Eastern Research Group, Inc.

Heavy-Highway Emission Inventory Update – 2012

Final Report

Prepared for:

Capital Area Council of Governments

Prepared by:

Eastern Research Group, Inc.

May 31, 2013

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1.0 Introduction

The purpose of this study was to develop site-specific emission inventory estimates for heavy-highway construction projects performed in the 5-county Austin-Round Rock-San Marcos Metropolitan Statistical Area (MSA) during 2012. These counties include Bastrop, Caldwell, Hays, Travis and Williamson.

Under a prior study,[1] Eastern Research Group, Inc. (ERG) worked with CAPCOG to obtain historical highway project information through Texas Department of Transportation (TxDOT) including project location, lane-miles, contract value, start and end dates, and equipment use in the study area. This information was used to develop a profile of equipment use and emissions for diesel construction equipment greater than 25 hp used in heavy-highway construction. The study focused on construction equipment included in the heavy-highway construction profile in the Texas Commission on Environmental Quality's (TCEQ's) TexN emissions model, including[2]:

- Crawler Tractor/Dozers;
- Surfacing Equipment;
- Excavators;
- Pavers;
- Paving Equipment;
- Rollers;
- Scrapers;
- Tractor/Loader/Backhoes; and
- Rubber Tire Wheeled Loaders.

In the prior study ERG categorized projects into five categories, based on general TxDOT project description, including:

- Bridgework;
- New/Rebuild;
- Repair/Resurface;
- Turn lane addition; and
- Miscellaneous.

These project categories were developed to capture the diverse types of equipment applications used in heavy-highway projects in the study area.

[1] "Heavy-Highway Emission Inventory Update", Eastern Research Group, Inc., prepared for CAPCOG, April 9, 2013.

[2] Although other diesel equipment is used during heavy-highway construction, such as skid steer loaders and rough terrain forklifts, the emissions associated with these equipment types are characterized in separate profiles within the TexN model, and are therefore excluded to avoid double-counting in the emission inventory.

Under the previous study, project-specific equipment use information was obtained from Daily Work Reports (DWR) submitted to TxDOT, indicating the type and number of equipment units utilized on-site for a given day. ERG used the DWR data, combined with other project information including lane-miles of construction and contract dollar value to develop equipment use profiles by project type. Activity profiles differed by project type, with equipment activity expressed in terms of number of piece-days required per lane-mile (for New/Rebuild, Repair/Resurface, and Turn Lane Addition profiles), and the number of piece-days required per million dollars of contract value (for the Bridgework and Miscellaneous profiles). These profiles were then combined with the corresponding lane-mile and contract value information for the 2006 and 2008 area projects to estimate the number of pieces of equipment used per day, by equipment type.

Under the current study, ERG compiled DWR and other TxDOT project data for highway construction projects underway during the summer of 2012 in the five county CAPCOG area. ERG combined the equipment population estimates from this data set with information from the TexN model regarding horsepower distributions, engine load factors, and average hours of use per day to estimate the total horsepower-hours associated with each construction project for the summer of 2012. The projects were then ranked by estimated horsepower-hours of engine use, and the top 25 projects from each analysis year were selected for project-specific emission estimation.

ERG then input the resulting equipment population and hours of use estimates into the TCEQ's TexN model to estimate project-specific ozone-season day emissions for each of the 25 projects, for 2012. Remaining projects (below the 25th ranking position) had their equipment population and use information aggregated and input into TexN to produce county-level emissions estimates.

ERG provided the resulting project-specific emissions information, along with geocoded endpoint and midpoint latitude and longitude, in order to facilitate ozone modeling for the 2012 calendar year. Total emissions estimates for all project activity were also provided in NIF and XML formats for uploading into the TCEQ's TexAER system. Separate estimates were provided for both ozone summer weekday and weekend scenarios.

The following sections summarize the data analysis methodology, noting any differences adopted relative to the prior ERG study, as well as the estimated emission levels.

2.0 Data Collection and Processing

2.1 Data Collection

ERG utilized the DWR and other project data obtained from TxDOT for the 2006/2008 project for this analysis. The data covered a three year period ending in November of 2012. DWR data included a subset of TxDOT projects underway in the in the area during this time period. Each row in the Excel file represented information on equipment use for each day during the project, for each equipment category. Additional project information was obtained for all TxDOT highway projects occurring in the 5-county area from 2000 through 2012.

