Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories

Final Report

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TCEQ Contract No. 582-19-92744
Work Order No. 582-21-22147-003

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ACRONYMS

ACS – American Community Survey

AERR - Air Emissions Reporting Requirements

APO - Aggregate Production Operations

AWS – Amazon Web Services

CAP – Criteria Air Pollutant

CDB – County Database

CERS – Consolidated Emissions Reporting Schema

CNG – Compressed Natural Gas

CO – Carbon Monoxide

DCE – Diesel Construction Equipment

EI – Emission Inventory

EIS – Emissions Inventory System

EPA – Environmental Protection Agency

ERG – Eastern Research Group, Inc.

GIS – Geographic Information System

HAP – Hazardous Air Pollutant

HP – Horsepower

LPG – Liquified Petroleum Gas

MOVES – Motor Vehicle Emissions Simulator

NAA – Nonattainment Area

NAAQS – National Ambient Air Quality Standard

NEI – National Emissions Inventory

NH_3 – Ammonia

NLCD – National Land Cover Database

NO_X – Nitrogen Oxides

OSD – Ozone Season Day

PM_{10} – Particulate Matter less than 10 microns in diameter

$PM_{2.5}$ – Particulate Matter less than 2.5 microns in diameter

PWC – Personal Watercraft

QA – Quality Assurance

RDM – Redesignation and Maintenance

RFG – Reformulated Gasoline

RFP – Reasonable Further Progress

SAS – Statistical Analysis Software

SCC – Source Classification Code

SIP – State Implementation Plan

SO_2 – Sulfur Dioxide

TCEQ – Texas Commission on Environmental Quality

TexAER – Texas Air Emissions Repository

TexN – Texas Nonroad

TexN2 – Texas Nonroad version 2

TPD – Tons per Day

TPY – Tons per Year

TxDOT – Texas Department of Transportation

TxLED – Texas Low Emission Diesel

VOC – Volatile Organic Compounds

XML – Extensible Markup Language

1.0 Overview

This report is Deliverable 9.2 for the project "Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories" (Contract Number 582-19-92744, Work Order 582-21-22147-003).

The purpose of this study was to develop a set of multipollutant, multiyear emissions inventories (EI) for all nonroad model mobile sources operating in Texas. These EIs are required to fulfill the United States Environmental Protection Agency (EPA)'s Air Emissions Reporting Requirements (AERR) and to support potential State Implementation Plan (SIP) development. The results include annual (tons per year) and average ozone season day (OSD) weekday (tons per day) emissions of criteria air pollutants (CAP), CAP precursors, and hazardous air pollutants (HAP) using the latest version of the Texas Nonroad (TexN) version 2 (TexN2) utility and EPA's Motor Vehicle Emission Simulator (MOVES) version 3 (MOVES3).

2.0 Background

The Texas Commission on Environmental Quality (TCEQ) contracted with Eastern Research Group, Inc. (ERG) to develop TexN version 1 and subsequent TexN2, which are utilities for estimating Texas-specific emissions from nonroad mobile sources, excluding commercial marine vessels, locomotives, drilling rigs, and aircraft. The TexN model used the EPA's standalone NONROAD model to calculate emissions, whereas TexN2 uses EPA's MOVES-Nonroad model. MOVES is required by the EPA for developing nonroad emissions estimates for SIP revisions, national emissions inventories (NEI), and reasonable further progress (RFP) analyses. Since TexN was first developed, the TCEQ has frequently updated the Texas-specific data and enhanced the utility's functions. The EPA recently updated the MOVES model, releasing MOVES3 in November of 2020 (US EPA, 2020), and TCEQ contracted with ERG to update TexN2 for full compatibility with MOVES3 (ERG, 2021). States are required to use the most recent version of the MOVES model when developing and submitting emissions estimates from specific nonroad mobile sources to EPA. Section 3 of this report describes the 2020 AERR EI development and results. Section 4 briefly describes the RFP and redesignation and maintenance (RDM) analyses that have separate, standalone full reports that are appended to this report as Appendix B, C, and D. Section 5 describes the data analysis and quality assurance (QA) checks performed on the EIs. All EIs described in this report and its appendices were generated using MOVES3 code version 3.0.1 with database version 'movesdb20210209' and TexN2 code version 2.2.0 with the TexN2 database last updated May 24, 2021.

3.0 2020 AERR EI

The U.S. EPA promulgated the AERR in December 2008, requiring states to submit EIs, and in some cases, inputs for EIs. The EPA requirement of state-submitted inputs for EIs is applicable to the nonroad sector (Section 3.3). The EPA uses state submittals along with other data sources to build the NEI, which is an official accounting of all emissions in the U.S. at a detailed level. The NEI serves as the foundation for trends analyses, air quality planning, regulation development, and health exposure analyses. The CAPs developed for the 2020 AERR EI include volatile organic compounds (VOC), carbon monoxide (CO), nitrogen oxides (NO_X), particulate matter (PM) with an aerodynamic diameter of less than 10 and 2.5 microns (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and ammonia (NH_3). Although lead is a CAP, MOVES does not produce emissions estimates because lead has been banned from motor vehicle gasoline since 1996. The HAPs are not listed individually in-text due to the large number of pollutants; see Tables 12 and 13 for the full list.

3.1 Inputs for TexN2

ERG implemented two key updates in the TexN2 database prior to developing the 2020 AERR EI, which included seasonal fuel properties and meteorology data.

3.1.1 Fuel Data

The TCEQ periodically collects and analyzes fuel samples taken from vehicle fueling stations across the state. The dataset ensures accuracy of local fuel information and provides the best data available to support SIP control strategy development. ERG incorporated the latest fuel sampling data conducted in the summer of 2020 (ERG, 2020a) into TexN2.2.

3.1.2 Meteorology Data

The TCEQ provided year 2019 meteorology data for the 2020 AERR EI as 2020 data was not available during the timeframe of this project. ERG converted TCEQ's Excel files (listed below) into the level of detail required for the TexN2 database `climate` table.

- mvs-zmh-texas-254-counties-2019-fall.csv
- mvs-zmh-texas-254-counties-2019-spring.csv
- mvs-zmh-texas-254-counties-2019-summer.csv
- mvs-zmh-texas-254-counties-2019-winter.csv

3.2 EI Development and Results

ERG developed the 2020 EI using MOVES version 3.0.1 and the database version *movesdb20210209*. The TexN2 utility version was 2.0.0, and the database version was imported from the utility file *TexN2_24may21.sql*, with the latest date stamp of "2021-05-21 20:17:16" in the TexN2 database `version` table. The TexN2 runs were executed in parallel for all 254 counties in Texas using the Amazon Web Services (AWS) cloud computing environment. The total time to complete the runs on AWS was 2 days.

The TexN2 utility estimates nonroad emissions by source classification code (SCC) and county for all fuel types. In addition, it allows for the disaggregation of diesel construction equipment (DCE) SCCs into unique DCE subsectors to account for differences in equipment activity by use in different sectors. Each DCE/SCC combination requires a separate MOVES-Nonroad run, resulting in up to 24 runs for each county, with a separate CDB created by TexN2 for each run. In addition to being disaggregated by DCE subsector, the TexN2 runs were performed with all emissions adjustments (e.g., for Texas Low Emission Diesel (TxLED) where applicable, altitude, etc.) applied in post-processing. These runs provide the most accurate emissions estimate for each county given the available Texas-specific data, and therefore form the basis of the emissions totals reported for the emissions inventory and this report.

The TexN2 utility generates several standard reports providing emissions by various categories, such as by county, SCC, etc. In addition, the utility outputs summary data adhering to the Consolidated Emissions Reporting Schema (CERS) written in the Extensible Markup Language (XML) compatible with the EPA's Emissions Inventory System (EIS) and the TCEQ's Texas Air Emissions Repository (TexAER). The CERS XML files for the 2020 AERR EI are provided separately as Deliverable 4.1.

Tables 1 through 13, A-1, and A-2 summarize the emissions for the 2020 AERR EI. Section 5.0 describes the relationship to the prior 2017 AERR EI and other data analysis and QA activities.

Table 1. 2020 OSD Criteria Emissions by Equipment Classification (Tons/Day)

Classification	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Agricultural Equipment	5.48	40.12	43.91	4.96	4.81	0.02	0.05
Commercial Equipment	23.9	17.71	735.49	1.84	1.74	0.03	0.06
Construction and Mining Equipment	15.42	76.11	195.85	6.73	6.47	0.08	0.21
Industrial Equipment	3.84	23.16	112.22	1.16	1.14	0.04	0.03
Lawn and Garden Equipment (Com)	61.77	14.17	1,244.31	5.69	5.26	0.03	0.08
Lawn and Garden Equipment (Res)	25.06	3.18	471.77	1.06	0.98	0.01	0.03
Logging Equipment	0.12	0.08	1.28	0.02	0.02	0	0
Pleasure Craft	28.25	10.93	132.78	0.34	0.32	0.01	0.02

Classification	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Railroad Equipment	0.09	0.41	1.42	0.05	0.05	0	0
Recreational Equipment	21.95	1.6	166.13	0.66	0.61	0	0.01
Total*	**185.87**	**187.49**	**3,105.14**	**22.52**	**21.39**	**0.22**	**0.49**

* Note that totals may not match the sum of counties due to rounding in the values by county. Additional significant digits in the EIs are available in the electronic file **Deliverable_4.3_AERR_Summary_Data_20210630.xlsx** that accompanies this report.

Table 2. 2020 Annual Criteria Emissions by Equipment Classification (Tons/Year)

Classification	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Agricultural Equipment	1,305	9,761	10,446	1,171	1,135	4	10
Commercial Equipment	7,457	6,123	220,828	580	549	12	18
Construction and Mining Equipment	4,147	21,945	50,783	1,805	1,735	21	57
Industrial Equipment	1,169	7,562	32,460	352	345	12	10
Lawn and Garden Equipment (Com)	16,133	3,763	295,219	1,532	1,413	13	19
Lawn and Garden Equipment (Res)	8,541	1,241	159,236	394	363	6	9
Logging Equipment	37	28	390	6	5	0	0
Pleasure Craft	10,518	5,116	59,670	156	145	5	9
Railroad Equipment	26	120	396	14	13	0	0
Recreational Equipment	6,896	561	51,406	211	194	2	3
Total*	**56,232**	**56,225**	**880,839**	**6,224**	**5,904**	**79**	**139**

* Note that totals may not match the sum of counties due to rounding in the values by county. Additional significant digits in the EIs are available in the electronic file **Deliverable_4.3_AERR_Summary_Data_20210630.xlsx** that accompanies this report.

Table 3. 2020 OSD Criteria Emissions by Selected Area (Tons/Day)

Regional Group	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Alamo Area Council of Governments	16.87	12.72	288.9	1.84	1.74	0.02	0.04
Beaumont-Port Arthur Area	2.9	2.14	50.98	0.27	0.26	0	0.01
Capital Area Council of Governments	14.01	11.95	243.92	1.65	1.56	0.02	0.04
Dallas-Fort Worth Area (10 county)	41.61	39.37	857.72	5.07	4.79	0.06	0.11
El Paso	2.91	3.13	63.97	0.33	0.31	0	0.01
East Texas Council of Governments	3.59	3.54	67.62	0.42	0.4	0	0.01
Houston-Galveston-Brazoria Area (8 county)	37.17	35.93	760.12	4.52	4.27	0.05	0.11
Victoria	0.47	0.51	8.85	0.07	0.06	0	0

Table 4. 2020 Annual Criteria Emissions by Selected Area (Tons/Year)

Regional Group	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Alamo Area Council of Governments	4,907	3,762	78,079	512	483	6	11
Beaumont-Port Arthur Area	919	702	14,645	79	75	1	2
Capital Area Council of Governments	4,082	3,555	66,169	458	432	6	11
Dallas-Fort Worth Area (10 county)	11,993	11,952	233,942	1,424	1,345	20	32
El Paso	868	933	18,159	96	91	1	2
East Texas Council of Governments	1,080	1,083	18,928	118	111	2	3
Houston-Galveston-Brazoria Area (8 county)	10,945	10,968	210,825	1,274	1,204	19	30
Victoria	147	151	2,574	18	17	0	0

Table 5. 2020 Austin Area OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Bastrop	0.26	0.53	4.48	0.06	0.05	0	0
Blanco	0.11	0.08	1.02	0.01	0.01	0	0
Burnet	1.21	0.52	11	0.07	0.07	0	0
Caldwell	0.22	0.27	2.33	0.03	0.03	0	0
Fayette	0.28	0.33	3.1	0.04	0.04	0	0
Hays	0.59	0.72	9.16	0.08	0.07	0	0
Lee	0.16	0.25	1.86	0.02	0.02	0	0
Llano	0.42	0.19	3.38	0.02	0.02	0	0
Travis	8.54	6.27	167.32	0.96	0.9	0.01	0.02
Williamson	2.22	2.77	40.26	0.36	0.34	0	0.01
Total	**14.01**	**11.93**	**243.91**	**1.65**	**1.55**	**0.01**	**0.03**

Table 6. 2020 Beaumont-Port Arthur Area OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Hardin	0.15	0.15	3.06	0.02	0.02	0.00	0.00
Jefferson	2.11	1.60	38.02	0.20	0.19	0.00	0.00
Orange	0.64	0.39	9.91	0.05	0.05	0.00	0.00
Total	**2.90**	**2.14**	**50.99**	**0.27**	**0.26**	**0.00**	**0.00**

Table 7. 2020 Dallas-Fort Worth Area OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Collin	6.51	5.15	127.66	0.79	0.75	0.01	0.02
Dallas	18.17	15.75	397.84	2.08	1.96	0.02	0.05
Denton	3.81	3.52	70.82	0.46	0.43	0.00	0.01
Ellis	0.84	1.99	13.85	0.19	0.18	0.00	0.00
Johnson	0.60	0.93	11.65	0.10	0.10	0.00	0.00
Kaufman	0.55	1.11	8.55	0.11	0.10	0.00	0.00
Parker	0.58	0.78	9.36	0.09	0.08	0.00	0.00
Rockwall	0.71	0.69	12.63	0.09	0.09	0.00	0.00
Tarrant	9.53	8.87	201.33	1.10	1.04	0.01	0.02
Wise	0.32	0.58	4.04	0.06	0.06	0.00	0.00
Total	**41.62**	**39.37**	**857.73**	**5.07**	**4.79**	**0.04**	**0.10**

Table 8. 2020 El Paso OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
El Paso	2.91	3.13	63.97	0.33	0.31	0.00	0.01

Table 9. 2020 Houston-Galveston-Brazoria Area OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Brazoria	1.90	2.11	29.02	0.22	0.21	0.00	0.01
Chambers	0.47	0.44	4.48	0.03	0.03	0.00	0.00
Fort Bend	2.54	2.44	52.68	0.34	0.32	0.00	0.01
Galveston	2.05	1.87	30.56	0.20	0.19	0.00	0.01
Harris	26.66	25.64	581.05	3.28	3.10	0.04	0.08
Liberty	0.35	0.49	5.09	0.05	0.05	0.00	0.00
Montgomery	2.79	2.62	50.02	0.35	0.33	0.00	0.01
Waller	0.41	0.33	7.20	0.05	0.05	0.00	0.00
Total	**37.17**	**35.94**	**760.10**	**4.52**	**4.28**	**0.04**	**0.12**

