9,723
Fredrick Co. TransiT	Sherry Burford	11.78	3,082
Corridor Transit (CTC)	Joe Gann	17.8	1,265
Crystal City Express		15	96
Skyline Crystal Express		15	144
PRTC OmniRide	Tim Roseboom	26.62	5,700
Loudoun Commuter Service	Sharon Affinito	25	1,866
MTA Commuter buses	Larry Dougherty	45	10,453
Lee Coaches	Joe Ann Foweler	45	70
Brooks Transit		45	750
Quicks Commuter Service	Robbie Quick	45	1,320
Eyre buses (under MTA)	Teri Lee Cosker	45	(under MTA)
Dillon buses (under MTA)	Ron Dillon Sr.	45	(under MTA)
Keller buses (under MTA)	Charles D. Keller	45	(under MTA)
National Coach Works	Jeff Bodnar	45	1,650
Greyhound / Trailways (VA)	David Cohen	55	5000
Peter Pan / Trailways	Christ Crean	55	2000
Carolina Trailways		55	500
Capitol Trailways	Ms.Gale Ellsworth	55	500
Martz / Grey Line sightseeing	Robert Lynch	55-68	5000
New World	Arnold Brown	20	299
Washington Flyer Coach Service	Nicholas Marshall	65	1,370
ShuttleUM (U. of MD)	Cynthia Trombly	11.1	1,864

TABLE 1
2001 Bus
Operating Statistics

Service	Contact	Average Speed	Daily VMT
	Name		
Georgetown U. shuttle	Diann Nock Smith	15	100
American U. shuttle	Thomas Leathers	20-25	83
George Washington U shuttle	John Kane	15	100
CIA Shuttle		15	200
EPA Shuttle		15	200
USDOT Shuttle	Franklin Weaver	15	200
Gallaudet Shuttle	Darnese Nicholson	15	100
Tourmobile	Richard Lewis	15	(Gas powered)
Old Town "trolley" buses		20	300
Metro Access - paratransit	Avon Mackel	15	5000
Fairfax Co. Fastran- paratransit	Steve Yaffe	14.53	11,427
Alexandria DOT-paratransit	Lakeshia Lewis	15	924
Arlington STAR-paratransit	Eric Smith	15	3,245
City of Ffx, City Wheels-paratransit.	Alex Verzosa	15	100
City of Falls Ch. Fare Wheels-paratransit	Letha Flippin	15	100
Loudoun Transit (LCTA)-paratransit	Mark McGregor	15	100
P.G. Co. paratransit	Frank Bell	15	3000
All buses excluding school			277,361
School buses - DC	Alfred Winder	14	10000
School buses- Mont. Co.	Qiyu C. Wu	30	27,000
School buses- P.G. Co.	Mark Dreszer	30	28,896
School buses- Fred. Co.	Richard Wandres	30	10,747
School buses- Alexandria	Velma Tsongos	25	3520
School buses- Arl. Co.	Daniel Roseboro	25	4800
School buses- Ffx. Co.	Tim Parker	30-35	24,112
School buses- Loud. Co.	J Michael Lunsfurg	30	11,906
School buses- P.W. Co.	Eward Bishop	30	8,144

Total for School Buses

129,126

Table 2A
2008 Regional Age Fractions
Vehicle Type=HDBS
Number of Decoded Vins=6484