An After review of the TxDOT historical project data CAPCOG determined that information on the Manor Expressway project (Hwy 290 E) was not included in the TxDOT data set. It was determined that the Manor Expressway is a "design-build" project (meaning it did not include the TxDOT bid phase), and was therefore excluded from the standard TxDOT funding and project tracking mechanisms. Therefore CAPCOG and ERG contacted the Central Texas Regional Mobility Authority (CTRMA) to obtain information regarding project length, contract value, and start/endpoint locations for the project during the 2012 analysis year.[3] (CTRMA also confirmed that no other design-build projects were underway in the five-county area during this time.)

2.2 Data Processing

A review of the DWR reports identified 45 projects that were underway in the five county area during the summer of 2012. ERG filtered these to exclude projects that did not utilize any of the equipment types listed in Section 1 above. For example, a number of landscaping-related projects only utilized mowing equipment, and were therefore dropped from the list. After filtering, 34 projects remained with DWR data. Using the DWR dataset, ERG summed the number of piece-days associated with each equipment type for each project, and estimated total hours of use based on default average hours per day values from the TexN model. In this way project-specific equipment use profiles were developed for all 34 of these projects.

ERG then cross-referenced these 34 projects with the comprehensive list of projects obtained from TxDOT through the end of 2012. While all 34 projects were identified on the comprehensive list, an additional 51 projects were found that were also underway in the five county area during the summer of 2012. Even after filtering this list for project categories that do not typically use the equipment types listed in Section 1 (e.g., landscaping and signalization), 33 additional projects remained,. ERG assigned these

[3] Personal communication, Sean Beal, CTRMA, May 2013.

projects to one of the five standard project categories developed under the prior study for CAPCOG, and followed the same activity and emissions estimation procedure applied in the earlier study.

ERG also assigned the Manor Expressway to the New/Rebuild project category, and used the lane-mile and start/end date information obtained from the CTRMA to estimate an activity profile for this project for the summer of 2012. Therefore a total of 78 projects were included in the final project list.

Once activity estimates were developed for all 78 projects, they were ranked by estimated hp-hour totals for the summer of 2012, with the top 25 in each calendar year selected for project-specific emissions modeling using TexN (see Section 3). (hp-hrs were selected for the ranking given their close correlation with NOx emissions levels.) Table 2-1 lists the top 25 projects for each year in rank order, along with the estimated hp-hr values and project category.

Table 2-1. Top 25 Projects Ranked by HP-HR Estimates 2012

TxDOT Control ID	Rank	TOTAL HP-HRS	Project Category
N/A – design/build	1	7,258,274	New/Rebuild
044001035	2	280,900	New/Rebuild
341703015	3	227,754	Repair/Resurface
001508132	4	204,669	Repair/Resurface
070003014	5	198,533	Repair/Resurface
011313106	6	183,999	Bridgework
068306027	7	180,736	New/Rebuild
026504057	8	158,441	Bridgework
070003114	9	119,654	Turn Lanes
001508131	10	118,989	Repair/Resurface
015109139	11	114,644	Repair/Resurface
114901025	12	108,980	Repair/Resurface
153301019	13	106,329	Misc
028502012	14	105,471	Turn Lanes
120002027	15	93,906	Repair/Resurface
011307050	16	81,327	Turn Lanes
137802034	17	77,041	New/Rebuild
015106135	18	75,165	Repair/Resurface
120003030	19	65,975	Repair/Resurface
015203055	20	65,330	Repair/Resurface
118601088	21	53,086	Turn Lanes

TxDOT Control ID	Rank	TOTAL HP-HRS	Project Category
070003105	22	50,396	Turn Lanes
001509165	23	46,017	Repair/Resurface
001508116	24	45,935	Repair/Resurface
203803006	25	45,814	Repair/Resurface

3.0 Emissions Estimation

ERG used the data regarding project location, equipment populations, hours of use, and seasonal activity distribution to develop input files for use in the TexN model. TexN scenario files were generated for each of the top 25 projects for 2012, to estimate project-specific ozone-season weekday emissions.