Table 10. 2020 San Antonio Area OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Atascosa	0.20	0.37	2.73	0.03	0.03	0.00	0.00
Bandera	0.65	0.13	4.04	0.03	0.02	0.00	0.00
Bexar	11.58	7.94	229.98	1.26	1.19	0.01	0.03
Comal	1.24	1.49	13.97	0.16	0.15	0.00	0.01

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Frio	0.12	0.18	1.28	0.02	0.02	0.00	0.00
Gillespie	0.19	0.23	2.78	0.03	0.02	0.00	0.00
Guadalupe	0.69	0.76	10.98	0.10	0.09	0.00	0.00
Karnes	0.07	0.15	1.01	0.02	0.02	0.00	0.00
Kendall	0.61	0.31	7.48	0.05	0.05	0.00	0.00
Kerr	1.14	0.32	9.70	0.06	0.05	0.00	0.00
Medina	0.27	0.56	3.18	0.06	0.06	0.00	0.00
Wilson	0.11	0.28	1.77	0.03	0.03	0.00	0.00
Total	**16.87**	**12.72**	**288.90**	**1.85**	**1.73**	**0.01**	**0.04**

Table 11. 2020 Tyler-Longview Area OSD Criteria Emissions (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Gregg	1.00	0.73	22.45	0.11	0.10	0.00	0.00
Harrison	0.42	0.96	5.54	0.07	0.07	0.00	0.00
Rusk	0.26	0.44	3.35	0.03	0.03	0.00	0.00
Smith	1.74	1.26	33.35	0.19	0.18	0.00	0.00
Upshur	0.16	0.16	2.93	0.02	0.02	0.00	0.00
Total	**3.58**	**3.55**	**67.62**	**0.42**	**0.40**	**0.00**	**0.00**

Table 12. 2020 Statewide OSD Hazardous Air Pollutant Emissions (Pounds/Day)

NEI Pollutant Code	Pollutant Name	Emissions Total (lbs./day)
108883	Toluene	31,634
1330207	Xylene	24,897
540841	2,2,4-Trimethylpentane	17,109
71432	Benzene	13,705
50000	Formaldehyde	9,770
100414	Ethyl Benzene	8,947
110543	Hexane	4,445
75070	Acetaldehyde	2,973
106990	1,3-Butadiene	1,650
123386	Propionaldehyde	702
100425	Styrene	1,284
107028	Acrolein	684
91203	Naphthalene	556
85018	Phenanthrene	93.0932
208968	Acenaphthylene	61.9101
86737	Fluorene	44.1566

NEI Pollutant Code	Pollutant Name	Emissions Total (lbs./day)
83329	Acenaphthene	26.9817
129000	Pyrene	19.7235
206440	Fluoranthene	16.7755
93	Arsenic Compounds	0.4095
120127	Anthracene	10.8549
191242	Benzo(g,h,i)perylene	24.0835
7440020	Nickel Compounds	0.5474
56553	Benz(a)anthracene	4.9806
193395	Indeno(1,2,3,c,d)pyrene	9.0499
218019	Chrysene	4.6916
50328	Benzo(a)pyrene	8.9788
205992	Benzo(b)fluoranthene	5.3244
207089	Benzo(k)fluoranthene	5.2899
7439965	Manganese Compounds	0.3096
18540299	Chromium 6+	0.0021
53703	Dibenzo(a,h)anthracene	0.2375
200	Mercury Elemental Gaseous	0.0092
201	Mercury Divalent Gaseous	0.0012
202	Mercury Particulate	0.0003
3268879	Octachlorodibenzo-p-dioxin	6.51E-06
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	9.55E-07
39001020	Octachlorodibenzofuran	1.72E-06
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.51E-06
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	7.95E-08
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran	1.79E-07
51207319	2,3,7,8-Tetrachlorodibenzofuran	6.58E-07
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran	1.47E-07
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	9.13E-08
57117314	2,3,4,7,8-Pentachlorodibenzofuran	2.52E-07
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran	1.68E-07
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	4.19E-08
57117416	1,2,3,7,8-Pentachlorodibenzofuran	2.27E-07
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	1.02E-07
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran	6.50E-08
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran	4.64E-08
40321764	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	4.00E-08

Table 13. 2020 Statewide Annual Hazardous Air Pollutant Emissions (Tons/Year)

NEI Pollutant Code	Pollutant Name	Emissions Total (tons/year)
108883	Toluene	4,798
1330207	Xylene	3,851
540841	2,2,4-Trimethylpentane	2,657
71432	Benzene	2,067
50000	Formaldehyde	1,375
100414	Ethyl Benzene	1,390
110543	Hexane	640
75070	Acetaldehyde	413
106990	1,3-Butadiene	254
123386	Propionaldehyde	97
100425	Styrene	199
107028	Acrolein	93.2833
91203	Naphthalene	85.2820
85018	Phenanthrene	13.5466
208968	Acenaphthylene	9.2659
86737	Fluorene	6.3120
83329	Acenaphthene	3.8160
129000	Pyrene	2.9888
206440	Fluoranthene	2.5576
93	Arsenic Compounds	0.0591
120127	Anthracene	1.6283
191242	Benzo(g,h,i)perylene	3.5460
7440020	Nickel Compounds	0.0763
56553	Benz(a)anthracene	0.7420
193395	Indeno(1,2,3,c,d)pyrene	1.3320
218019	Chrysene	0.6993
50328	Benzo(a)pyrene	1.3221
205992	Benzo(b)fluoranthene	0.7912
207089	Benzo(k)fluoranthene	0.7866
7439965	Manganese Compounds	0.0435
18540299	Chromium 6+	0.0003
53703	Dibenzo(a,h)anthracene	0.0345
200	Mercury Elemental Gaseous	0.0013
201	Mercury Divalent Gaseous	0.0002
202	Mercury Particulate	3.66E-05
3268879	Octachlorodibenzo-p-dioxin	9.48E-07
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	1.38E-07
39001020	Octachlorodibenzofuran	2.52E-07
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran	2.20E-07

NEI Pollutant Code	Pollutant Name	Emissions Total (tons/year)
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	1.15E-08
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran	2.59E-08
51207319	2,3,7,8-Tetrachlorodibenzofuran	9.41E-08
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran	2.18E-08
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	1.35E-08
57117314	2,3,4,7,8-Pentachlorodibenzofuran	3.58E-08
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran	2.43E-08
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	6.19E-09
57117416	1,2,3,7,8-Pentachlorodibenzofuran	3.28E-08
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	1.49E-08
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran	9.27E-09
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran	6.80E-09
40321764	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	5.92E-09

3.3 NEI Submittal Materials

As mentioned previously, U.S. EPA requires nonroad model mobile source inputs for the NEI. The required inputs include county databases (CDBs) in MOVES3 format, a QA report, a submittal checklist, and documentation of the data sources and processes used to organize the information into the CDB format (US EPA, 2021). These materials for the 2020 AERR EI/NEI are provided separately as Deliverable 4.2.

ERG created 254 CDBs in accordance with EPA's expectation of one CDB per county, using the TexN2 utility's feature *Generate CDBs for NEI* (a function on the Run tab of the TexN2 utility) for the calendar year 2020. The *Generate CDBs for NEI* function produced one CDB per county by aggregating populations across the 25 DCE subsectors to arrive at county total equipment populations by SCC and HP. TexN2 names the CDBs following the EPA naming convention of `c48001y2020_nr_20210613` for Anderson County (county ID 48001), year 2020, created on June 13, 2021. These CDBs were created on a local PC, requiring approximately 16 hours of run time to complete.

ERG then ran EPA's NEI QA Tool[1] using the newly built-in feature inside of MOVES3.0.1. EPA's QA Tool verifies that all CDB table contents meet the naming convention, format, data validity, and other checks. To run the EPA QA Tool, MOVES3.0.1 (or later) must be installed on the PC. ERG followed the EPA's instructions. The steps are summarized here to assist TCEQ staff with generating CDBs for EPA submittal in-house in the future. First, ERG opened a command line window from inside the MOVES3 installation directory, which by default is

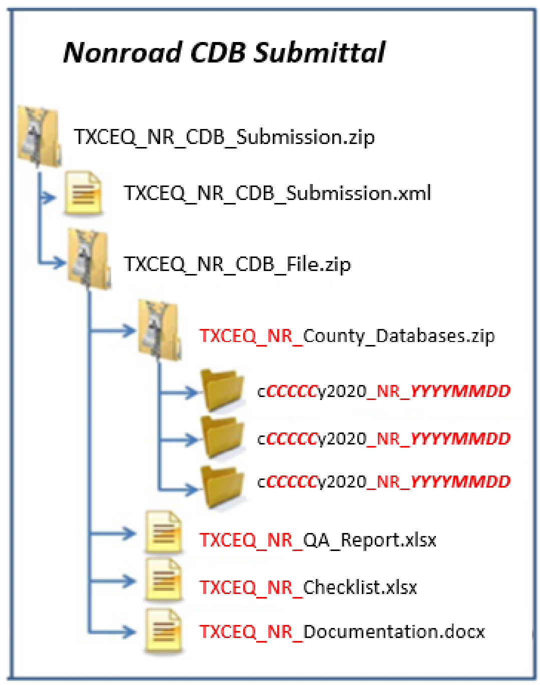
[1] Documentation on MOVES NEI Submissions QA Tool. Available online (as of 6/22/2021) https://www.epa.gov/sites/production/files/2021-03/documents/neiqainstructions.pdf

C:\Users\Public\EPA\MOVES\MOVES3.0. Then, ERG created a file list of all 254 Texas CDBs, each database name listed in a separate line. ERG named the file TXCEQ_db_list.txt. Following the QA Tool instructions, ERG ran the file "setenv.bat" from the windows command line inside the MOVES3 directory, then ran the QA tool, listing TXCEQ_db_list.txt as the input file, and providing the filename "TXCEQ_NR_QA_Report.xlsx" as the output file name. The checks completed in less than 40 minutes on a single computer. ERG opened the file TXCEQ_NR_QA_Report.xlsx to verify that all tables passed the QA checks; there were no errors indicated. The text box below documents the specific steps to initiate the QA Tool from the command line.

```
C:\Users\Public\EPA\MOVES\MOVES3.0>setenv.bat

C:\Users\Public\EPA\MOVES\MOVES3.0>ant nonroadNEIQA -Dinput=C:\Projects\TCEQ_FY21\Task4\TXCEQ_db_list.txt
-Doutput=C:\Projects\TCEQ_FY21\Task4\TXCEQ_NR_QA_Report.xlsx
```

ERG prepared the required NEI submittal checklist starting from EPA's 2020 template file[2] and named the completed file "TXCEQ_NR_Checklist.xlsx." ERG created TXCEQ_NR_Documentation.docx to describe the data sources and processes to create the CDBs. ERG named and organized the submittal package components according to EPA's instructions, which is summarized in the inset figure to the right. To submit the package, the TCEQ should first edit the XML wrapper, a file named "TXCEQ_NR_CDB_Submission.xml" line 4 (Author Name), line 5 (Organization Name), and line 24 (Your EIS user ID). ERG included the example from the prior 2017 NEI (Sample_NR_CDB_Submission.xml) as an example. After editing the XML wrapper, the XML file and TXCEQ_NR_CDB_File.zip should be archived together by zipping into a new file named "TXCEQ_NR_CDB_Submission.zip." This is the file that should be uploaded to the EIS.



[2] US EPA MOVES Nonroad County Checklist. Available online as of 6/22/2021: https://gaftp.epa.gov/air/nei/2020/doc/supporting_data/nonroad/MOVES_Nonroad_County_Checklist.xlsx

4.0 Other EIs for SIP Development

Section 3 describes the 2020 AERR EI development and results. Additionally, ERG developed RFP EIs for the 2008 Ozone NAAQS (Appendix B), RFP EIs for the 2015 Ozone NAAQS (Appendix C) and RDM EIs for the City of El Paso 1987 PM10 Nonattainment Area (Appendix D). These EIs are described in standalone reports appended to this document. The following Section 5.0 describes QA for the entire project, including the 2020 AERR EI and the EIs described in Appendix B, C, and D.

5.0 Data Analysis and QA of the EIs

Section 5 addresses Task 8 of the Work Plan: data analysis and QA. The approach to reviewing the various inventories included several different types of checks listed below.

1. Compared the 2020 AERR EI to the prior 2017 AERR EI.
2. Checked for consistency among the various inventories by year across the four project tasks: the Task 4 2020 AERR, Tasks 5 and 6 RFP EIs, and the Task 7 RDM EI for El Paso.
3. Searched for outliers.
4. Scanned the TexN2 log files to check for error messages.
5. VOC emissions increase in Bexar County

Comparison of the 2020 AERR EI to the prior 2017 AERR EI

There are large differences between the 2020 AERR EI and the prior 2017 AERR EI primarily due to updates made to the equipment populations for all 25 DCE subsectors. ERG previously developed the 2017 AERR EI with the beta version release of TexN2.0 dated October 2018 (ERG, 2018). Since that time, ERG has made two major updates to the TexN2 utility database. In the first, ERG updated equipment populations for calendar years 2012 and later for each DCE subsector and Texas county (ERG, 2020b). The second update occurred during ERG's project to make TexN2.1 compatible with MOVES3 (resulting in the current version, TexN2.2). This second update in the prior project replaced all equipment populations in DCE subsectors 0 (Non-DCE) and 25 (Off-Road Tractors, Misc. Equipment, and all Equipment < 25 HP) by SCC, HP, county, and year. The net impact was a 20% increase in DCE subsector 0 equipment populations and a 35% increase in DCE 25 equipment populations in calendar year 2020. Most of that increase was in gasoline-fueled equipment population. Appendix A of the prior project report further describes those changes (ERG, 2021). Both updates affected all calendar years of EIs in this study.

Table 14 shows the differences in statewide equipment populations by DCE subsector used in the 2017 AERR EI (with TexN2.0) versus the 2020 AERR EI (with TexN2.2). Table 15 summarizes the same information by fuel type instead of DCE subsector. The gasoline equipment counts markedly increased while the diesel equipment counts declined from the 2017 AERR EI to the 2020 AERR EI. The statewide total equipment population increased by 11 percent between the two EIs. This increase is partly due to the change in utility versions with different population data and partly due to the 3-year difference between EIs. Either utility alone estimates a smaller change over the 3-year period (4 percent growth with TexN2.0 and 6 percent growth with TexN2.2). In addition, the relative decrease in diesel and increase in gasoline equipment counts is mostly a result of the population updates between TexN2.0 and TexN2.2 (Table 15).