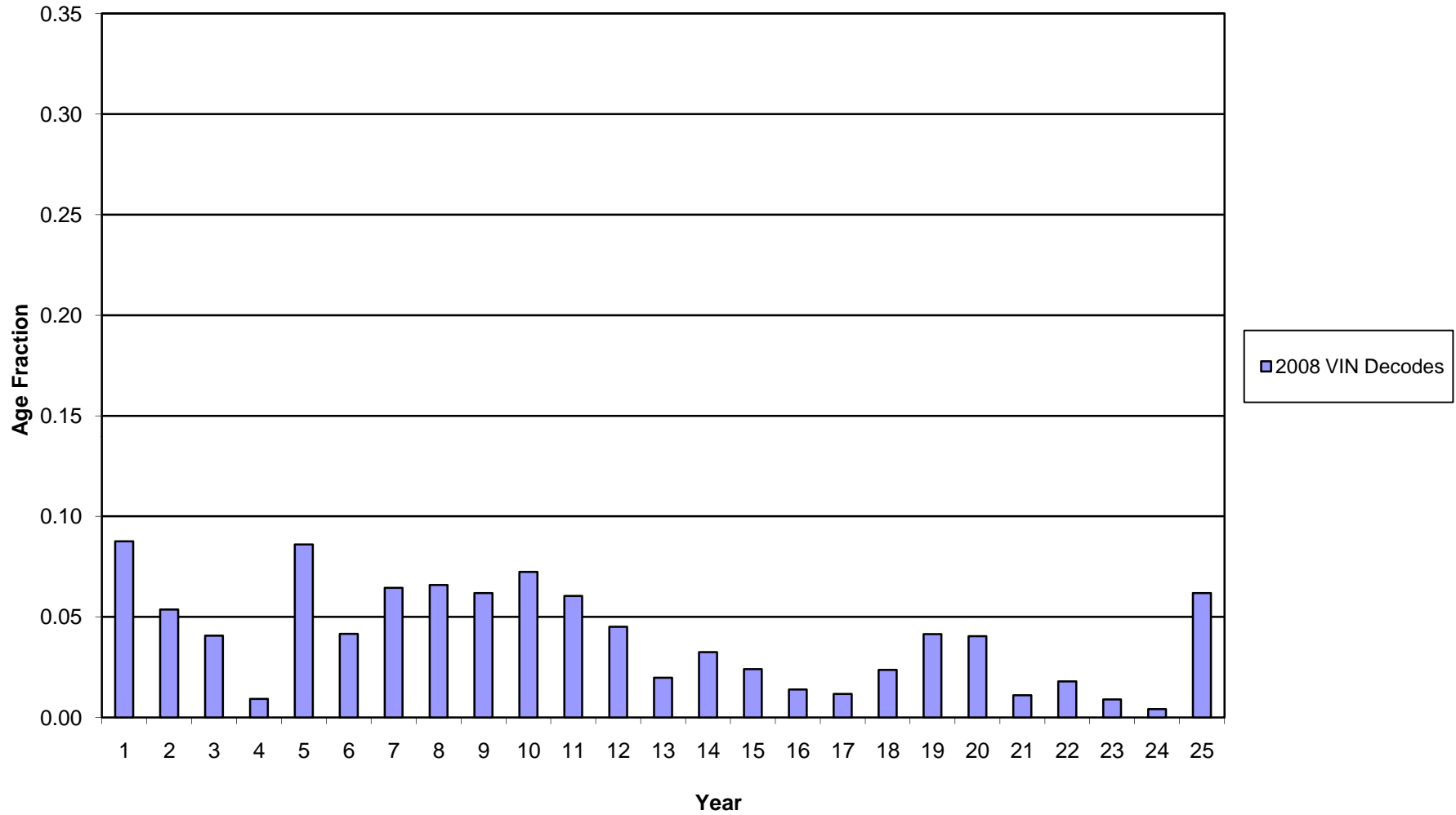


Table 2B
2008 Regional Age Fractions
Vehicle Type=HDBT
Number of Decoded Vins=6148