ERG first began the modeling task by entering zero for all non-heavy-highway equipment population values for each of the five counties, in order to estimate default TexN emissions for heavy-highway diesel equipment in 2012. ERG then created individual scenario files for each of the 25 target projects, entering equipment population and hours per year estimates through the TexN GUI. All TexN scenarios were set to output ozone-season daily emissions, and assumed the use of TxLED fuel in all counties.

Using the project duration in days, as well as the months with activity, monthly allocation factors were generated for each project for use in the TexN Season.dat file. If a project was underway for the full year, the default Season.dat distribution was used (for diesel construction equipment operating in the Southwest). If a project was underway for less than the full twelve month period, the default allocation factors were re-normalized to adjust for the shorter operation period. Table 3-1 presents an example allocation adjustment for a project that operated from January through August. In this way all equipment activity is allocated by TexN to active project months only.

Table 3-1. Seasonal Allocation Adjustment Example: Project Operation January - August

	Jan	Feb	Mar	Apr	May	Jun
12-month (default)	0.075	0.075	0.084	0.084	0.084	0.09
Jan-Aug	0.111	0.111	0.125	0.125	0.125	0.134

	Jul	Aug	Sept	Oct	Nov	Dec
12-month (default)	0.09	0.091	0.084	0.084	0.084	0.075
Jan-Aug	0.134	0.135	0.000	0.000	0.000	0.000

The remaining projects (below the 25th ranking position) had their equipment population and use information aggregated and input into TexN to produce county-level emissions estimates. For these model runs, the hours of equipment use and the Season.dat file were adjusted to allocate activity only to the summer months (June – August), in order to exclude projects with no ozone season activity. Specifically, the default hours per year values in TexN were divided by four to estimate ozone-season hours of equipment use. In addition, the Season.dat file had factors of 0.333, 0.333, and

0.334 assigned to the June – August fields, and 0.000 assigned to the remaining months for these runs.[4]

Thirty TexN runs were performed: 25 project-specific runs and one run per county/year combination for the aggregated projects. The resulting project-specific emissions estimates were matched with geocoded endpoint and midpoint latitude and longitude, in order to facilitate ozone modeling for the 2012 calendar year. The TexN emission estimates for the aggregated county-level model runs were allocated back to their specific projects based on the relative summertime hp-hr values. These emissions were also matched with geocoded endpoint and midpoint data by CAPCOG, for modeling purposes.

ERG also estimated ozone season weekend emissions using the relative weekday:weekend activity allocation from the EPA's NONROAD emissions model (0.08334/0.16667 = 0.5, from the Season.dat file). Therefore all ozone season weekday emission estimates obtained from the TexN model outputs were reduced by 50% to reflect ozone season weekend emission levels.

Total emissions estimates for all project activity were provided in NIF and XML formats for uploading into the TCEQ's TexAER system, for both weekday and weekend scenarios.

[4] August was assigned 0.334 in order for the fractions to sum to 1.0, as required by TexN.

4.0 Results

4.1 Emissions Estimates

Table 4-1 presents the emissions estimates in tons per ozone-season weekday, for the top ranked projects sorted from highest to lowest emissions, as well as the allocated emissions for the county-level aggregated projects.