Table 14. Differences in Statewide Equipment Populations by DCE Subsector between the 2020 and 2017 AERR EIs

DCE ID	DCE Subsector Name	2017 AERR, TexN2.0	2020 AERR, TexN2.2	Percent Change
0	Non DCE	10,548,096	11,795,605	12%
1	Agricultural Activities	3,936	3,879	-1%
2	Boring and Drilling Equipment	1,183	1,035	-13%
3	Brick and Stone Operations	373	322	-14%
4	City and County Road Construction	4,563	4,912	8%
5	Commercial Construction	72,210	60,397	-16%
6	Concrete Operations	598	709	19%
7	County-Owned Construction Equipment	1,326	1,288	-3%
8	Cranes	7,164	7,317	2%
9	Heavy Highway Construction	8,196	3,559	-57%
10	Landfill Operations	561	599	7%
11	Landscaping Activities	9,625	17,134	78%
12	Manufacturing Operations	841	746	-11%
13	Municipal-Owned Construction Equipment	7,382	7,310	-1%
14	Transportation/Sales/Services	8,901	25,274	184%
15	Residential Construction	7,567	10,480	38%
16	Rough Terrain Forklifts	25,227	22,216	-12%
17	Scrap Recycling Operations	698	2,126	204%
18	Skid Steer Loaders	88,199	66,317	-25%
19	Special Trades Construction	8,283	9,028	9%
20	Trenchers	22,564	19,790	-12%
21	TxDOT Construction Equipment	3,859	1,773	-54%
22	Utility Construction	17,849	17,268	-3%
23	Mining and Quarry Operations	9,028	8,147	-10%
	Subtotal of DCE Subsector 1 through 23	***310,134***	***291,627***	***-6%***
25	Off-Road Tractors, Misc. Equipment, and all Equipment < 25 HP	24,706	25,016	1%
	Total	**10,882,937**	**12,112,248**	**11%**

* Note that DCE subsector ID 24 is intentionally unused in TexN2.

Table 15. Differences in Statewide Equipment Populations by Fuel Type between the 2020 and 2017 AERR EIs

Fuel ID	Fuel Type Description	AERR 2017, TexN2.0	AERR 2020, TexN2.2	Percent change
1	Gasoline	9,961,159	11,342,588	14%
3	Compressed Natural Gas (CNG)	7,557	9,424	25%
4	Liquefied Petroleum Gas (LPG)	100,719	106,415	6%
	Subtotal of Non-Diesel	***10,069,435***	***11,458,427***	***14%***
23 & 24	Nonroad & Marine Diesel Fuel	813,501	653,821	-20%
	Total	**10,882,937**	**12,112,248**	**11%**

Table 16 shows the differences in statewide emissions totals in tons per year between 2020 and 2017, while Table 17 shows this information on a per-equipment unit level. All pollutants except for CO decrease in 2020 compared to 2017. The CO increase is likely caused by the large increase in gasoline-fueled equipment population (Table 15) as well as larger populations for the smaller horsepower (HP) units less than 25 HP, which have higher CO emissions per HP-hour than larger HP gasoline units. The large spark ignition equipment is required to have catalysts, which reduces the CO emissions.

Table 16. Differences in Statewide 2020 and 2017 AERR EIs (Tons/Year)

Pollutant	Emissions 2017 AERR* (with TexN2.0)	Emissions 2020 AERR (with TexN2.2)	Percent Change
VOC	58,635	56,232	-4%
CO	624,982	880,839	41%
NO_X	90,015	56,225	-38%
PM_{10}	8,213	6,224	-24%
$PM_{2.5}$	7,855	5,904	-25%
SO2	82	79	-3%

* The 2017 EI emissions totals come from tables in Appendix A of the prior 2017 AERR report (ERG, 2018).

Table 17. Differences in Statewide 2020 and 2017 AERR Emissions Divided by Equipment Population (Pounds per Equipment Unit)

Pollutant	Emissions Per Equipment* 2017 AERR (with TexN2.0)	Emissions Per Equipment 2020 AERR (with TexN2.2)	Percent Change
VOC	10.776	9.286	-14%
CO	114.857	145.459	27%
NO_X	16.543	9.285	-44%
PM_{10}	1.509	1.028	-32%
$PM_{2.5}$	1.444	0.975	-32%
SO2	0.015	0.013	-13%

* The 2017 Emissions Per Equipment comes from Table 15 of the prior 2017 AERR report (ERG, 2018).

Total CO emissions were expected to increase for several reasons. First, nonroad CO emissions are predominantly due to gasoline equipment, with small units less than 25 HP emitting CO at per HP-hour rates an order of magnitude or more above large spark ignition engines (equipped with catalysts) and diesel engines. Second, there is effectively no downward regulatory pressure on CO emissions from spark ignition engines over time, with the gram/HP-hour standards for these units being flat for the last 20+ years. Third, the statewide gasoline equipment population increased by about 14% from the 2017 TexN2.0 estimates to the 2020 TexN2.2 estimates. Finally, the previously mentioned shift toward lower HP bins in the 2020 gasoline populations in TexN2.2 further increase the CO emissions per unit as well.

Similar to CO, total VOC emissions were expected to increase in 2020 due to the increase in gasoline equipment population, yet they decreased. Total VOC declined in the 2020 AERR EI by 4% on a TPY basis (Table 16) and by 14% on a pounds (lbs.) per unit basis (Table 17). There was a substantial variation in VOC changes at the county level between the 2020 and 2017 AERR EIs. For example, Harris County saw an increase in nonroad VOC emissions of 44% during this period from 18.56 TPD (ERG, 2018) to 26.66 TPD (Table A-1), while Galveston County saw a decrease of 29% from 2.88 TPD (ERG, 2018) to 2.05 TPD (Table A-1) during this same period. ERG investigated the causes of the variation in VOC emissions to ensure the accuracy of the TexN2.2 model outputs. Because nonroad VOC emissions are heavily dominated by gasoline SCCs (approximately 92% of VOC emissions are from gasoline units in Harris County and 94% in Galveston County in 2020), ERG restricted the QA assessment to this fuel type.

The changes made to the TexN2 utility between the version used to generate the 2017 AERR EI (TexN2.0) and that used for the 2020 AERR EI (TexN2.2) included significant updates to equipment populations for gasoline SCCs in all years. For this reason, ERG began by calculating total VOC and population ratios for each SCC (2020/2017) to identify which VOC changes are explained by simple population differences. ERG selected one county (Galveston) to investigate in detail. TexN utility outputs for Galveston County emissions and equipment populations were broken out by SCC, HP bin, model year, control technology, and (for emissions only) emissions process type (e.g., running exhaust, tank permeation, etc.). Table 18 presents the ratios for total VOC and equipment population for each gasoline SCC.

Table 18. Galveston County VOC and Equipment Population Ratios of 2020 to 2017 AERR EI Values by SCC

SCC Description	Total VOC	Population	Pop/VOC Change Ratio
2-Str All Terrain Vehicles	0.11	0.20	1.84
2-Str Chain Saws < 6 HP (com)	1.01	1.00	0.99
2-Str Chain Saws < 6 HP (res)	1.17	1.16	0.99
2-Str Concrete/Industrial Saws	1.67	1.65	0.99
2-Str Crushing/Proc. Equipment	1.68	1.66	0.99
2-Str Generator Sets	1.12	1.10	0.99
2-Str Hydro Power Units	1.10	1.09	0.99
2-Str Leafblowers/Vacuums (com)	1.20	1.19	0.99
2-Str Leafblowers/Vacuums (res)	1.16	1.16	1.00
2-Str Offroad Motorcycles	0.52	0.58	1.10
2-Str Outboard	0.45	0.42	0.93
2-Str Paving Equipment	1.68	1.66	0.99
2-Str Personal Watercraft	0.18	0.26	1.45
2-Str Plate Compactors	1.67	1.65	0.99
2-Str Pumps	1.12	1.10	0.99
2-Str Rotary Tillers < 6 HP (com)	1.26	1.25	0.99
2-Str Rotary Tillers < 6 HP (res)	1.10	1.11	1.01
2-Str Specialty Vehicle Carts	1.21	1.29	1.06
2-Str Tampers/Rammers	1.67	1.65	0.99
2-Str Trimmers/Edgers/Brush Cutter (com)	2.32	2.29	0.99
2-Str Trimmers/Edgers/Brush Cutter (res)	1.16	1.16	1.00
4-Str Aerial Lifts	8.11	9.11	1.12
4-Str Air Compressors	1.12	1.10	0.99
4-Str All Terrain Vehicles	0.48	0.52	1.08
4-Str Bore/Drill Rigs	1.69	1.65	0.98
4-Str Cement & Mortar Mixers	1.51	1.65	1.09
4-Str Chippers/Stump Grinders (com)	0.48	0.47	0.99
4-Str Commercial Turf Equipment (com)	87.01	85.17	0.98
4-Str Concrete/Industrial Saws	1.69	1.65	0.98
4-Str Cranes	1.49	1.62	1.09
4-Str Crushing/Proc. Equipment	1.68	1.66	0.99
4-Str Dumpers/Tenders	1.55	1.66	1.07
4-Str Forklifts	10.15	10.62	1.05
4-Str Front Mowers (com)	4.49	4.98	1.11
4-Str Generator Sets	1.03	1.10	1.08
4-Str Golf Carts	1.31	1.29	0.98
4-Str Hydro Power Units	1.12	1.10	0.98

SCC Description	Total VOC	Population	Pop/VOC Change Ratio
4-Str Inboard/Sterndrive	0.65	0.56	0.86
4-Str Lawn & Garden Tractors (res)	1.03	1.11	1.08
4-Str Lawn mowers (com)	1.92	1.89	0.98
4-Str Lawn mowers (res)	1.01	1.16	1.14
4-Str Leafblowers/Vacuums (com)	17.76	17.44	0.98
4-Str Leafblowers/Vacuums (res)	1.07	1.16	1.08
4-Str Offroad Motorcycles	0.53	0.58	1.08
4-Str Other Construction Equipment	1.55	1.80	1.16
4-Str Other General Industrial Eqp	9.17	9.06	0.99
4-Str Other Lawn & Garden Eqp. (com)	1.69	2.01	1.19
4-Str Other Lawn & Garden Eqp. (res)	0.93	1.11	1.19
4-Str Pavers	1.67	1.64	0.98
4-Str Paving Equipment	1.64	1.65	1.01
4-Str Plate Compactors	1.68	1.65	0.99
4-Str Pressure Washers	1.10	1.10	1.00
4-Str Pumps	1.11	1.10	0.99
4-Str Rear Engine Riding Mowers (com)	0.18	0.18	0.99
4-Str Rear Engine Riding Mowers (res)	1.01	1.11	1.10
4-Str Rollers	1.67	1.63	0.98
4-Str Rotary Tillers < 6 HP (com)	14.98	15.53	1.04
4-Str Rotary Tillers < 6 HP (res)	0.99	1.11	1.13
4-Str Rough Terrain Forklift	1.42	1.60	1.12
4-Str Rubber Tire Loaders	1.54	1.63	1.06
4-Str Shredders < 6 HP (com)	23.37	24.68	1.06
4-Str Skid Steer Loaders	1.60	1.66	1.04
4-Str Specialty Vehicle Carts	1.09	1.29	1.18
4-Str Surfacing Equipment	1.69	1.65	0.98
4-Str Sweepers/Scrubbers	9.08	9.32	1.03
4-Str Tractors/Loaders/Backhoes	1.69	1.67	0.98
4-Str Trenchers	1.68	1.65	0.98
4-Str Trimmers/Edgers/Brush Cutter (com)	7.77	7.64	0.98
4-Str Trimmers/Edgers/Brush Cutter (res)	1.13	1.16	1.03
4-Str Welders	1.12	1.10	0.99

Table 18 also presents the ratio of the population change to VOC change in the far-right column. Where total VOC and population ratios track closely this ratio is close to 1.0, and we can reasonably assume changes in VOC emissions are primarily attributable to population changes. Small differences between the VOC change and population change ratios (e.g., < 10%) are most likely attributable differences in evaporative emission rates caused by different temperature and fuel specifications for 2017 vs 2020. However, 12 of the 70 gasoline SCCs had population-to-VOC change ratios of more than 10% (see highlighted values flagged in Table 18). The suspected cause of these differences was changes in HP distributions (resulting from the base year population update) and turnover effects.[3]

ERG selected one SCC to investigate the cause of these differences in detail, 2-stroke personal watercraft with a population-to-VOC change ratio of 1.45. Table 19 presents the VOC estimates for the 2017 and 2020 AERR EIs, showing an 82% reduction in total VOCs. The table also indicates that over 85% of total VOC emissions for this SCC are attributable to running exhaust emissions. For this reason, ERG focused on running exhaust estimates to identify the primary causes of the high population-to-VOC change ratio.

Table 20 presents the corresponding equipment population by HP bin. Two significant changes are evident from the table: 1) total equipment population decreased by 74 percent, and 2) the base period population update introduced a substantially different HP distribution, heavily weighted toward larger engines. Table 21 presents the running VOC exhaust emissions by AERR EI year and HP bin. The table shows an 83% reduction in total running exhaust emissions between the two AERR EI years, although reductions vary substantially by HP bin. Table 22 presents the pounds of running VOC exhaust emissions per unit by AERR EI year and HP bin, showing a total reduction in emissions per unit of 33% across all HP bins.

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[3] Many SCCs with rapid turnover (e.g., handheld lawn and garden equipment and small commercial equipment such as pressure washers and air compressors) exhibit minimal change in VOC emission rates due to equipment turnover since most units already use the most advanced control technologies by 2017. In addition, the small hp range for these units does not allow for the changes in hp distributions seen in some other SCCs. Therefore, their overall population-to-VOC change ratios are very close to 1.0.