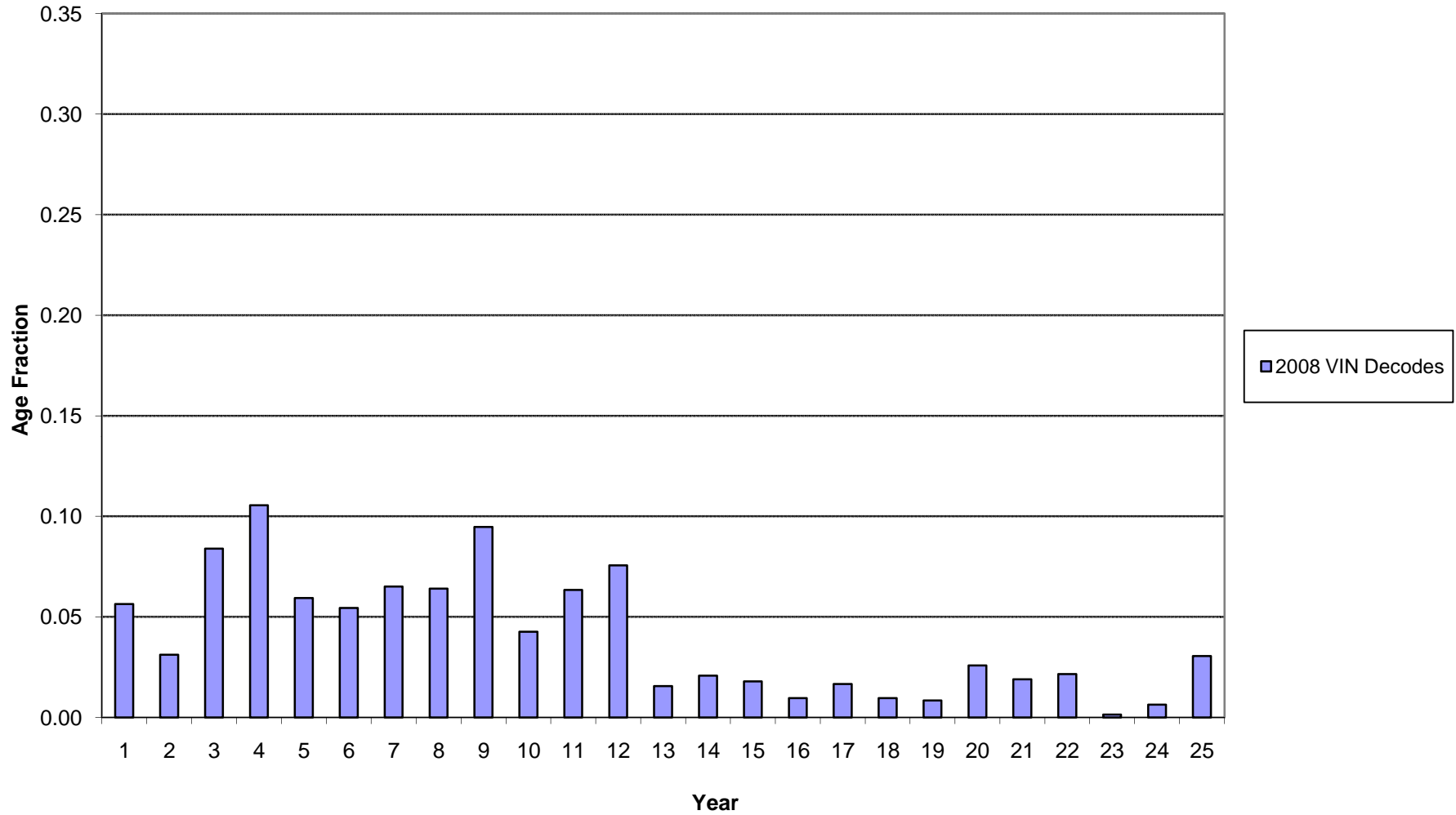


Table 3
National Average Vehicle Miles Traveled Fractions By Vehicle Class
Using MOBILE6

Calendar Year	LDV 1	LDT1 2	LDT2 3	LDT3 4	LDT4 5	HDV2B 6	HDV3 7	HDV4 8	HDV5 9	HDV6 10	HDV7 11	HDV6A 12	HDV6B 13	HD8S 14	HD8T 15	MC 16
1990	0.6284	0.0420	0.1397	0.0586	0.0260	0.0332	0.0034	0.0020	0.0018	0.0064	0.0079	0.0094	0.0337	0.0017	0.0008	0.0073
1991	0.6212	0.0435	0.1446	0.0560	0.0257	0.0336	0.0035	0.0021	0.0017	0.0066	0.0081	0.0095	0.0341	0.0017	0.0008	0.0072
1992	0.6109	0.0456	0.1518	0.0555	0.0255	0.0342	0.0036	0.0022	0.0017	0.0068	0.0083	0.0097	0.0346	0.0017	0.0008	0.0071
1993	0.6009	0.0477	0.1587	0.0551	0.0253	0.0348	0.0036	0.0023	0.0018	0.0070	0.0085	0.0098	0.0350	0.0017	0.0008	0.0070
1994	0.5910	0.0497	0.1655	0.0546	0.0251	0.0354	0.0037	0.0024	0.0018	0.0072	0.0087	0.0100	0.0355	0.0018	0.0008	0.0070
1995	0.5815	0.0517	0.1721	0.0542	0.0248	0.0356	0.0037	0.0025	0.0019	0.0073	0.0089	0.0101	0.0360	0.0018	0.0009	0.0069
1996	0.5721	0.0534	0.1776	0.0547	0.0252	0.0362	0.0037	0.0025	0.0019	0.0075	0.0090	0.0102	0.0364	0.0018	0.0009	0.0068
1997	0.5669	0.0557	0.1863	0.0571	0.0263	0.0367	0.0037	0.0026	0.0020	0.0077	0.0092	0.0104	0.0370	0.0018	0.0009	0.0067
1998	0.5360	0.0590	0.1983	0.0605	0.0276	0.0372	0.0038	0.0027	0.0021	0.0079	0.0095	0.0106	0.0378	0.0019	0.0009	0.0065
1999	0.5153	0.0622	0.2071	0.0638	0.0284	0.0377	0.0038	0.0026	0.0021	0.0081	0.0097	0.0107	0.0382	0.0019	0.0009	0.0064
2000	0.4953	0.0655	0.2179	0.0672	0.0309	0.0380	0.0038	0.0029	0.0022	0.0082	0.0098	0.0108	0.0386	0.0019	0.0009	0.0062
2001	0.4785	0.0683	0.2273	0.0700	0.0322	0.0381	0.0038	0.0029	0.0022	0.0083	0.0099	0.0109	0.0388	0.0019	0.0009	0.0061
2002	0.4646	0.0706	0.2349	0.0724	0.0333	0.0382	0.0038	0.0030	0.0022	0.0084	0.0100	0.0109	0.0390	0.0019	0.0009	0.0060
2003	0.4507	0.0729	0.2425	0.0748	0.0344	0.0384	0.0038	0.0030	0.0023	0.0085	0.0100	0.0110	0.0392	0.0019	0.0009	0.0059
2004	0.4365	0.0752	0.2503	0.0771	0.0355	0.0386	0.0038	0.0030	0.0023	0.0085	0.0101	0.0111	0.0394	0.0019	0.0009	0.0058
2005	0.4231	0.0774	0.2577	0.0794	0.0365	0.0387	0.0038	0.0031	0.0023	0.0086	0.0102	0.0111	0.0395	0.0020	0.0009	0.0057
2006	0.4096	0.0797	0.2654	0.0818	0.0376	0.0387	0.0038	0.0031	0.0023	0.0086	0.0102	0.0111	0.0396	0.0020	0.0009	0.0056
2007	0.3952	0.0822	0.2735	0.0843	0.0388	0.0387	0.0038	0.0031	0.0023	0.0086	0.0102	0.0111	0.0396	0.0020	0.0009	0.0056
2008	0.3807	0.0846	0.2817	0.0866	0.0399	0.0388	0.0038	0.0031	0.0024	0.0087	0.0102	0.0111	0.0397	0.0020	0.0009	0.0055
2009	0.3669	0.0869	0.2894	0.0892	0.0410	0.0389	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0398	0.0020	0.0010	0.0054
2010	0.3544	0.0891	0.2966	0.0914	0.0420	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0399	0.0020	0.0010	0.0054
2011	0.3428	0.0911	0.3031	0.0934	0.0430	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0398	0.0020	0.0010	0.0053
2012	0.3325	0.0928	0.3090	0.0952	0.0438	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0399	0.0020	0.0010	0.0053
2013	0.3231	0.0944	0.3143	0.0969	0.0445	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0399	0.0020	0.0010	0.0053
2014	0.3145	0.0959	0.3191	0.0983	0.0452	0.0391	0.0038	0.0032	0.0024	0.0088	0.0103	0.0112	0.0400	0.0020	0.0010	0.0052
2015	0.3071	0.0971	0.3233	0.0996	0.0458	0.0391	0.0039	0.0032	0.0024	0.0088	0.0104	0.0112	0.0400	0.0020	0.0010	0.0052
2016	0.3004	0.0982	0.3270	0.1008	0.0463	0.0392	0.0039	0.0033	0.0024	0.0088	0.0104	0.0112	0.0400	0.0020	0.0010	0.0052
2017	0.2944	0.0992	0.3304	0.1018	0.0468	0.0392	0.0039	0.0033	0.0024	0.0088	0.0104	0.0113	0.0401	0.0020	0.0010	0.0051
2018	0.2892	0.1001	0.3332	0.1027	0.0472	0.0393	0.0039	0.0033	0.0024	0.0088	0.0104	0.0113	0.0402	0.0020	0.0010	0.0051
2019	0.2846	0.1008	0.3357	0.1035	0.0476	0.0394	0.0039	0.0033	0.0025	0.0088	0.0104	0.0113	0.0403	0.0020	0.0010	0.0051
2020 - 2050	0.2793	0.1017	0.3384	0.1043	0.0480	0.0396	0.0039	0.0033	0.0025	0.0089	0.0105	0.0114	0.0405	0.0020	0.0010	0.0051