Table 4-1. Tons per Ozone Season Weekday, by Project

ERG Project #	County	VOC	PM10	PM2.5	CO	NOx
12-1	Travis	0.02527	0.024859	0.024113	0.13890	0.26150
12-2	Williamson	0.00153	0.001401	0.001359	0.00815	0.01526
12-3	Travis	0.00125	0.001060	0.001028	0.00661	0.01223
12-4	Williamson	0.00096	0.000922	0.000894	0.00537	0.00980
12-5	Travis	0.00115	0.000996	0.000966	0.00591	0.01105
12-6	Travis	0.00068	0.000656	0.000636	0.00366	0.00678
12-7	Williamson	0.00106	0.000964	0.000935	0.00555	0.01033
12-8	Bastrop	0.00080	0.000668	0.000648	0.00409	0.00765
12-9	Travis	0.00062	0.000573	0.000556	0.00338	0.00652
12-10	Williamson	0.00056	0.000549	0.000532	0.00319	0.00557
12-11	Travis	0.00037	0.000374	0.000363	0.00214	0.00376
12-12	Travis	0.00038	0.000373	0.000361	0.00214	0.00377
12-13	Bastrop	0.00059	0.000498	0.000483	0.00291	0.00558
12-14	Hays	0.00064	0.000552	0.000536	0.00346	0.00639
12-15	Travis	0.00053	0.000415	0.000402	0.00296	0.00532
12-16	Hays	0.00057	0.000494	0.000479	0.00272	0.00523
12-17	Williamson	0.00033	0.000352	0.000341	0.00182	0.00345
12-18	Travis	0.00026	0.000255	0.000247	0.00150	0.00263
12-19	Travis	0.00025	0.000249	0.000242	0.00147	0.00257
12-20	Caldwell	0.00035	0.000379	0.000367	0.00174	0.00326
12-21	Travis	0.00018	0.000176	0.000171	0.00088	0.00172
12-22	Travis	0.00029	0.000233	0.000226	0.00153	0.00272
12-23	Williamson	0.00025	0.000191	0.000185	0.00140	0.00258
12-24	Williamson	0.00023	0.000191	0.000186	0.00109	0.00203
12-25	Williamson	0.00024	0.000195	0.000189	0.00129	0.00239
12-Bastrop, Other	Bastrop	0.00122	0.00101	0.00098	0.00625	0.01149
12-Caldwell. Other	Caldwell	0.00036	0.00040	0.00039	0.00201	0.00360
12-Hays, Other	Hays	0.00167	0.00148	0.00143	0.00878	0.01609
12-Travis, Other	Travis	0.00264	0.00217	0.00210	0.01379	0.02468
12-Williamson, Other	Williamson	0.00206	0.00174	0.00169	0.01151	0.02040
Total		**0.04728**	**0.04438**	**0.04305**	**0.25623**	**0.47635**

The estimated summertime hp-hr values for the projects below the top 25 cuttoff, the relative weighting factors, and allocated emissions, are presented in Table A-1. Table A-2 provides the latitude/longitude coordinates for each project.

4.2 Comparison with TexN Default Values

ERG also compared the emissions estimates shown above with the default estimates generated by the TexN model for the heavy-highway sector, as shown in Table 4-2.

Table 4-2. Emission Estimation Comparison with TexN Defaults

COUNTY	VOC	PM10	PM2.5	CO	NOx
CAPCOG Tons/Ozone Season Day					
Bastrop	0.002604	0.002174	0.002108	0.013247	0.024716
Caldwell	0.000709	0.000783	0.000759	0.003756	0.006860
Hays	0.002884	0.002525	0.002450	0.014962	0.027706
Travis	0.033870	0.032387	0.031415	0.184884	0.345245
Williamson	0.007208	0.006509	0.006313	0.039378	0.071820
Total	**0.04728**	**0.04438**	**0.04305**	**0.25623**	**0.47635**
TexN Tons/Ozone Season Day					
Bastrop	0.00287	0.002801	0.002717	0.015701	0.029230
Caldwell	0.00123	0.001197	0.001161	0.006785	0.012526
Hays	0.00886	0.008632	0.008373	0.048380	0.090313
Travis	0.13861	0.135081	0.131029	0.756720	1.412207
Williamson	0.06222	0.060636	0.058817	0.339702	0.633962
Total	**0.21379**	**0.208346**	**0.202096**	**1.167288**	**2.178240**
Percent	**22%**	**21%**	**21%**	**22%**	**22%**

The above table indicates the estimated emission level for 2012 is much lower than the TexN value, by about 80%. This is comparable to the reduction observed with the 2008 inventory estimate of about 75%.