Table 19. 2-stroke Personal Watercraft VOC Tons per OSD Weekday by Emissions Process (Galveston County 2017 and 2020 AERR EIs)

AERR Year	Diurnal	Hose Perm	Hotsoak	RunLoss	Tank Perm	Refuel Disp Vap	Refuel Spillage	Running Exh	Total
2017	0.0024	0.0043	0.0029	0.0027	0.0259	0.0061	0.0004	0.3008	**0.3454**
2020	0.0007	0.0009	0.0007	0.0007	0.0038	0.0024	0.0001	0.0518	**0.0612**
Reduction	**71%**	**78%**	**74%**	**74%**	**85%**	**61%**	**67%**	**83%**	**82%**

Table 20. 2-stroke Personal Watercraft Population by HP Bin (Galveston County 2017 and 2020 AERR EIs)

AERR Year	1-3 HP	3-6 HP	6-11 HP	16-25 HP	25-40 HP	40-50 HP	50-75 HP	75-100 HP	100-175 HP	175-300 HP	Total
2017				30	370	371	3,387		977		5,135
2020	1	1	7		8	3	67	249	922	61	1,318
Reduction	**N/A**	**N/A**	**N/A**	**100%**	**98%**	**99%**	**98%**	**N/A**	**6%**	**N/A**	**74%**

Table 21. 2-stroke Personal Watercraft Running Exhaust VOC Tons per OSD Weekday by HP Bin (Galveston County 2017 and 2020 AERR EIs)

AERR Year	1-3 HP	3-6 HP	6-11 HP	16-25 HP	25-40 HP	40-50 HP	50-75 HP	75-100 HP	100-175 HP	175-300 HP	Total
2017				0.0004	0.0028	0.0178	0.2343		0.0456		0.3008
2020	0.0000	0.0000	0.0000		0.0001	0.0001	0.0023	0.0113	0.0321	0.0059	0.0518
Reduction	**N/A**	**N/A**	**N/A**	**100%**	**98%**	**100%**	**99%**	**N/A**	**30%**	**N/A**	**83%**

Table 22. 2-stroke Personal Watercraft OSD Weekday Running Exhaust VOC Lbs. Per Unit by HP Bin (Galveston County 2017 and 2020 AERR EI)

AERR Year	1-3 HP	3-6 HP	6-11 HP	16-25 HP	25-40 HP	40-50 HP	50-75 HP	75-100 HP	100-175 HP	175-300 HP	Total
2017				0.0235	0.0150	0.0960	0.1383		0.0934		0.1172
2020	0.0022	0.0056	0.0073		0.0149	0.0485	0.0679	0.0910	0.0697	0.1928	0.0785
Reduction	**N/A**	**N/A**	**N/A**	**100%**	**1%**	**49%**	**51%**	**N/A**	**25%**	**N/A**	**33%**

As seen in the tables above, the change in 2-stroke personal watercraft VOC emission estimates between the 2017 and 2020 AERR EI submissions is likely caused by a combination of changing HP distributions and VOC per unit emission rates (likely due to equipment turnover effects). To investigate the changes in per unit emission rates, ERG focused on the population and running exhaust VOC outputs for the 100-175 HP bin. First, exhaust rates per unit and associated equipment populations were determined by engine technology type for both years, as shown in Table 23.

Table 23. 2-stroke Personal Watercraft OSD Weekday Running Exhaust VOC Lbs. Per Unit and Population by Control Technology (Galveston County 2017 and 2020 AERR EIs)

Control Technology	Average of lbs/Unit		Population		% Population	
	2017	2020	2017	2020	2017	2020
PWC* 2 stroke Carbureted	1.020	1.031	27	7	3%	1%
PWC 2 stroke Carbureted Catalyst	0.504	0.510	4	1	0%	0%
PWC 2 stroke Direct Injection	0.244	0.247	19	6	2%	1%
PWC 4 stroke Direct Injection	0.068	0.069	189	65	19%	7%
PWC 4 stroke Indirect Injection	0.083	0.084	20	8	2%	1%
PWC meets 2010 Standards	0.059	0.060	718	836	73%	91%
Total			**977**	**922**		
Weighted Avg lbs/unit	0.093	0.070				
% Reduction		**25%**				

* PWC stands for personal watercraft.

Table 23 also shows the weighted average lbs./unit across all model years for the 2017 and 2020 equipment populations (0.093 and 0.070 respectively). The 25% reduction in the lbs./unit values is due to replacement of older, higher emitting equipment with newer equipment using advanced control technologies. Note the emission rates by engine technology type are almost identical for both AERR EI years, with the 2020 values being slightly higher than the 2017 values due to deterioration, as expected.

Finally, the 25% reduction in emission rates estimated for the 100-175 HP bin was independently validated by comparing it to the relative change in exhaust emission standards for spark ignition recreational marine engines (EPA, 2016d). Table 24 shows the emission standards by model year, expressed as grams of HC + NO_x per kW-hr (assuming a 120 HP (90 kW) engine), as well as the percent of equipment in each model year by AERR EI year.

Table 24. 2-stroke Personal Watercraft Exhaust Emission Standards and Population by Model Year (Galveston County 2017 and 2020 AERR EIs, 100-175 HP Bin)

Model Year	HC + NO_X g/kW-hr	2017 %	2020 %
1998	150	0.1%	0.0%
1999	136	0.3%	0.0%
2000	123	0.5%	0.0%
2001	110	0.6%	0.1%
2002	96	0.9%	0.3%
2003	83	1.1%	0.5%
2004	69	1.4%	0.7%
2005	55	1.8%	0.9%
2006-2009	42	20%	7%
2010+	15	73%	91%
Weighted Avg g/kW-hr		**25**	**18**
Reduction			**27%**

The estimated emission rates were combined with the model year distributions to determine the weighted average emission rates across all model years for each AERR EI year. Assuming HC is reduced in direct proportion to the exhaust standards, the estimated reduction of 27% matches the percent reduction derived from the TexN2 utilities shown in Table 23 (25%) to within 2%.

Given that only equipment populations and HP distributions were revised for the gasoline SCCs, these factors appear to be fully sufficient to explain the VOC differences observed across the two AERR EI years.

The large decreases in NO_X and PM emissions indicated in Tables 16 and 17 are due in part to attrition, with Tier 1 and 2 diesel units being retired and replaced by Tier 4 final units by 2020. Both pollutants are emitted at higher rates from diesel equipment than from gasoline equipment, so the previously mentioned shift of the statewide equipment population from diesel to gasoline with TexN2.2 compared to TexN2.0 (Table 15) also contributes to the decrease.

The decreases in SO_2 emissions indicated in Tables 16 and 17 are due to changes in gasoline and diesel sulfur content between the calendar years 2017 and 2020. In 2017, the summer and winter fuels contained in the TexN2 database have gasoline that ranges from 18 to 29 parts per million (ppm) sulfur content depending on the county. In 2020, the fuels in the TexN2 database indicate a range of 5 to 11 ppm sulfur for summer, again varying by county. Because the 2020 fuels study data (ERG, 2020a) only sampled during the summer, the winter fuels came from the MOVES3 database which has 10 ppm sulfur gasoline for all Texas counties in 2020. Similarly, the nonroad diesel fuel sulfur content decreased from 2017 levels of 4 to 10 ppm to 2020 levels of 2 to 7 ppm. Marine diesel sulfur content (15 ppm) and the liquid and compressed natural gas sulfur content (7.6 ppm) did not change between 2017 and 2020. The relatively large decrease in gasoline and nonroad diesel sulfur content was tempered by the overall increase in equipment population, leading to the net 13% reduction in SO_2 emissions per equipment, as shown in Table 17.

Consistency Among Project Tasks

ERG compared the emissions estimates across Tasks 4 through 7 by pooling the tons per day results from the four main project tasks for the subset of counties with multiple analyses as indicated below in Table 25. Combining results into a single trendline per county provided an opportunity to look for inconsistencies and outliers.

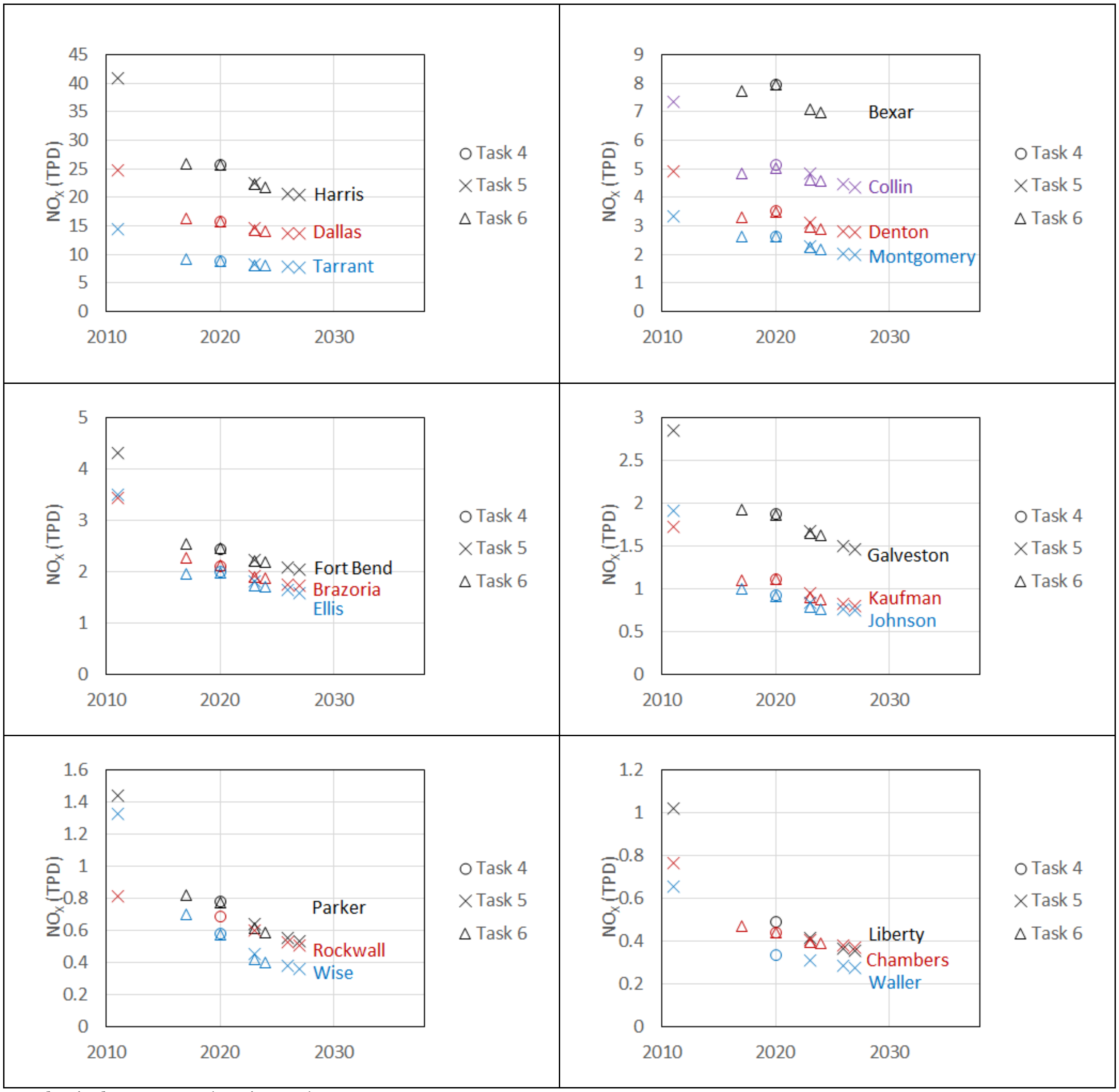
Table 25. OSD Fully Controlled EIs by County Available for QA of Trends

County	Task 4 [A]	Task 5 [B]	Task 6 [C]	Task 7 [D]
Brazoria	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Chambers	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Fort Bend	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Galveston	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Harris	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Liberty	2020	2011, 2023, 2026, 2027		
Montgomery	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Waller	2020	2011, 2023, 2026, 2027		
Collin	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Dallas	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Denton	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Ellis	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Johnson	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Kaufman	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Parker	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Rockwall	2020	2011, 2023, 2026, 2027		
Tarrant	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Wise	2020	2011, 2023, 2026, 2027	2017, 2020, 2023, 2024	
Bexar	2020		2017, 2020, 2023, 2024	
El Paso	2020			2017, 2023, 2029, 2035

[A] Task 4 is the AERR EI (Section 3.0)
[B] Task 5 is the RFP EIs for the 2008 Ozone NAAQS (Appendix B)
[C] Task 6 is the RFP EIs for the 2015 Ozone NAAQS (Appendix C)
[D] Task 7 is the RDM EIs for the 1987 PM_{10} NAAQS (Appendix D)

Figure 1 shows the NO_X trend for 19 of the 20 counties (all except El Paso). The Task 4 EIs, indicated by circle symbols, are the 2020 AERR EI results for OSD weekday. The Task 5 EIs are indicated with an 'x' symbol, and these are the OSD weekday fully controlled scenario from the RFP EIs in Appendix B. The Task 6 EIs are indicated by a triangle; these are the OSD weekday fully controlled scenario from RFP EIs in Appendix C.

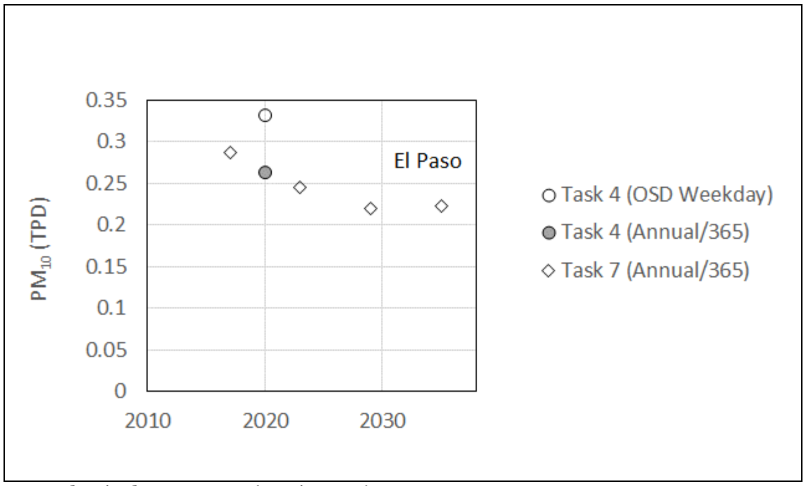
The NO_X emissions generally decrease with each calendar year with two exceptions. First, the Task 6 EIs appear to stagnate or slightly increase in 2020 relative to 2017. Second, the 2020 and 2023 EIs have overlap from different project tasks, yet the emissions are not identical. The small discrepancy in NO_X emissions for the same calendar year is likely caused by the slight variations in temperature and humidity data in the meteorology years of Task 4 (2019), Task 5 (2011), and Task 6 (2017). The TexN2 utility applies post-processing adjustments to NO_X based on temperature and humidity, which are applied depending on the requirements of each task.



* Task 4 is the AERR EI (Section 3.0)
Task 5 is the RFP EIs for the 2008 Ozone NAAQS (Appendix B)
Task 6 is the RFP EIs for the 2015 Ozone NAAQS (Appendix C)

Figure 1. Comparison of OSD NO_x EIs from Tasks 4, 5, and 6

Figure 2 compares PM_{10} emissions estimates for El Paso County between the 2020 AERR EI (Task 4) and the RDM EIs (Task 7, in Appendix D). The Task 7 emissions are in line with the Task 4 annual emissions divided by 365 days. The annual average day emissions are significantly lower than the Task 4 OSD Weekday emissions. It is expected that equipment activity is generally higher on weekdays than average days which include weekday and weekend activity.



* Task 4 is the AERR EI (Section 3.0)
Task 7 is the RDM EIs for the 1987 PM_{10} NAAQS (Appendix D)

Figure 2. Comparison of OSD and Annual Average Day PM_{10} EIs from Tasks 4 and 7

Search for Outliers

ERG wrote a script using Statistical Analysis Software (SAS) to read TexN2 output EI reports and generate several hundred plots within a single PDF to allow efficient review of run results. The SAS plots include county equipment populations for each RFP control scenario (to ensure no changes), county comparisons of equipment populations (to ensure largest populations are in Harris, Dallas, Tarrant, and Bexar), and unit-level emissions factors for each county (to look for outliers). These SAS plots showed consistency among counties in source category contributions, which are different for NO_X (where the agricultural sector is dominant) and VOC (where Lawn & Garden is dominant).