Source: Technical Guidance on the use of Mobile 6 for Emission Inventory Preparation, U.S. EPA, January 2002.

Table 4
MWCOG Regional 2011 Ozone Season Bus Emission Factors

Road Type	Speed (mph)	Diesel Bus Emission Factors (grams/mile)			
		School Bus		Transit Bus	
		VOC	NOx	VOC	NOx
Arterial/Freeway	1.00	1.766	14.362	1.059	17.398
Arterial/Freeway	2.00	1.766	14.362	1.059	17.398
Arterial/Freeway	3.00	1.695	13.871	1.016	16.8
Arterial/Freeway	4.00	1.606	13.257	0.963	16.051
Arterial/Freeway	5.00	1.552	12.888	0.931	15.602
Arterial/Freeway	6.00	1.441	12.145	0.864	14.696
Arterial/Freeway	7.00	1.362	11.614	0.816	14.048
Arterial/Freeway	8.00	1.302	11.216	0.781	13.563
Arterial/Freeway	9.00	1.256	10.906	0.753	13.185
Arterial/Freeway	10.0	1.219	10.658	0.731	12.883
Arterial/Freeway	11.0	1.153	10.242	0.691	12.376
Arterial/Freeway	12.0	1.098	9.896	0.658	11.954
Arterial/Freeway	13.0	1.052	9.602	0.631	11.597
Arterial/Freeway	14.0	1.012	9.351	0.607	11.29
Arterial/Freeway	15.0	0.978	9.133	0.586	11.025
Arterial/Freeway	16.0	0.934	8.878	0.56	10.714
Arterial/Freeway	17.0	0.895	8.653	0.537	10.439
Arterial/Freeway	18.0	0.861	8.453	0.516	10.195
Arterial/Freeway	19.0	0.83	8.274	0.498	9.977
Arterial/Freeway	20.0	0.802	8.113	0.481	9.781
Arterial/Freeway	21.0	0.771	7.96	0.463	9.595
Arterial/Freeway	22.0	0.743	7.821	0.446	9.425
Arterial/Freeway	23.0	0.718	7.694	0.43	9.271
Arterial/Freeway	24.0	0.694	7.578	0.416	9.129
Arterial/Freeway	25.0	0.673	7.471	0.403	8.999
Arterial/Freeway	26.0	0.651	7.394	0.39	8.904
Arterial/Freeway	27.0	0.63	7.322	0.378	8.817
Arterial/Freeway	28.0	0.611	7.255	0.366	8.736
Arterial/Freeway	29.0	0.593	7.193	0.356	8.66
Arterial/Freeway	30.0	0.577	7.135	0.346	8.589
Arterial/Freeway	31.0	0.561	7.12	0.336	8.571
Arterial/Freeway	32.0	0.546	7.106	0.327	8.553
Arterial/Freeway	33.0	0.531	7.092	0.319	8.537
Arterial/Freeway	34.0	0.518	7.08	0.311	8.522
Arterial/Freeway	35.0	0.505	7.068	0.303	8.507
Arterial/Freeway	36.0	0.494	7.111	0.296	8.56
Arterial/Freeway	37.0	0.483	7.151	0.289	8.609
Arterial/Freeway	38.0	0.472	7.19	0.283	8.656
Arterial/Freeway	39.0	0.462	7.227	0.277	8.701
Arterial/Freeway	40.0	0.453	7.261	0.271	8.743
Arterial/Freeway	41.0	0.444	7.366	0.266	8.87
Arterial/Freeway	42.0	0.436	7.465	0.262	8.991
Arterial/Freeway	43.0	0.429	7.56	0.257	9.107
Arterial/Freeway	44.0	0.422	7.65	0.253	9.217
Arterial/Freeway	45.0	0.415	7.737	0.249	9.323