Appendix A - Detailed Project and Equipment Data

Table A-1. Summertime HP-HR Estimates and Emission Allocation Factors for Aggregated 2012 Projects (not top 25)

Emissions Allocation fraction	ERG Project #	Total VOC	PM10	PM2.5	CO	NOx
0.05050	12-26	0.0004016	0.0003435	0.0003332	0.0021381	0.0038517
0.04751	12-27	0.0003778	0.0003232	0.0003135	0.0020114	0.0036235
0.04666	12-28	0.0003711	0.0003174	0.0003079	0.0019754	0.0035585
0.04492	12-29	0.0003572	0.0003056	0.0002964	0.0019018	0.0034260
0.04365	12-30	0.0003472	0.0002969	0.0002880	0.0018481	0.0033292
0.04304	12-31	0.0003423	0.0002927	0.0002840	0.0018220	0.0032822
0.04102	12-32	0.0003262	0.0002790	0.0002707	0.0017367	0.0031287
0.03892	12-33	0.0003095	0.0002647	0.0002568	0.0016477	0.0029683
0.03891	12-34	0.0003095	0.0002647	0.0002568	0.0016475	0.0029679
0.03792	12-35	0.0003015	0.0002579	0.0002502	0.0016053	0.0028919
0.03333	12-36	0.0002650	0.0002267	0.0002199	0.0014110	0.0025418
0.03175	12-37	0.0002525	0.0002160	0.0002095	0.0013443	0.0024216
0.03079	12-38	0.0002448	0.0002094	0.0002031	0.0013034	0.0023480
0.02993	12-39	0.0002380	0.0002036	0.0001975	0.0012672	0.0022828
0.02942	12-40	0.0002340	0.0002001	0.0001941	0.0012456	0.0022439
0.02855	12-41	0.0002270	0.0001942	0.0001884	0.0012087	0.0021774
0.02788	12-42	0.0002217	0.0001896	0.0001840	0.0011803	0.0021263
0.02635	12-43	0.0002096	0.0001792	0.0001739	0.0011156	0.0020097
0.02510	12-44	0.0001996	0.0001707	0.0001656	0.0010626	0.0019141
0.02388	12-45	0.0001899	0.0001624	0.0001576	0.0010109	0.0018211
0.02355	12-46	0.0001873	0.0001602	0.0001554	0.0009971	0.0017963
0.02349	12-47	0.0001868	0.0001598	0.0001550	0.0009947	0.0017918
0.02343	12-48	0.0001863	0.0001594	0.0001546	0.0009920	0.0017870
0.02317	12-49	0.0001843	0.0001576	0.0001529	0.0009811	0.0017675
0.02147	12-50	0.0001707	0.0001460	0.0001417	0.0009090	0.0016375
0.02085	12-51	0.0001658	0.0001418	0.0001375	0.0008826	0.0015899
0.01478	12-52	0.0001175	0.0001005	0.0000975	0.0006258	0.0011273
0.01218	12-53	0.0000969	0.0000829	0.0000804	0.0005157	0.0009290

Emissions Allocation fraction	ERG Project #	Total VOC	PM10	PM2.5	CO	NOx
0.01202	12-54	0.0000956	0.0000818	0.0000793	0.0005088	0.0009166
0.01158	12-55	0.0000921	0.0000788	0.0000764	0.0004905	0.0008835
0.01141	12-56	0.0000907	0.0000776	0.0000753	0.0004830	0.0008700
0.01042	12-57	0.0000829	0.0000709	0.0000687	0.0004411	0.0007946
0.00968	12-58	0.0000770	0.0000659	0.0000639	0.0004099	0.0007385
0.00935	12-59	0.0000743	0.0000636	0.0000617	0.0003958	0.0007130
0.00664	12-60	0.0000528	0.0000452	0.0000438	0.0002813	0.0005068
0.00651	12-61	0.0000517	0.0000443	0.0000429	0.0002755	0.0004963
0.00626	12-62	0.0000498	0.0000426	0.0000413	0.0002649	0.0004772
0.00596	12-63	0.0000474	0.0000405	0.0000393	0.0002521	0.0004542
0.00448	12-64	0.0000356	0.0000305	0.0000296	0.0001897	0.0003417
0.00434	12-65	0.0000345	0.0000295	0.0000287	0.0001838	0.0003312
0.00380	12-66	0.0000303	0.0000259	0.0000251	0.0001611	0.0002902
0.00311	12-67	0.0000248	0.0000212	0.0000205	0.0001318	0.0002374
0.00276	12-68	0.0000219	0.0000188	0.0000182	0.0001168	0.0002104
0.00245	12-69	0.0000195	0.0000167	0.0000162	0.0001036	0.0001867
0.00227	12-70	0.0000181	0.0000154	0.0000150	0.0000962	0.0001732
0.00179	12-71	0.0000142	0.0000122	0.0000118	0.0000757	0.0001363
0.00122	12-72	0.0000097	0.0000083	0.0000081	0.0000517	0.0000932
0.00051	12-73	0.0000041	0.0000035	0.0000034	0.0000216	0.0000389
0.00024	12-74	0.0000019	0.0000016	0.0000016	0.0000102	0.0000184
0.00014	12-75	0.0000011	0.0000009	0.0000009	0.0000058	0.0000105
0.00007	12-76	0.0000005	0.0000005	0.0000005	0.0000029	0.0000053
0.00003	12-77	0.0000003	0.0000002	0.0000002	0.0000015	0.0000026