ERG also examined the ratios of OSD to annual emissions from the 2020 AERR EI to look for outliers. ERG found instances where some combinations of SCC and county had zero emissions for OSD but non-zero emissions for Annual. These turned out to be snowmobiles in all 254 counties which TexN2 assumes have zero activity in the summer months. Other than the snowmobiles, other SCC and county combinations all fell within similar range, where OSD increased linearly with Annual. Most SCCs have higher emissions on an OSD weekday than the annual average day (annual emissions/365) due to the MOVES input data table (*NRDayAllocation* table) that specifies hours of activity is typically higher on weekdays than weekend days. Some equipment do not follow this pattern. For example, AC Refrigeration Units have equal activity on all day types, whereas Residential Lawn & Garden equipment and recreational marine vessels have higher activity on the weekends. Groups of SCCs follow specific patterns of weekday/weekend activity allocations, and this is visible in the QA plots below. Figure 3 shows a subset of the $PM_{2.5}$ emissions from the AERR EI, while Figure 4 shows a subset of the same EI for NO_X. Each data point represents one SCC and county. The data with values of zero for OSD that fall along the X-axis are the snowmobiles. The $PM_{2.5}$

emissions (as well as PM_{10}, CO, and NH_3 that are not shown) all follow the linear pattern where the SCC-county EI combinations lie on distinctive bands that correspond to the level of detail available in the MOVES *NRDayAllocation* table.

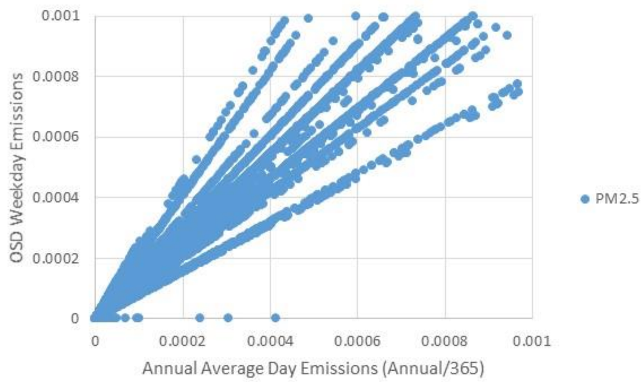


Figure 3. Comparison of OSD and Annual Average Day $PM_{2.5}$ Emissions

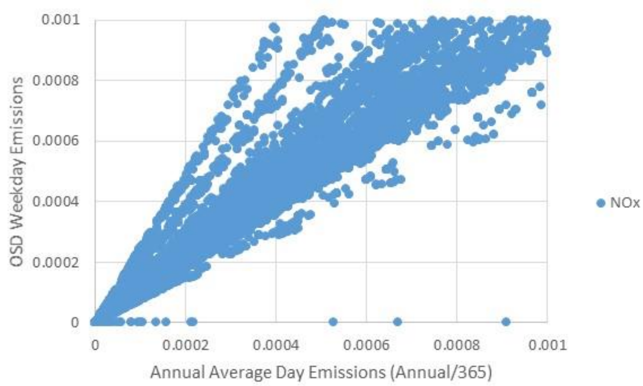


Figure 4. Comparison of OSD and Annual Average Day NO_X Emissions

In contrast to the distinctive bands shown in Figure 3, some pollutants such as NO_X in Figure 4 (as well as VOC, and SO2 that are not shown) exhibit more variation or deviation from the bands. The reason for this is county-level adjustments that TexN2 applies for NO_X for TxLED fuel, and adjustments based on temperature and humidity. Furthermore, the VOC emissions (particularly evaporative) output from MOVES are sensitive to county-specific temperatures and fuel properties which are different for OSD months vs. the annual average period. The SO_2 emissions plots of OSD weekday versus annual average day show high deviation from the patterns in Figure 3 because of county-specific sulfur levels in the utility. The OSD weekday versus annual average day QA did find outliers (snowmobiles), but all had reasonable explanations such that ERG does not believe there are any problems with the results.

TexN2 Logfiles Check

ERG compiled the individual TexN2.2 logfiles from hundreds of runs that took place in parallel on local PCs and on AWS to search for any run problems, such as a premature shutdown or missing log file. There were no run errors in the logs.

VOC Emissions Increase in Bexar County

During review of the Task 6 RFP EIs, TCEQ staff noted that Bexar County VOC emissions increased significantly between the prior 2017 AERR EI (6.57 TPD) and the 2017 RFP fully controlled scenario (11.22 TPD). The 2017 RFP VOC of 11.22 TPD was higher than the NO_X value of 7.70 TPD. These changes, while surprising at first glance, are consistent with changes in the inputs to the TexN2 utility. The 2017 AERR EI was developed with TexN2.0, and since that version, there has been a significant increase in the gasoline-fueled equipment population identified and updated in the development of TexN2.2. In Bexar County, the 2-stroke and 4-stroke gasoline equipment population increased by 25% and 20%, respectively, for the same calendar year 2017. Most of the increase came from Lawn and Garden (L&G) equipment. The L&G equipment is small HP and would not cause a corresponding increase in NO_X emissions, which explains the increase in VOC emissions versus NO_X emissions.

More generally, because of the gasoline-fueled equipment population increase in TexN2.2, more counties (80 counties) now have higher VOC emissions totals than NO_X emissions totals in the 2020 AERR EI. The 2017 AERR EI indicated only 40 counties with VOC emissions totals higher than NO_X emissions totals. At the statewide level, the nonroad VOC emissions total is very close to the NO_X emissions total in the 2020 AERR EI (Tables 1 and 2). There is much variation in the magnitude of VOC among counties due mainly to the evaporative diurnal emission process, which is highly sensitive to temperature and gasoline vapor pressure.

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Appendix A: 2020 AERR EI County-Level Results

Table A-1. 2020 OSD Criteria Emissions by County (Tons/Day)

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Anderson	0.232	0.242	3.396	0.03	0.029	0	0.001
Andrews	0.06	0.163	1.045	0.016	0.015	0	0
Angelina	0.83	0.48	11.873	0.06	0.056	0.001	0.001
Aransas	1.568	0.62	9.497	0.037	0.035	0.001	0.001
Archer	0.14	0.163	1.229	0.017	0.016	0	0
Armstrong	0.018	0.134	0.184	0.012	0.012	0	0
Atascosa	0.204	0.369	2.727	0.035	0.033	0	0.001
Austin	0.226	0.338	3.409	0.041	0.039	0	0.001
Bailey	0.082	0.375	1.154	0.041	0.04	0	0
Bandera	0.647	0.127	4.043	0.025	0.024	0	0
Bastrop	0.263	0.534	4.48	0.057	0.055	0.001	0.001
Baylor	0.209	0.201	1.324	0.018	0.018	0	0
Bee	0.083	0.202	1.441	0.026	0.025	0	0
Bell	1.207	1.313	18.144	0.156	0.149	0.002	0.004
Bexar	11.582	7.941	229.98	1.265	1.187	0.012	0.027
Blanco	0.11	0.076	1.025	0.009	0.009	0	0
Borden	0.056	0.121	0.294	0.011	0.011	0	0
Bosque	0.303	0.224	3.237	0.03	0.028	0	0.001
Bowie	0.642	0.614	10.24	0.071	0.067	0.001	0.002
Brazoria	1.903	2.108	29.022	0.221	0.21	0.003	0.005
Brazos	0.947	0.789	17.196	0.113	0.107	0.001	0.002
Brewster	0.108	0.152	1.112	0.017	0.016	0	0
Briscoe	0.033	0.162	0.348	0.017	0.017	0	0
Brooks	0.221	0.131	1.339	0.014	0.013	0	0
Brown	0.38	0.691	4.306	0.068	0.065	0.001	0.002
Burleson	0.199	0.235	2.11	0.028	0.027	0	0
Burnet	1.214	0.524	10.998	0.075	0.07	0.001	0.002
Caldwell	0.218	0.272	2.325	0.032	0.03	0	0.001
Calhoun	2.563	1.249	14.781	0.065	0.062	0.001	0.002
Callahan	0.129	0.165	1.293	0.018	0.017	0	0
Cameron	3.915	2.189	39.843	0.237	0.224	0.002	0.006
Camp	0.17	0.078	1.329	0.011	0.01	0	0
Carson	0.061	0.343	0.709	0.035	0.034	0	0.001
Cass	0.252	0.206	3.453	0.024	0.023	0	0.001
Castro	0.105	0.614	1.198	0.068	0.066	0	0.001
Chambers	0.466	0.441	4.478	0.034	0.033	0.001	0.001

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Cherokee	0.181	0.289	3.038	0.03	0.029	0	0.001
Childress	0.064	0.214	0.782	0.022	0.021	0	0
Clay	0.148	0.189	1.036	0.019	0.019	0	0
Cochran	0.062	0.427	0.685	0.046	0.045	0	0.001
Coke	0.192	0.115	1.173	0.007	0.007	0	0
Coleman	0.175	0.227	1.521	0.026	0.025	0	0
Collin	6.505	5.147	127.658	0.794	0.747	0.007	0.016
Collingsworth	0.046	0.251	0.548	0.027	0.027	0	0
Colorado	0.282	0.488	3.005	0.052	0.05	0.001	0.002
Comal	1.24	1.486	13.974	0.157	0.15	0.002	0.006
Comanche	0.153	0.314	1.882	0.035	0.034	0	0.001
Concho	0.109	0.217	0.715	0.026	0.025	0	0
Cooke	0.447	0.452	5.233	0.054	0.052	0.001	0.001
Coryell	0.151	0.329	2.287	0.035	0.034	0	0.001
Cottle	0.02	0.111	0.263	0.011	0.011	0	0
Crane	0.021	0.106	0.259	0.011	0.011	0	0
Crockett	0.082	0.052	0.719	0.005	0.005	0	0
Crosby	0.117	0.609	1.371	0.066	0.064	0	0.001
Culberson	0.015	0.112	0.187	0.007	0.007	0	0
Dallam	0.116	0.707	1.419	0.077	0.075	0	0.001
Dallas	18.173	15.753	397.837	2.077	1.959	0.023	0.047
Dawson	0.132	0.7	1.769	0.079	0.076	0	0.001
Deaf Smith	0.086	0.224	1.56	0.02	0.019	0	0.001
Delta	0.079	0.505	0.807	0.044	0.042	0	0.001
Denton	3.81	3.52	70.821	0.46	0.435	0.005	0.011
De Witt	0.141	0.264	2.58	0.032	0.031	0	0.001
Dickens	0.031	0.142	0.301	0.015	0.015	0	0
Dimmit	0.199	0.062	1.422	0.009	0.009	0	0
Donley	0.108	0.137	0.822	0.015	0.014	0	0
Duval	0.067	0.133	0.758	0.014	0.013	0	0
Eastland	0.199	0.276	2.558	0.03	0.029	0	0.001
Ector	0.647	0.909	13.943	0.081	0.077	0.001	0.002
Edwards	0.008	0.036	0.134	0.002	0.002	0	0
Ellis	0.843	1.992	13.845	0.191	0.184	0.002	0.004
El Paso	2.908	3.132	63.97	0.332	0.315	0.003	0.008
Erath	0.217	0.4	3.919	0.045	0.043	0	0.001
Falls	0.113	0.364	1.489	0.045	0.043	0	0.001
Fannin	0.187	0.479	2.782	0.058	0.056	0	0.001
Fayette	0.283	0.33	3.101	0.041	0.04	0	0.001
Fisher	0.046	0.265	0.426	0.03	0.029	0	0

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Floyd	0.111	0.599	1.441	0.067	0.065	0	0.001
Foard	0.031	0.14	0.349	0.015	0.015	0	0
Fort Bend	2.538	2.437	52.682	0.336	0.318	0.003	0.007
Franklin	0.087	0.099	0.982	0.011	0.011	0	0
Freestone	0.096	0.175	1.321	0.018	0.017	0	0
Frio	0.123	0.178	1.282	0.02	0.019	0	0
Gaines	0.155	0.879	1.831	0.096	0.093	0	0.001
Galveston	2.051	1.867	30.564	0.196	0.185	0.002	0.005
Garza	0.04	0.146	0.55	0.015	0.015	0	0
Gillespie	0.188	0.228	2.777	0.026	0.024	0	0.001
Glasscock	0.034	0.251	0.318	0.027	0.027	0	0
Goliad	0.054	0.079	0.614	0.009	0.009	0	0
Gonzales	0.147	0.211	1.909	0.026	0.025	0	0
Gray	0.192	0.266	3.702	0.033	0.031	0	0.001
Grayson	1.087	0.953	15.236	0.12	0.114	0.001	0.002
Gregg	0.998	0.725	22.448	0.108	0.101	0.001	0.002
Grimes	0.227	0.221	3.208	0.028	0.027	0	0.001
Guadalupe	0.686	0.765	10.977	0.096	0.092	0.001	0.002
Hale	0.233	1.01	3.558	0.111	0.108	0.001	0.001
Hall	0.054	0.275	0.625	0.03	0.029	0	0
Hamilton	0.058	0.14	0.991	0.017	0.016	0	0
Hansford	0.081	0.364	1.179	0.04	0.039	0	0
Hardeman	0.11	0.202	0.845	0.024	0.023	0	0
Hardin	0.151	0.151	3.057	0.018	0.017	0	0
Harris	26.658	25.635	581.055	3.278	3.098	0.039	0.077
Harrison	0.425	0.96	5.542	0.069	0.066	0.001	0.002
Hartley	0.079	0.465	0.862	0.05	0.048	0	0.001
Haskell	0.134	0.598	1.165	0.067	0.065	0	0.001
Hays	0.594	0.718	9.164	0.078	0.074	0.001	0.002
Hemphill	0.044	0.106	0.613	0.009	0.009	0	0
Henderson	1.015	0.565	10.918	0.07	0.066	0.001	0.002
Hidalgo	3.52	2.489	45.291	0.317	0.301	0.002	0.007
Hill	0.451	0.679	3.908	0.083	0.08	0.001	0.001
Hockley	0.174	0.827	2.405	0.091	0.088	0	0.001
Hood	0.329	0.345	5.535	0.04	0.038	0.001	0.001
Hopkins	0.174	0.32	2.876	0.038	0.036	0	0.001
Houston	0.158	0.203	1.802	0.025	0.024	0	0
Howard	0.195	0.391	2.489	0.041	0.04	0	0.001
Hudspeth	0.091	0.175	0.611	0.016	0.016	0	0
Hunt	0.617	0.653	8.371	0.077	0.074	0.001	0.002