Table 4
MWCOG Regional 2011 Ozone Season Bus Emission Factors

Road Type	Speed (mph)	Diesel Bus Emission Factors (grams/mile)			
		School Bus		Transit Bus	
		VOC	NOx	VOC	NOx
Arterial/Freeway	46.0	0.409	7.913	0.245	9.537
Arterial/Freeway	47.0	0.403	8.082	0.242	9.743
Arterial/Freeway	48.0	0.398	8.244	0.239	9.94
Arterial/Freeway	49.0	0.393	8.399	0.236	10.13
Arterial/Freeway	50.0	0.388	8.548	0.233	10.311
Arterial/Freeway	51.0	0.385	8.816	0.231	10.638
Arterial/Freeway	52.0	0.381	9.074	0.228	10.952
Arterial/Freeway	53.0	0.378	9.321	0.226	11.254
Arterial/Freeway	54.0	0.375	9.56	0.225	11.545
Arterial/Freeway	55.0	0.371	9.79	0.223	11.826
Arterial/Freeway	56.0	0.37	10.183	0.222	12.304
Arterial/Freeway	57.0	0.368	10.561	0.221	12.765
Arterial/Freeway	58.0	0.366	10.927	0.22	13.211
Arterial/Freeway	59.0	0.365	11.28	0.219	13.642
Arterial/Freeway	60.0	0.363	11.622	0.218	14.058
Arterial/Freeway	61.0	0.363	12.191	0.218	14.752
Arterial/Freeway	62.0	0.363	12.742	0.218	15.424
Arterial/Freeway	63.0	0.363	13.276	0.218	16.074
Arterial/Freeway	64.0	0.363	13.793	0.218	16.705
Arterial/Freeway	65.0	0.363	14.294	0.218	17.315
Fwy Ramp	34.6	0.51	7.268	0.306	8.859
Local	12.9	1.07	9.703	0.641	11.719

TABLE 5A
2010 CLRP/FY2011-2016 TIP AIR QUALITY CONFORMITY ANALYSIS
2011 SCHOOL BUS CHARACTERISTICS / EMISSIONS
(8-HOUR OZONE AREA*)

Jurisdiction	2002 Daily VMT	2010 Daily VMT	Average Speed	VOC			NOx		
				factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	12,696	13,331	14	1.012	13490.7696	0.0149	9.351	124656.3108	0.1374
Montgomery	100,000	105,000	30	0.577	60585.0000	0.0668	7.135	749175.0000	0.8258
Prince George's	129,967	136,465	30	0.577	78740.5070	0.0868	7.135	973680.2723	1.0733
Frederick	25,589	26,868	30	0.577	15503.0957	0.0171	7.135	191706.3908	0.2113
Charles	20,801	21,841	30	0.577	12602.2859	0.0139	7.135	155835.8918	0.1718
Calvert	25,653	26,936	30	0.577	15541.8701	0.0171	7.135	192185.8628	0.2118
Alexandria	2,028	2,129	25	0.673	1433.0862	0.0016	7.471	15908.7474	0.0175
Arlington	2,600	2,730	25	0.673	1837.2900	0.0020	7.471	20395.8300	0.0225
Fairfax	96,524	101,350	30	0.577	58479.0654	0.0645	7.135	723133.6770	0.7971
Prince William	36,114	37,920	30	0.577	21879.6669	0.0241	7.135	270557.0595	0.2982
Loudoun	28,347	29,764	30	0.577	17174.0300	0.0189	7.135	212368.6373	0.2341
TOTAL	480,319				297266.6666	0.3277		3629603.6795	4.0010

* MSA excluding Stafford County

TABLE 5B
2010 CLRP/FY2011-2016 TIP AIR QUALITY CONFORMITY ANALYSIS
2011 TRANSIT BUS CHARACTERISTICS / EMISSIONS
(8-HOUR OZONE AREA*)