Table A-2. Selected Project Coordinates for Photochemical Modeling (2012)

		START		MIDPOINT		END	
County	**ERG Proj #**	**Longitude Midpoint**	**Latitude Midpoint**	**Longitude Start**	**Latitude Start**	**Longitude End**	**Latitude End**
Travis	12-1	-97.67376083	30.32573946	-97.62303109	30.33098586	-97.57868894	30.34471471
Williamson	12-2	-97.80215843	30.85332369	-97.78944256	30.83301916	-97.77518178	30.81679286
Travis	12-3	-97.61667244	30.36912235	-97.59920355	30.35586856	-97.58098169	30.34443248
Williamson	12-4	-97.66406043	30.67410302	-97.62520883	30.78030545	-97.58923322	30.85661371
Travis	12-5	-98.065168	30.35359855	-98.05658418	30.34788054	-98.04438604	30.34268206
Travis	12-6	-97.76516751	30.22387959	-97.75280816	30.21697889	-97.7364558	30.21582872
Williamson	12-7	-97.70601179	30.47984503	-97.71042632	30.47871844	-97.70549447	30.47713094
Bastrop	12-8	-97.46657597	30.13935057	-97.49652362	30.15671776	-97.52944226	30.17654757
Travis	12-9	-97.91673316	30.28287299	-97.91537839	30.27770061	-97.91295405	30.27314377
Williamson	12-10	-97.66406043	30.67410302	-97.62520883	30.78030545	-97.58923322	30.85661371
Travis	12-11	-97.66764747	30.3207825	-97.66621474	30.28222604	-97.68656606	30.24963739
Travis	12-12	-97.67207986	30.14955111	-97.64056353	30.12476158	-97.61161414	30.10243335
Bastrop	12-13	-97.37048047	30.34960596	-97.40508664	30.27516045	-97.44520698	30.21191892
Hays	12-14	-98.153917	30.02027807	-98.12219039	30.01402855	-98.11601071	30.00628988
Travis	12-15	-97.51445348	30.4056207	-97.52479254	30.38132634	-97.53798377	30.34871935
Hays	12-16	-98.14408682	30.20658572	-98.11919	30.20462783	-98.10245735	30.19460327
Williamson	12-17	-97.8160401	30.52516003	-97.81066854	30.52679793	-97.80615262	30.52827201
Travis	12-18	-97.72611663	30.37317838	-97.71453611	30.35267764	-97.69345297	30.3357824
Travis	12-19	-97.61455557	30.25306864	-97.62344061	30.23862823	-97.63398218	30.22236396
Caldwell	12-20	-97.66781007	29.84697185	-97.67113758	29.82965347	-97.67351438	29.80923867
Travis	12-21	-97.5873007	30.24921716	-97.58516158	30.24829323	-97.58290362	30.24766625
Travis	12-22	-97.93186386	30.30240693	-97.92396101	30.29435224	-97.91671177	30.28419315
Williamson	12-23	-97.69299331	30.53599894	-97.69299331	30.57872399	-97.69121071	30.62552085
Williamson	12-24	-97.66893563	30.66675429	-97.66565583	30.67207776	-97.66246097	30.67730281
Williamson	12-25	-97.58748727	30.7350852	-97.58477773	30.70566222	-97.58591858	30.67488108