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Hutchinson	0.143	0.36	1.986	0.028	0.027	0	0.001
Irion	0.016	0.032	0.304	0.003	0.003	0	0
Jack	0.058	0.133	0.865	0.012	0.011	0	0
Jackson	0.247	0.45	2.292	0.053	0.051	0	0.001
Jasper	0.281	0.193	3.47	0.018	0.017	0	0
Jeff Davis	0.077	0.04	0.586	0.005	0.005	0	0
Jefferson	2.111	1.597	38.016	0.202	0.19	0.002	0.005
Jim Hogg	0.031	0.18	0.352	0.017	0.016	0	0
Jim Wells	0.208	0.34	3.39	0.043	0.041	0	0.001
Johnson	0.598	0.929	11.647	0.104	0.099	0.001	0.003
Jones	0.224	0.676	2.334	0.072	0.069	0.001	0.002
Karnes	0.069	0.154	1.014	0.019	0.018	0	0
Kaufman	0.548	1.111	8.551	0.108	0.104	0.001	0.003
Kendall	0.609	0.308	7.477	0.048	0.045	0	0.001
Kenedy	2.307	0.945	9.926	0.036	0.034	0.001	0.002
Kent	0.02	0.11	0.268	0.011	0.011	0	0
Kerr	1.136	0.322	9.702	0.058	0.055	0	0.001
Kimble	0.084	0.048	0.698	0.005	0.005	0	0
King	0.01	0.035	0.06	0.003	0.003	0	0
Kinney	0.025	0.027	0.211	0.002	0.002	0	0
Kleberg	1.104	0.609	6.447	0.043	0.041	0	0.001
Knox	0.071	0.327	0.981	0.037	0.036	0	0
Lamar	0.301	0.533	5.033	0.062	0.06	0.001	0.001
Lamb	0.156	0.84	1.847	0.092	0.089	0	0.001
Lampasas	0.135	0.15	1.45	0.017	0.016	0	0
La Salle	0.126	0.143	0.711	0.011	0.01	0	0
Lavaca	0.087	0.25	1.675	0.029	0.028	0	0
Lee	0.164	0.255	1.861	0.024	0.023	0	0.001
Leon	0.109	0.203	1.446	0.022	0.022	0	0
Liberty	0.353	0.488	5.088	0.054	0.052	0.001	0.001
Limestone	0.2	0.306	2.006	0.03	0.029	0	0.001
Lipscomb	0.023	0.128	0.299	0.012	0.012	0	0
Live Oak	0.31	0.184	2.086	0.017	0.017	0	0
Llano	0.417	0.192	3.38	0.02	0.019	0	0
Loving	0.025	0.038	0.107	0.002	0.002	0	0
Lubbock	1.718	2.129	29.384	0.24	0.229	0.002	0.005
Lynn	0.13	0.818	1.371	0.088	0.085	0	0.001
McCulloch	0.067	0.197	0.764	0.02	0.02	0	0
McLennan	1.328	1.404	24.796	0.178	0.169	0.002	0.004
McMullen	0.178	0.113	0.772	0.006	0.006	0	0

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Madison	0.049	0.1	0.723	0.011	0.011	0	0
Marion	0.228	0.179	1.694	0.012	0.011	0	0
Martin	0.067	0.323	0.852	0.035	0.034	0	0
Mason	0.08	0.062	0.653	0.008	0.007	0	0
Matagorda	2.008	1.133	13.841	0.086	0.082	0.001	0.002
Maverick	0.206	0.178	2.497	0.015	0.015	0	0.001
Medina	0.274	0.563	3.178	0.06	0.057	0	0.001
Menard	0.016	0.028	0.294	0.003	0.003	0	0
Midland	0.91	0.726	17.457	0.088	0.083	0.001	0.002
Milam	0.196	0.445	3.244	0.054	0.052	0	0.001
Mills	0.039	0.094	0.558	0.01	0.01	0	0
Mitchell	0.088	0.342	0.755	0.033	0.032	0	0.001
Montague	0.125	0.21	1.713	0.022	0.022	0	0
Montgomery	2.793	2.618	50.025	0.346	0.327	0.003	0.008
Moore	0.172	0.539	2.085	0.054	0.052	0	0.001
Morris	0.072	0.106	1.297	0.011	0.01	0	0
Motley	0.022	0.1	0.279	0.011	0.01	0	0
Nacogdoches	0.451	0.332	5.99	0.036	0.034	0	0.001
Navarro	0.49	0.488	6.925	0.066	0.063	0.001	0.001
Newton	0.193	0.064	1.702	0.011	0.01	0	0
Nolan	0.098	0.31	1.615	0.03	0.029	0	0.001
Nueces	3.412	2.707	42.686	0.299	0.284	0.003	0.007
Ochiltree	0.057	0.164	1.113	0.015	0.015	0	0
Oldham	0.023	0.11	0.337	0.009	0.009	0	0
Orange	0.64	0.392	9.908	0.055	0.052	0.001	0.001
Palo Pinto	0.314	0.299	3.282	0.028	0.026	0	0.001
Panola	0.294	0.28	2.734	0.025	0.024	0	0.001
Parker	0.576	0.777	9.355	0.087	0.083	0.001	0.002
Parmer	0.144	0.669	1.877	0.072	0.07	0	0.001
Pecos	0.243	0.159	1.774	0.018	0.017	0	0
Polk	0.503	0.245	4.488	0.025	0.023	0	0.001
Potter	0.985	0.883	13.683	0.093	0.088	0.001	0.002
Presidio	0.089	0.048	0.703	0.005	0.005	0	0
Rains	0.219	0.132	1.489	0.012	0.012	0	0
Randall	0.499	0.716	8.864	0.073	0.07	0.001	0.002
Reagan	0.029	0.104	0.42	0.011	0.011	0	0
Real	0.144	0.034	0.984	0.006	0.006	0	0
Red River	0.095	0.178	1.14	0.022	0.021	0	0
Reeves	0.087	0.26	0.794	0.015	0.015	0	0.001
Refugio	0.367	0.285	2.411	0.03	0.028	0	0.001

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Roberts	0.009	0.075	0.088	0.006	0.006	0	0
Robertson	0.135	0.38	1.616	0.034	0.032	0	0.001
Rockwall	0.711	0.686	12.626	0.093	0.087	0.001	0.002
Runnels	0.125	0.506	1.598	0.058	0.056	0	0.001
Rusk	0.261	0.444	3.347	0.034	0.032	0	0.001
Sabine	0.537	0.207	3.447	0.014	0.013	0	0
San Augustine	0.342	0.162	2.037	0.009	0.008	0	0
San Jacinto	0.34	0.171	2.582	0.012	0.011	0	0
San Patricio	0.648	0.742	7.916	0.105	0.1	0.001	0.002
San Saba	0.06	0.134	0.768	0.013	0.013	0	0
Schleicher	0.013	0.058	0.241	0.005	0.005	0	0
Scurry	0.191	0.344	2.169	0.038	0.037	0	0.001
Shackelford	0.03	0.127	0.317	0.012	0.011	0	0
Shelby	0.327	0.207	3.575	0.022	0.02	0	0
Sherman	0.084	0.512	1.038	0.057	0.055	0	0.001
Smith	1.743	1.256	33.353	0.187	0.176	0.002	0.004
Somervell	0.288	0.136	2.011	0.017	0.016	0	0.001
Starr	0.183	0.654	2.137	0.059	0.057	0	0.002
Stephens	0.198	0.128	1.501	0.01	0.009	0	0
Sterling	0.008	0.039	0.153	0.002	0.002	0	0
Stonewall	0.027	0.112	0.245	0.012	0.012	0	0
Sutton	0.025	0.032	0.483	0.003	0.003	0	0
Swisher	0.08	0.411	1.11	0.045	0.043	0	0.001
Tarrant	9.526	8.873	201.333	1.099	1.037	0.013	0.025
Taylor	0.915	1.331	15.774	0.139	0.133	0.002	0.005
Terrell	0.017	0.111	0.162	0.011	0.011	0	0
Terry	0.124	0.669	1.518	0.074	0.072	0	0.001
Throckmorton	0.038	0.114	0.331	0.012	0.012	0	0
Titus	0.312	0.216	3.876	0.025	0.024	0	0.001
Tom Green	0.837	0.854	12.17	0.101	0.097	0.001	0.002
Travis	8.536	6.274	167.323	0.957	0.9	0.01	0.021
Trinity	0.43	0.121	2.77	0.019	0.018	0	0
Tyler	0.178	0.1	1.876	0.012	0.012	0	0
Upshur	0.16	0.157	2.934	0.021	0.02	0	0
Upton	0.021	0.06	0.432	0.005	0.005	0	0
Uvalde	0.561	0.313	4.097	0.045	0.043	0	0.001
Val Verde	0.736	0.307	5.291	0.027	0.026	0	0.001
Van Zandt	0.325	0.344	4.031	0.043	0.041	0	0.001
Victoria	0.474	0.509	8.848	0.066	0.063	0.001	0.001
Walker	0.413	0.21	4.658	0.029	0.027	0	0.001

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Waller	0.405	0.334	7.202	0.051	0.049	0	0.001
Ward	0.041	0.105	0.645	0.008	0.007	0	0.001
Washington	0.396	0.315	6.225	0.046	0.043	0	0.001
Webb	1.285	2.446	20.295	0.22	0.211	0.002	0.006
Wharton	0.438	0.81	6.99	0.113	0.109	0.001	0.001
Wheeler	0.045	0.189	0.637	0.018	0.017	0	0
Wichita	0.647	0.846	12.483	0.094	0.09	0.001	0.002
Wilbarger	0.135	0.436	1.43	0.049	0.047	0	0.001
Willacy	1.033	0.68	4.961	0.047	0.045	0	0.001
Williamson	2.216	2.774	40.259	0.356	0.338	0.004	0.009
Wilson	0.108	0.282	1.772	0.032	0.031	0	0.001
Winkler	0.034	0.116	0.479	0.012	0.011	0	0
Wise	0.321	0.579	4.042	0.057	0.055	0.001	0.002
Wood	0.603	0.32	5.736	0.037	0.035	0	0.001
Yoakum	0.082	0.398	1.188	0.043	0.042	0	0.001
Young	0.258	0.185	2.694	0.022	0.021	0	0
Zapata	0.753	0.249	3.502	0.022	0.021	0	0.001
Zavala	0.056	0.106	0.54	0.012	0.011	0	0
Total*	**185.874**	**187.487**	**3105.145**	**22.520**	**21.393**	**0.221**	**0.491**

* Note that totals may not match the sum of counties due to rounding in the values by county. Additional significant digits in the EIs are available in the electronic file **Deliverable_4.3_AERR_Summary_Data_20210630.xlsx** that accompanies this report.

Table A-2. 2020 Annual Criteria Emissions by County (Tons/Year)

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Anderson	75	72	1,047	8	8	0	0
Andrews	17	44	316	4	4	0	0
Angelina	274	166	3,535	18	17	0	0
Aransas	588	271	3,759	14	13	0	1
Archer	45	49	415	4	4	0	0
Armstrong	5	34	51	3	3	0	0
Atascosa	64	106	833	9	9	0	0
Austin	70	97	986	11	10	0	0
Bailey	22	92	323	10	10	0	0
Bandera	200	41	1,261	8	7	0	0
Bastrop	81	154	1,328	16	15	0	0
Baylor	68	64	501	5	5	0	0
Bee	27	53	434	7	6	0	0
Bell	379	395	5,413	43	41	1	1
Bexar	3,300	2,372	60,899	353	332	4	7
Blanco	34	23	313	3	2	0	0
Borden	18	34	110	3	3	0	0
Bosque	96	67	961	8	8	0	0
Bowie	207	194	3,084	20	19	0	0
Brazoria	609	670	8,642	63	59	1	2
Brazos	281	238	4,760	31	30	0	1
Brewster	32	40	336	4	4	0	0
Briscoe	9	41	101	4	4	0	0
Brooks	67	38	417	4	4	0	0
Brown	116	204	1,345	19	18	0	0
Burleson	66	69	677	7	7	0	0
Burnet	367	161	3,175	22	20	0	1
Caldwell	69	77	714	9	8	0	0
Calhoun	969	532	6,064	23	22	1	1
Callahan	39	46	404	5	4	0	0
Cameron	1,306	765	12,845	71	67	1	2
Camp	56	25	435	3	3	0	0
Carson	16	87	205	9	8	0	0
Cass	85	67	1,069	7	7	0	0
Castro	27	149	331	16	16	0	0
Chambers	164	160	1,595	10	10	0	0
Cherokee	60	87	965	8	8	0	0
Childress	18	56	239	5	5	0	0
Clay	48	56	375	5	5	0	0

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Cochran	15	104	184	11	11	0	0
Coke	65	42	461	2	2	0	0
Coleman	53	61	476	7	6	0	0
Collin	1,820	1,548	33,390	219	206	3	4
Collingsworth	12	63	156	7	6	0	0
Colorado	92	142	949	14	13	0	1
Comal	386	441	4,090	44	42	1	2
Comanche	46	86	585	9	9	0	0
Concho	32	55	215	6	6	0	0
Cooke	141	137	1,607	15	14	0	0
Coryell	49	94	722	9	9	0	0
Cottle	5	28	77	3	3	0	0
Crane	5	27	75	3	3	0	0
Crockett	25	15	222	1	1	0	0
Crosby	31	150	380	16	15	0	0
Culberson	4	30	57	2	2	0	0
Dallam	30	174	395	19	18	0	0
Dallas	5,217	4,833	108,587	590	556	9	13
Dawson	34	170	490	19	18	0	0
Deaf Smith	24	62	474	5	5	0	0
Delta	22	143	226	11	11	0	0
Denton	1,110	1,067	19,288	128	121	2	3
De Witt	41	75	711	8	8	0	0
Dickens	8	36	88	4	4	0	0
Dimmit	58	20	437	3	3	0	0
Donley	32	37	258	4	4	0	0
Duval	20	37	242	4	3	0	0
Eastland	60	77	787	8	8	0	0
Ector	187	271	4,127	23	22	0	1
Edwards	2	10	42	1	1	0	0
Ellis	250	573	3,937	51	49	1	1
El Paso	868	933	18,159	96	91	1	2
Erath	62	111	1,119	12	11	0	0
Falls	34	96	447	11	11	0	0
Fannin	57	130	826	15	14	0	0
Fayette	91	96	966	11	10	0	0
Fisher	12	66	118	7	7	0	0
Floyd	28	146	394	16	15	0	0
Foard	9	36	102	4	4	0	0
Fort Bend	733	732	14,354	93	88	1	2