Jurisdiction	Operator	2002 Daily VMT	2010 VMT w/o Stafford	Average Speed	VOC			NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	Metrobus	50,552	56,113	10	0.7310	41018.3983	0.0452	12.8830	722900.1718	0.7969
District of Columbia	MTA Commuter buses	2,510	2,786	45	0.2490	693.7389	0.0008	9.3230	25974.8103	0.0286
District of Columbia	Peter Pan / Trailways	200	222	55	0.2230	49.5060	0.0001	11.8260	2625.3720	0.0029
District of Columbia	Carolina Trailways	20	22	55	0.2230	4.9506	0.0000	11.8260	262.5372	0.0003
District of Columbia	Capitol Trailways	100	111	55	0.2230	24.7530	0.0000	11.8260	1312.6860	0.0014
District of Columbia	Martz / Grey Line sightseeing	500	555	55	0.2230	123.7650	0.0001	11.8260	6563.4300	0.0072
District of Columbia	New World Tours	100	111	20	0.4810	53.3910	0.0001	9.7810	1085.6910	0.0012
District of Columbia	Georgetown U. shuttle	100	111	15	0.5860	65.0460	0.0001	11.0250	1223.7750	0.0013
District of Columbia	American U. shuttle	83	92	20	0.4810	44.3145	0.0000	9.7810	901.1235	0.0010
District of Columbia	George Washington U shuttle	100	111	15	0.5860	65.0460	0.0001	11.0250	1223.7750	0.0013
District of Columbia	EPA Shuttle	200	222	15	0.5860	130.0920	0.0001	11.0250	2447.5500	0.0027
District of Columbia	USDOT Shuttle	200	222	15	0.5860	130.0920	0.0001	11.0250	2447.5500	0.0027
District of Columbia	Gallaudet Shuttle	100	111	15	0.5860	65.0460	0.0001	11.0250	1223.7750	0.0013
District of Columbia	Metro Access - paratransit	5,000	5,550	15	0.5860	3252.3000	0.0036	11.0250	61188.7500	0.0674
Maryland	Corridor Transit (CTC)	1,265	1,404	18	0.5160	724.5414	0.0008	10.1950	14315.3093	0.0158
Maryland	Peter Pan / Trailways	1,800	1,998	55	0.2230	445.5540	0.0005	11.8260	23628.3480	0.0260
Maryland	Carolina Trailways	225	250	55	0.2230	55.6943	0.0001	11.8260	2953.5435	0.0033
Maryland	Capitol Trailways	400	444	55	0.2230	99.0120	0.0001	11.8260	5250.7440	0.0058
Maryland	Martz / Grey Line sightseeing	2,250	2,498	55	0.2230	556.9425	0.0006	11.8260	29535.4350	0.0326
Maryland	New World Tours	100	111	20	0.4810	53.3910	0.0001	9.7810	1085.6910	0.0012
Montgomery	Metrobus	17,262	19,161	15	0.5860	11228.2405	0.0124	11.0250	211248.0405	0.2329
Montgomery	MTA Commuter buses	2,180	2,420	45	0.2490	602.5302	0.0007	9.3230	22559.7954	0.0249
Montgomery	Mont. Co. Ride-On	35,616	39,534	15	0.5860	23166.7834	0.0255	11.0250	435859.7040	0.4805
Prince George's	Metrobus	24,660	27,373	15	0.5860	16040.3436	0.0177	11.0250	301782.9150	0.3327

TABLE 5B
2010 CLRP/FY2011-2016 TIP AIR QUALITY CONFORMITY ANALYSIS
2011 TRANSIT BUS CHARACTERISTICS / EMISSIONS
(8-HOUR OZONE AREA*)

Jurisdiction	Operator	2002 Daily VMT	2010 VMT w/o Stafford	Average Speed	VOC			NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
Prince George's	MTA Commuter buses	6,840	7,592	45	0.2490	1890.5076	0.0021	9.3230	70783.9452	0.0780
Prince George's	PG Co. The Bus	9,723	10,793	15	0.5860	6324.4226	0.0070	11.0250	118987.6433	0.1312
Prince George's	ShuttleUM (U. of MD)	1,864	2,069	11	0.6910	1429.7066	0.0016	12.3760	25606.4390	0.0282
Prince George's	P.G. Co. paratransit	3,000	3,330	15	0.5860	1951.3800	0.0022	11.0250	36713.2500	0.0405
Frederick	MTA Commuter buses	370	411	45	0.2490	102.2643	0.0001	9.3230	3828.9561	0.0042
Frederick	Fredrick Co. TransiT	3,082	3,421	12	0.6580	2251.0312	0.0025	11.9540	40894.8731	0.0451
Charles	MTA Commuter buses	2,290	2,542	45	0.2490	632.9331	0.0007	9.3230	23698.1337	0.0261
Calvert	MTA Commuter buses	1,080	1,199	45	0.2490	298.5012	0.0003	9.3230	11176.4124	0.0123
Virginia	Metrobus	30,825	34,216	15	0.5860	20050.4295	0.0221	11.0250	377228.6438	0.4158
Virginia	Lee Coaches	70	54	45	0.2490	13.5431	0.0000	9.3230	507.0780	0.0006
Virginia	Brooks Transit	750	583	45	0.2490	145.1048	0.0002	9.3230	5432.9783	0.0060
Virginia	Quicks Commuter Service	1,320	1,026	45	0.2490	255.3844	0.0003	9.3230	9562.0417	0.0105
Virginia	National Coach Works	1,650	1,282	45	0.2490	319.2305	0.0004	9.3230	11952.5522	0.0132
Virginia	Greyhound / Trailways (VA)	5,000	3,885	55	0.2230	866.3550	0.0010	11.8260	45944.0100	0.0506
Virginia	Carolina Trailways	225	175	55	0.2230	38.9860	0.0000	11.8260	2067.4805	0.0023
Virginia	Martz / Grey Line sightseeing	2,250	1,748	55	0.2230	389.8598	0.0004	11.8260	20674.8045	0.0228
Virginia	New World Tours	100	78	20	0.4810	37.3737	0.0000	9.7810	759.9837	0.0008
Alexandria	Alexandria DASH	3,454	3,834	13	0.6310	2419.2161	0.0027	11.5970	44462.2022	0.0490
Alexandria	Old Town "trolley" buses	300	333	20	0.4810	160.1730	0.0002	9.7810	3257.0730	0.0036
Alexandria	Alexandria DOT-paratransit	924	1,026	15	0.5860	601.0250	0.0007	11.0250	11307.6810	0.0125
Arlington	Arlington Co. ART	794	881	16	0.5600	493.5504	0.0005	10.7140	9442.6768	0.0104
Arlington	Crystal City Express	96	107	15	0.5860	62.4442	0.0001	11.0250	1174.8240	0.0013
Arlington	Skyline Crystal Express	144	160	15	0.5860	93.6662	0.0001	11.0250	1762.2360	0.0019
Arlington	Arlington STAR-paratransit	3,245	3,602	15	0.5860	2110.7427	0.0023	11.0250	39711.4988	0.0438

TABLE 5B
2010 CLRP/FY2011-2016 TIP AIR QUALITY CONFORMITY ANALYSIS
2011 TRANSIT BUS CHARACTERISTICS / EMISSIONS
(8-HOUR OZONE AREA*)

Jurisdiction	Operator	2002 Daily VMT	2010 VMT w/o Stafford	Average Speed	VOC			NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
Fairfax	Fairfax Connector	18,036	20,020	15	0.5860	11731.6966	0.0129	11.0250	220720.0590	0.2433
Fairfax	Washington Flyer Coach Service	1,370	1,521	65	0.2180	331.5126	0.0004	17.3150	26330.9205	0.0290
Fairfax	Fairfax Co. Fastran- paratransit	11,427	12,684	15	0.5860	7432.8064	0.0082	11.0250	139840.7693	0.1541
Fairfax	City of Fairfax CUE	1,483	1,646	15	0.5860	964.6322	0.0011	11.0250	18148.5833	0.0200
Fairfax	City of Ffx, City Wheels- paratransit.	100	111	15	0.5860	65.0460	0.0001	11.0250	1223.7750	0.0013
Fairfax	City of Falls Ch. Fare Wheels- paratransit	100	111	15	0.5860	65.0460	0.0001	11.0250	1223.7750	0.0013
Prince William	PRTC Omnalink	4,038	4,482	15	0.5860	2626.5575	0.0029	11.0250	49416.0345	0.0545
Prince William	PRTC OmniRide	5,700	6,327	27	0.3780	2391.6060	0.0026	8.8170	55785.1590	0.0615
Loudoun	Loudoun Transportation Assc.	4,532	5,031	15	0.5860	2947.8847	0.0032	11.0250	55461.4830	0.0611
Loudoun	Loudoun Commuter Service	1,866	2,071	25	0.4030	834.7178	0.0009	8.9990	18639.2687	0.0205
Loudoun	Loudoun Transit (LCTA)- paratransit	100	111	15	0.5860	65.0460	0.0001	11.0250	1223.7750	0.0013
TOTAL		273,671	299,990			171087.8548	0.1886		3384551.5416	3.7308

* MSA excluding Stafford County

Notes:

- 1) Used WMATA percent VMT by jurisdiction from FY03-08 AQC, Appendix I (page I-3)
- 2) Assumed average freeway speed of 55 mph where higher than 55 speed limit is available, and 45 mph where speed limit is 55

Table 5C
2010 CLRP / FY2011-2016 TIP AIR QUALITY CONFORMITY ANALYSIS
2011 SCHOOL BUS CHARACTERISTICS / EMISSIONS
(PM_{2.5})

Jurisdiction	2001 Annual VMT	2002 Daily VMT	2010 Daily VMT	Average Speed	WINTER (January - April)					
					PM _{2.5}			precursor NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	2,800,000	12,670	13,303	14	0.5077	6754.0181	0.0074	10.1870	135519.3665	0.1494
Montgomery	19,000,000	85,973	90,271	30	0.5077	45830.8371	0.0505	7.7730	701680.3167	0.7735
Prince George's	21,000,000	95,023	99,774	30	0.5077	50655.1357	0.0558	7.7730	775541.4027	0.8549
Frederick	6,400,000	28,959	30,407	30	0.5077	15437.7557	0.0170	7.7730	236355.4751	0.2605
Charles	3,950,000	17,873	18,767	30	0.5077	9527.9898	0.0105	7.7730	145875.6448	0.1608
Alexandria	446,264	2,019	2,120	25	0.5077	1076.4554	0.0012	8.1390	17256.7866	0.0190
Arlington	571,986	2,588	2,718	25	0.5077	1379.7156	0.0015	8.1390	22118.3880	0.0244
Fairfax	18,200,000	82,353	86,471	30	0.5077	43901.1176	0.0484	7.7730	672135.8824	0.7409
Prince William	6,900,000	31,222	32,783	30	0.5077	16643.8303	0.0183	7.7730	254820.7466	0.2809
Loudoun	6,100,000	27,602	28,982	30	0.5077	14714.1109	0.0162	7.7730	225276.3122	0.2483
TOTAL	85,368,250	386,282	405,596			205920.9663	0.2270		3186580.3217	3.5126