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Franklin	30	30	321	3	3	0	0
Freestone	32	51	420	5	5	0	0
Frio	37	49	393	5	5	0	0
Gaines	40	213	497	23	22	0	0
Galveston	662	625	9,291	57	54	1	2
Garza	11	37	153	4	4	0	0
Gillespie	55	64	803	7	7	0	0
Glasscock	8	63	83	7	6	0	0
Goliad	19	23	209	2	2	0	0
Gonzales	47	60	590	7	6	0	0
Gray	58	73	1,059	9	8	0	0
Grayson	341	291	4,447	33	31	0	1
Gregg	290	227	6,139	31	29	0	1
Grimes	71	66	929	8	7	0	0
Guadalupe	207	222	3,127	26	25	0	1
Hale	62	253	1,014	27	26	0	0
Hall	14	69	179	7	7	0	0
Hamilton	16	37	290	4	4	0	0
Hansford	22	91	334	10	9	0	0
Hardeman	32	52	253	6	6	0	0
Hardin	49	48	924	5	5	0	0
Harris	7,720	7,743	159,644	926	875	14	22
Harrison	138	289	1,724	19	19	0	1
Hartley	21	114	231	12	12	0	0
Haskell	37	150	346	16	16	0	0
Hays	182	212	2,671	22	21	0	1
Hemphill	13	30	183	2	2	0	0
Henderson	340	190	3,423	20	19	0	0
Hidalgo	1,069	744	13,608	90	85	1	2
Hill	144	191	1,247	21	20	0	0
Hockley	46	204	681	22	21	0	0
Hood	101	105	1,584	11	10	0	0
Hopkins	55	91	892	10	9	0	0
Houston	53	58	579	7	6	0	0
Howard	57	105	752	11	10	0	0
Hudspeth	27	45	183	4	4	0	0
Hunt	198	197	2,526	21	20	0	0
Hutchinson	45	103	641	8	7	0	0
Irion	4	9	82	1	1	0	0
Jack	17	38	260	3	3	0	0

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Jackson	85	129	767	13	13	0	0
Jasper	101	69	1,170	5	5	0	0
Jeff Davis	24	11	173	1	1	0	0
Jefferson	666	524	10,858	58	55	1	1
Jim Hogg	8	48	103	4	4	0	0
Jim Wells	60	93	985	11	11	0	0
Johnson	176	273	3,272	28	27	0	1
Jones	65	176	705	18	17	0	0
Karnes	22	43	318	5	5	0	0
Kaufman	171	330	2,537	29	28	0	1
Kendall	177	91	2,033	14	13	0	0
Kenedy	823	422	4,435	14	13	0	1
Kent	5	28	77	3	3	0	0
Kerr	344	99	2,824	17	16	0	0
Kimble	26	14	218	2	1	0	0
King	3	10	21	1	1	0	0
Kinney	8	8	72	1	1	0	0
Kleberg	394	239	2,585	13	13	0	0
Knox	19	82	282	9	9	0	0
Lamar	96	154	1,526	16	16	0	0
Lamb	41	206	512	22	21	0	0
Lampasas	40	44	442	5	4	0	0
La Salle	38	43	237	3	3	0	0
Lavaca	27	70	511	8	7	0	0
Lee	52	75	574	6	6	0	0
Leon	37	59	471	6	6	0	0
Liberty	114	146	1,557	15	14	0	0
Limestone	70	93	686	8	8	0	0
Lipscomb	6	33	88	3	3	0	0
Live Oak	113	66	786	5	5	0	0
Llano	133	67	1,119	6	6	0	0
Loving	8	12	46	0	0	0	0
Lubbock	488	599	8,425	65	62	1	1
Lynn	33	200	366	21	20	0	0
McCulloch	20	53	241	5	5	0	0
McLennan	402	416	7,057	49	46	1	1
McMullen	63	42	337	2	2	0	0
Madison	16	28	231	3	3	0	0
Marion	85	65	659	4	4	0	0
Martin	17	79	232	8	8	0	0

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Mason	24	17	201	2	2	0	0
Matagorda	742	446	5,228	26	25	0	1
Maverick	62	58	809	5	4	0	0
Medina	81	155	958	15	15	0	0
Menard	5	8	92	1	1	0	0
Midland	254	218	4,842	25	24	0	1
Milam	58	122	915	14	13	0	0
Mills	12	26	175	2	2	0	0
Mitchell	26	91	238	8	8	0	0
Montague	39	60	540	6	6	0	0
Montgomery	825	794	13,792	97	91	1	2
Moore	52	142	651	14	13	0	0
Morris	24	33	403	3	3	0	0
Motley	6	25	78	3	3	0	0
Nacogdoches	152	112	1,902	11	10	0	0
Navarro	150	142	1,955	18	17	0	0
Newton	64	22	543	3	3	0	0
Nolan	28	83	480	8	7	0	0
Nueces	1,149	902	13,390	85	81	1	2
Ochiltree	17	45	340	4	4	0	0
Oldham	7	30	102	2	2	0	0
Orange	204	130	2,864	16	15	0	0
Palo Pinto	101	97	1,072	8	7	0	0
Panola	100	89	906	7	7	0	0
Parker	173	228	2,659	24	23	0	1
Parmer	39	167	534	17	17	0	0
Pecos	73	45	551	5	5	0	0
Polk	178	91	1,560	8	7	0	0
Potter	303	267	4,155	27	26	0	1
Presidio	27	14	221	2	2	0	0
Rains	77	46	551	4	3	0	0
Randall	142	207	2,570	20	19	0	0
Reagan	8	27	126	3	3	0	0
Real	44	10	293	2	2	0	0
Red River	31	50	361	5	5	0	0
Reeves	26	74	262	4	4	0	0
Refugio	132	95	901	8	8	0	0
Roberts	2	20	25	2	2	0	0
Robertson	44	110	519	9	8	0	0
Rockwall	206	209	3,349	25	24	0	1

County	VOC	NO_x	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Runnels	34	128	456	14	14	0	0
Rusk	88	136	1,086	10	9	0	0
Sabine	199	89	1,330	5	5	0	0
San Augustine	131	69	850	3	3	0	0
San Jacinto	128	69	991	4	4	0	0
San Patricio	202	207	2,278	27	26	0	0
San Saba	18	37	243	3	3	0	0
Schleicher	4	15	73	1	1	0	0
Scurry	56	91	654	10	9	0	0
Shackelford	9	34	99	3	3	0	0
Shelby	115	74	1,166	6	6	0	0
Sherman	21	125	276	14	13	0	0
Smith	514	385	9,122	52	49	1	1
Somervell	92	42	626	5	5	0	0
Starr	56	188	676	16	15	0	0
Stephens	66	45	552	3	3	0	0
Sterling	2	11	46	1	1	0	0
Stonewall	8	28	74	3	3	0	0
Sutton	8	10	150	1	1	0	0
Swisher	21	101	317	11	10	0	0
Tarrant	2,767	2,720	55,634	313	296	5	7
Taylor	259	383	4,427	38	36	1	1
Terrell	4	28	45	3	3	0	0
Terry	32	164	430	18	17	0	0
Throckmorton	11	30	106	3	3	0	0
Titus	102	70	1,201	7	7	0	0
Tom Green	241	245	3,497	27	26	0	1
Travis	2,437	1,892	44,481	268	252	3	6
Trinity	145	43	938	6	5	0	0
Tyler	62	34	622	4	3	0	0
Upshur	50	47	857	6	5	0	0
Upton	6	16	130	1	1	0	0
Uvalde	169	87	1,249	12	12	0	0
Val Verde	235	112	1,801	9	8	0	0
Van Zandt	105	101	1,252	12	11	0	0
Victoria	147	151	2,574	18	17	0	0
Walker	134	68	1,435	9	8	0	0
Waller	118	98	1,951	14	13	0	0
Ward	12	30	200	2	2	0	0
Washington	120	94	1,721	12	12	0	0

County	VOC	NO_X	CO	PM_{10}-PRI	$PM_{2.5}$-PRI	SO_2	NH_3
Webb	361	722	5,834	61	59	1	2
Wharton	127	213	1,908	28	27	0	0
Wheeler	13	50	191	4	4	0	0
Wichita	185	253	3,602	26	25	0	1
Wilbarger	38	113	437	12	12	0	0
Willacy	364	249	2,090	14	13	0	0
Williamson	637	798	10,829	96	91	1	3
Wilson	33	77	538	8	8	0	0
Winkler	9	29	146	3	3	0	0
Wise	104	171	1,287	15	15	0	1
Wood	205	109	1,884	11	10	0	0
Yoakum	21	98	328	10	10	0	0
Young	80	56	841	6	6	0	0
Zapata	234	92	1,285	7	7	0	0
Zavala	16	29	172	3	3	0	0
Total*	**56,232**	**56,225**	**880,839**	**6,224**	**5,904**	**79**	**139**

* Note that totals may not match the sum of counties due to rounding in the values by county. Additional significant digits in the EIs are available in the electronic file **Deliverable_4.3_AERR_Summary_Data_20210630.xlsx** that accompanies this report.

Appendix B: RFP EIs for the 2008 Ozone NAAQS

Report begins on the following page.

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Development of the Nonroad Model RFP Emissions Inventories for the HGB Eight-County and DFW Ten-County Ozone Nonattainment Areas

Prepared for:

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July 28, 2021

ERG No.: 0344.00.003

Development of the Nonroad Model RFP Emissions Inventories for the HGB Eight-County and DFW Ten-County Ozone Nonattainment Areas

TCEQ Contract No. 582-19-92744
Work Order No. 582-21-22147-003

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July 28, 2021

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1.0 Overview

This Report is Deliverable 5.2 for the project "Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories" (Contract Number 582-19-92744, Work Order 582-21-22147-003). The sections below describe the work performed under Task 5 to estimate emissions for a potential severe reclassification state implementation plan (SIP) revision for the 2008 eight-hour ozone national ambient air quality standard (NAAQS).

2.0 Background

The Texas Commission on Environmental Quality (TCEQ) contracted with Eastern Research Group, Inc. (ERG) to develop Texas NONROAD (TexN) version 1 and subsequent version 2 (TexN2), which are utilities for estimating Texas-specific emissions from nonroad mobile sources, excluding commercial marine vessels, locomotives, drilling rigs, and aircraft. The TexN model used the United States Environmental Protection Agency's (EPA) standalone NONROAD model to calculate emissions, whereas TexN2 uses EPA's MOVES-Nonroad model. MOVES is required by the EPA for state development of nonroad emissions estimates for SIP revisions, national emissions inventories, and reasonable further progress (RFP) analyses. Since TexN was first developed, the TCEQ has frequently updated the Texas-specific data and enhanced the utility's functions. The EPA recently updated the MOVES model, releasing MOVES3[1] in November of 2020, and TCEQ contracted with ERG to update TexN2 for full compatibility with MOVES3[2]. States are required to use the most recent version of MOVES when developing and submitting emissions estimates from specific nonroad mobile sources to the EPA.

The purpose of Task 5 of this project is to provide RFP emissions inventories (EI) to support the TCEQ with a potential severe reclassification SIP revision for the 2008 ozone NAAQS. The EIs include ozone season day (OSD) weekday estimates of volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) for the base year 2011 and future years 2023, 2026, and 2027. The RFP EIs were generated using MOVES3 code version 3.0.1 with database version 'movesdb20210209' and TexN2 code version 2.2.0 with the TexN2 database last updated May 24, 2021.

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[1] US EPA, 2020. "MOVES3: Latest Version of Motor Vehicle Emission Simulator." https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves. Accessed 17 February 2020.

[2] ERG, 2021. "TexN2.2 Utility Updates for Compatibility with the US EPA MOVES3 Model." Prepared for the Texas Commission on Environmental Quality, Air Quality Division, Austin, TX 78711-3087. April 23.

3.0 Emissions Inventory Development and Results

The geographic scope of the EIs includes the eight-county Houston-Galveston-Brazoria (HGB) area (defined as Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) and the ten-county Dallas-Fort Worth (DFW) area (defined as Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties).

The temporal scope of the EIs is OSD weekday for the years 2011, 2023, 2026, and 2027. The period type "OSD weekday" represents weekday emissions averaged over the summer months June, July, and August. TexN2 allocates annual activity to these months with monthly and day type allocation factors contained in tables within the TexN2 utility database.

The meteorology data in the EIs was specific to the base year 2011, applied to all RFP analysis years 2011, 2023, 2026, and 2027. The fuel types in each analysis year are specific to 2011 for the base year and 2020 for the three later years. At the time of writing (June 2021), year 2020 is the latest available fuel survey data contained in the TexN2 database.

The RFP EIs include VOC and NO_X emissions from ten separate runs that the TexN2 utility automatically initiates in sequence corresponding to the scenarios listed below. The first scenario represents a case without any emission controls. The second through tenth RFP scenarios add successive federal and state emissions controls. TexN2 sets up the MOVES runs for each scenario using alternate versions of the MOVES input table that describes technology fractions by equipment model year. TexN2 disables the inclusion of reformulated gasoline (RFG) in the HGB and DFW areas until the final RFP scenario, *allRules_cntl*, representing the fully controlled scenario. RFG fuels are used in the final control strategy in all eight HGB counties and four of the ten DFW counties (Collin, Dallas, Denton, and Tarrant). Similarly, the benefits of Texas Low Emission Diesel (TxLED) fuel are delayed until the final RFP scenario, where they are included as a post-processing adjustment to NO_X from diesel-fueled equipment. All 18 counties are part of the 110-county TxLED fuel control area.

RFP Scenario Name	Description
smallSprk1_uncntl	No controls
smallSprk1_cntl	Controls through Small nonroad spark ignition (SI) engines (Phase 1)
Tier1_cntl	Controls through Tier 1 nonroad diesel engines
Tier2_3_cntl	Controls through Tiers 2 and 3 nonroad diesel engines
smallSprk2_cntl	Controls through Small nonroad SI engines (Phase II)
largeSprk_cntl	Controls through Large nonroad SI engines
Tier4_cntl	Controls through Tier 4 nonroad diesel engines
recMarine_cntl	Controls through Diesel recreational marine engines
smallSI_cntl	Controls through SI marine engines
allRules_cntl	Controls through SI marine engines, includes RFG and TxLED fuel controls

Tables 1 and 2 show results for each RFP scenario for the HGB and DFW areas, respectively. They include separate line items showing RFG and TxLED benefits as control scenarios number 9 and 10. The final scenario (Fully Controlled) corresponds to the "allRules_cntl" RFP scenario. The Fully Controlled case contains the same values as the prior TxLED line item because TexN2 does not model any further emission controls after RFG and TxLED. It remains in the tables for clarity to indicate the cumulative effect of all controls.