Jurisdiction	2001 Annual VMT	2002 Daily VMT	2010 Daily VMT	Average Speed	SUMMER (May - September)					
					PM _{2.5}			precursor NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	2,800,000	12,670	13,303	14	0.4657	6195.2851	0.0068	9.3510	124397.9186	0.1371
Montgomery	19,000,000	85,973	90,271	30	0.4657	42039.4344	0.0463	7.1350	644087.1041	0.7100
Prince George's	21,000,000	95,023	99,774	30	0.4657	46464.6380	0.0512	7.1350	711885.7466	0.7847
Frederick	6,400,000	28,959	30,407	30	0.4657	14160.6516	0.0156	7.1350	216955.6561	0.2392
Charles	3,950,000	17,873	18,767	30	0.4657	8739.7771	0.0096	7.1350	133902.3190	0.1476
Alexandria	446,264	2,019	2,120	25	0.4657	987.4045	0.0011	7.4710	15840.4537	0.0175
Arlington	571,986	2,588	2,718	25	0.4657	1265.5773	0.0014	7.4710	20303.0442	0.0224
Fairfax	18,200,000	82,353	86,471	30	0.4657	40269.3529	0.0444	7.1350	616967.6471	0.6801
Prince William	6,900,000	31,222	32,783	30	0.4657	15266.9525	0.0168	7.1350	233905.3167	0.2578
Loudoun	6,100,000	27,602	28,982	30	0.4657	13496.8710	0.0149	7.1350	206785.8597	0.2279
TOTAL	85,368,250	386,282	405,596			188885.9445	0.2082		2925031.0658	3.2243

Jurisdiction	2001 Annual VMT	2002 Daily VMT	2010 Daily VMT	Average Speed	FALL (October - December)					
					PM _{2.5}			precursor NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	2,800,000	12,670	13,303	14	0.3696	4916.8507	0.0054	9.7720	129998.5520	0.1433
Montgomery	19,000,000	85,973	90,271	30	0.3696	33364.3439	0.0368	7.4490	672432.3529	0.7412
Prince George's	21,000,000	95,023	99,774	30	0.3696	36876.3801	0.0406	7.4490	743214.7059	0.8193
Frederick	6,400,000	28,959	30,407	30	0.3696	11238.5158	0.0124	7.4490	226503.5294	0.2497
Charles	3,950,000	17,873	18,767	30	0.3696	6936.2715	0.0076	7.4490	139795.1471	0.1541
Alexandria	446,264	2,019	2,120	25	0.3696	783.6477	0.0009	7.8010	16540.1391	0.0182
Arlington	571,986	2,588	2,718	25	0.3696	1004.4178	0.0011	7.8010	21199.8458	0.0234
Fairfax	18,200,000	82,353	86,471	30	0.3696	31959.5294	0.0352	7.4490	644119.4118	0.7100
Prince William	6,900,000	31,222	32,783	30	0.3696	12116.5249	0.0134	7.4490	244199.1176	0.2692
Loudoun	6,100,000	27,602	28,982	30	0.3696	10711.7104	0.0118	7.4490	215886.1765	0.2380
TOTAL	85,368,250	386,282	405,596			149908.1921	0.1652		3053888.9781	3.3663

Table 5D
2010 CLRP/FY2011-2016 TIP AIR QUALITY CONFORMITY
2011 SCHOOL BUS CHARACTERISTICS / EMISSIONS
Wintertime CO

Jurisdiction	Daily VMT	Average Speed	Wintertime CO		
			factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia *	13,331	14	4.061	54136	0.0597
Montgomery *	105,000	30	1.9000	199500	0.2199
Prince George's *	136,465	30	1.9000	259284	0.2858
Frederick	26,868	30	1.9000	51050	0.0563
Charles	21,841	30	1.9000	41498	0.0457
Calvert	26,936	30	1.9000	51178	0.0564
Alexandria *	2,129	25	2.2970	4891	0.0054
Arlington *	2,730	25	2.2970	6271	0.0069
Fairfax	101,350	30	1.9000	192565	0.2123
Prince William	37,920	30	1.9000	72047	0.0794
Loudoun	29,764	30	1.9000	56552	0.0623
Stafford	10,091	30	1.9000	19172	0.0211
TOTAL	514,425			1008145.3956	1.1113
TOTAL FOR CO NON-ATTAINMENT AREA*:					0.5777

* The non-attainment area for wintertime CO includes:

DC, ARL, ALEX, MONT, PG