Table 1. NO_X and VOC Emissions for the HGB Eight-County Area (Tons/Day)

Emissions Control Scenario	2011 NO_X	2011 VOC	2023 NO_X	2023 VOC	2026 NO_X	2026 VOC	2027 NO_X	2027 VOC
Uncontrolled	105.39	155.18	158.94	203.54	166.31	214.59	169.52	218.55
1. smallSprk1_cntl	110.50	114.45	165.61	150.30	173.38	158.27	176.73	161.15
2. Tier1_cntl	107.60	110.10	165.24	144.87	173.34	152.78	176.77	155.64
3. Tier2_3_cntl	99.32	107.77	162.43	144.30	171.26	152.37	174.91	155.28
4. smallSprk2_cntl	95.75	69.73	157.65	94.35	166.20	99.75	169.75	101.73
5. largeSprk_cntl	72.54	62.30	106.24	76.67	107.82	79.86	108.89	81.09
6. Tier4_cntl	60.20	58.79	37.42	62.07	35.02	64.60	34.63	65.57
7. recMarine_cntl	60.20	58.79	37.40	62.06	34.99	64.60	34.59	65.57
8. smallSI_cntl	59.38	55.07	32.61	40.19	29.85	41.29	29.35	41.79
9. RFG	59.41	54.62	32.61	39.89	29.85	40.98	29.35	41.47
10. TxLED	57.32	54.62	31.59	39.89	29.03	40.98	28.57	41.47
Fully Controlled	57.32	54.62	31.59	39.89	29.03	40.98	28.57	41.47

The NO_X and VOC emissions generally decline from Uncontrolled to Fully Controlled except for small nonroad SI engines Phase 1 (smallSprk1_cntl), which increases NO_X by approximately 5 tons per day in 2011. The minor NO_X increase was allowed under the small SI rule, where some equipment have their standards defined in terms of combined hydrocarbons plus NO_X.

Generally, the uncontrolled and the earlier control scenarios show increased NO_X emissions over the RFP years of 2011 to 2027 within the scenario, whereas the later controls scenarios show NO_X decreases in the EI over time due to tighter emissions standards which reduce nonroad mobile source emissions despite a gradual growth in equipment population. These trends are more apparent in Figures 1 and 2 for the HGB and DFW areas. Figure 1 shows that for NO_X, the two RFP scenarios *largeSprk_cntl* and *Tier4_cntl* are responsible for most of the reductions in all years. The VOC emissions reductions appear more evenly impacted by the successive controls.

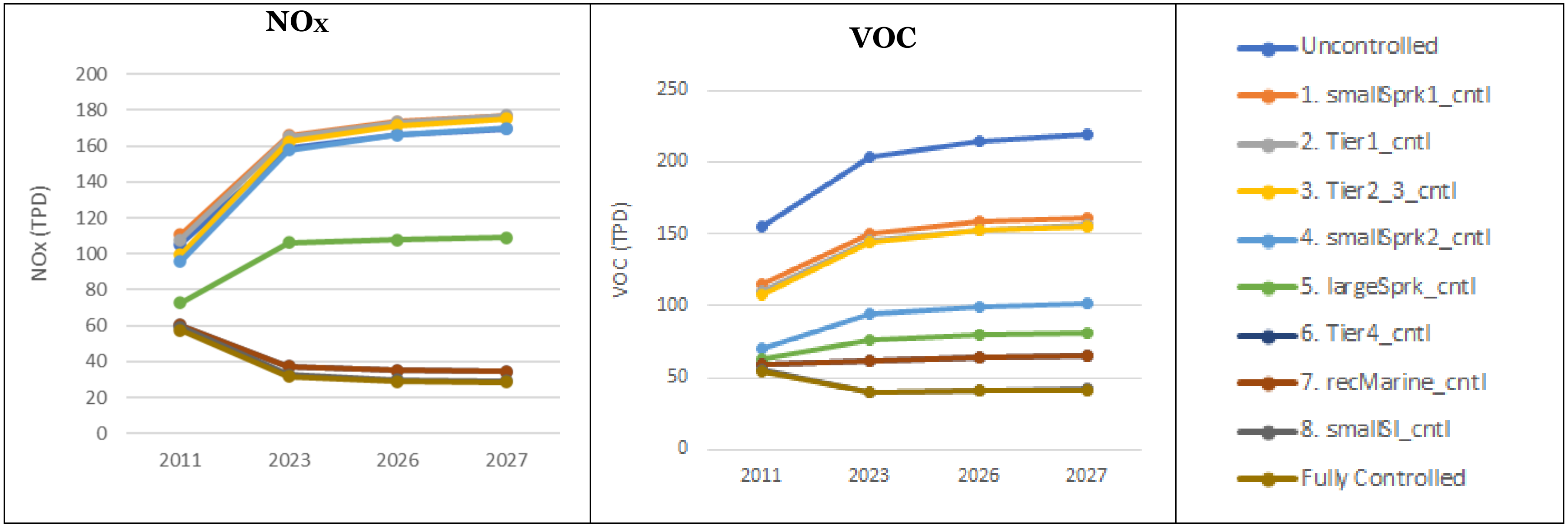

Figure 1. NOx and VOC Emissions for the HGB Eight-County Area (Tons/Day)

Table 2 and Figure 2 for the ten-county DFW area show similar trends to the HGB area. NO_X emissions slightly increase with *smallSprk1_cntl*, then decline or stay the same for all other successive controls. Figure 2 trends look similar to Figure 1.

Table 2. NO_X and VOC Emissions for the DFW Ten-County Area (Tons/Day)

Emissions Control Scenario	2011 NO_X	2011 VOC	2023 NO_X	2023 VOC	2026 NO_X	2026 VOC	2027 NO_X	2027 VOC
Uncontrolled	111.93	173.23	169.59	228.32	178.44	241.25	182.11	245.84
1. smallSprk1_cntl	117.60	126.13	176.99	166.81	186.29	176.15	190.11	179.49
2. Tier1_cntl	114.45	123.05	176.06	163.25	185.79	172.61	189.72	175.95
3. Tier2_3_cntl	105.62	120.65	172.49	162.59	182.98	172.11	187.16	175.50
4. smallSprk2_cntl	101.65	76.57	167.19	104.77	177.36	111.19	181.44	113.50
5. largeSprk_cntl	78.57	68.77	116.79	87.02	120.18	91.25	121.84	92.81
6. Tier4_cntl	65.29	65.20	42.43	71.70	39.94	74.91	39.47	76.10
7. recMarine_cntl	65.29	65.20	42.42	71.70	39.93	74.90	39.46	76.10
8. smallSI_cntl	64.41	60.71	37.36	46.03	34.54	47.59	33.96	48.23
9. RFG	64.43	60.09	37.37	45.17	34.55	46.69	33.97	47.31
10. TxLED	62.08	60.09	36.14	45.17	33.52	46.69	32.99	47.31
Fully Controlled	62.08	60.09	36.14	45.17	33.52	46.69	32.99	47.31

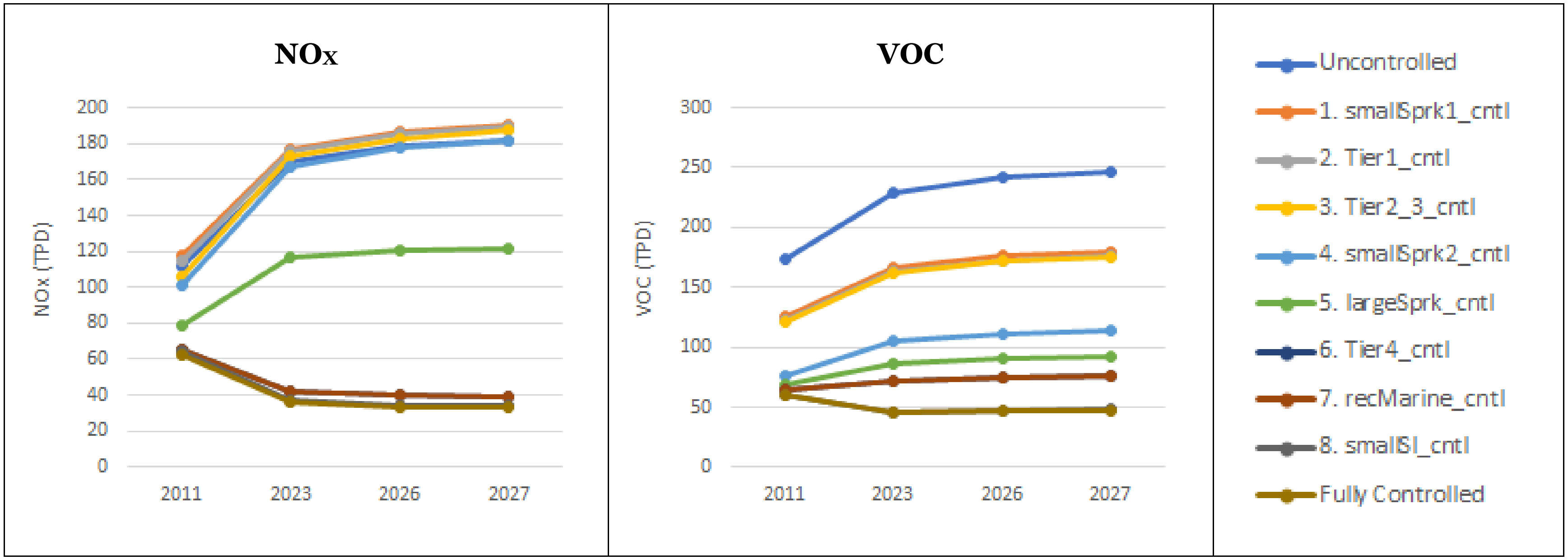

Figure 2. NO_X and VOC Emissions for the DFW Ten-County Area (Tons/Day)

4.0 Quality Assurance

The TexN2 "Automated RFP" function prevents much of the potential for human error by automating the creation of MOVES county databases with alternative nonroad equipment engine technologies by model year, while keeping all other modeling inputs constant.

TexN2 Automated RFP runs were performed in a cloud computing environment using Amazon Web Services (AWS). The use of AWS allowed runs to progress much faster by running 18 instances in parallel (corresponding to the 18 counties). ERG performed a subset of the Task 5 runs on both a local PC and on AWS to compare output emissions reports, ensuring that TexN2.2 with MOVES3 generated identical results between computing environments.

ERG retrieved the TexN2 utility logfiles from the cloud and used a script to scan them for error messages associated with the runs. Finally, ERG generated a large PDF containing plots to examine unit-level emissions factors, emissions, and population by county and emissions scenario. ERG reviewed the plots for outliers and did not find any.

To ensure consistency of Task 5 results with other tasks of the project, ERG also compared the fully controlled scenario (allRules_cntl) to the EIs for EPA's Air Emissions Reporting Requirements and separate RFP EIs associated with a potential SIP revision associated with the 2015 eight-hour ozone NAAQS. The emissions trends of pooled results across this project are consistent, steadily declining with advancing calendar years and the small differences in overlapping or neighboring years make sense considering the minor differences in EI inputs, such as the meteorological data year.

Further information on the comparisons between EIs and quality assurance of the TexN2.2 utility in general can be found in Section 5.0 of the final project report, "Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories."

Appendix C: RFP EIs for the 2015 Ozone NAAQS

Report begins on the following page.

Development of the Nonroad Model RFP Emissions Inventories for the HGB Six-County, DFW Nine-County, and Bexar County Ozone Nonattainment Areas

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July 28, 2021

ERG No.: 0344.00.003

Development of the Nonroad Model RFP Emissions Inventories for the HGB Six-County, DFW Nine-County, and Bexar County Ozone Nonattainment Areas

TCEQ Contract No. 582-19-92744
Work Order No. 582-21-22147-003

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July 28, 2021

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1.0 Overview

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2.0 Background

The Texas Commission on Environmental Quality (TCEQ) contracted with Eastern Research Group, Inc. (ERG) to develop Texas NONROAD (TexN) version 1 and subsequent version 2 (TexN2), which are utilities for estimating Texas-specific emissions from nonroad mobile sources, excluding commercial marine vessels, locomotives, drilling rigs, and aircraft. The TexN model used the United States Environmental Protection Agency's (EPA) standalone NONROAD model to calculate emissions, whereas TexN2 uses EPA's MOVES-Nonroad model. MOVES is required by the EPA for state development of nonroad emissions estimates for SIP revisions, national emissions inventories, and reasonable further progress (RFP) analyses. Since TexN was first developed, the TCEQ has frequently updated the Texas-specific data and enhanced the utility's functions. The EPA recently updated the MOVES model, releasing MOVES3[1] in November of 2020, and TCEQ contracted with ERG to update TexN2 for full compatibility with MOVES3[2]. States are required to use the most recent version of MOVES when developing and submitting emissions estimates from specific nonroad mobile sources to the EPA.

The purpose of Task 6 of this project is to provide RFP emissions inventories (EI) to support the TCEQ with a potential moderate reclassification SIP revision for the 2015 ozone NAAQS. The EIs include ozone season day (OSD) weekday estimates of volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) for the base year 2017 and future years 2020, 2023, and 2024. The RFP EIs were generated using MOVES3 code version 3.0.1 with database version 'movesdb20210209' and TexN2 code version 2.2.0 with the TexN2 database last updated May 24, 2021.

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[1] US EPA, 2020. "MOVES3: Latest Version of Motor Vehicle Emission Simulator." https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves. Accessed 17 February 2020.

[2] ERG, 2021. "TexN2.2 Utility Updates for Compatibility with the US EPA MOVES3 Model." Prepared for the Texas Commission on Environmental Quality, Air Quality Division, Austin, TX 78711-3087. April 23.

3.0 Emissions Inventory Development and Results

The geographic scope of the EIs includes the six-county Houston-Galveston-Brazoria (HGB) area (defined as Brazoria, Chambers, Fort Bend, Galveston, Harris, and Montgomery Counties), the nine-county Dallas-Fort Worth (DFW) area (defined as Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise Counties) and Bexar County.

The temporal scope of the EIs is OSD weekday for the years 2017, 2020, 2023, and 2024. The period type "OSD weekday" represents weekday emissions averaged over the summer months June, July, and August. TexN2 allocates annual activity to these months with monthly and day type allocation factors contained in tables within the TexN2 utility database.

The meteorology data in the EIs was specific to the base year 2017, applied to all RFP analysis years 2017, 2020, 2023, and 2024. The fuel types in each analysis year are specific to 2011 for the base year and 2020 for the three later years. At the time of writing (June 2021), year 2020 is the latest available fuel survey data contained in the TexN2 database.

The RFP EIs include VOC and NO_X emissions from ten separate runs that the TexN2 utility automatically initiates in sequence corresponding to the scenarios listed below. The first scenario represents a case without any emission controls. The second through tenth RFP scenarios add successive federal and state emissions controls. TexN2 sets up the MOVES runs for each scenario using alternate versions of the MOVES input table that describes technology fractions by equipment model year. TexN2 disables the inclusion of reformulated gasoline (RFG) in the HGB and DFW areas, until the final RFP scenario, *allRules_cntl*, representing the fully controlled scenario. RFG fuels, where they are in use, are implemented as the final control strategy in all six HGB counties and four of the nine DFW counties (Collin, Dallas, Denton, and Tarrant). Five of the DFW counties and Bexar County do not have RFG fuel, so these areas do not receive any emissions benefits from RFG. Similarly, the benefits of Texas Low Emission Diesel (TxLED) fuel are delayed until the final RFP scenario, where they are included as a post-processing adjustment to NO_X from diesel-fueled equipment. All 16 counties are part of the 110-county TxLED fuel control area.

RFP Scenario Name	Description
smallSprk1_uncntl	No controls
smallSprk1_cntl	Controls through Small nonroad spark ignition (SI) engines (Phase 1)
Tier1_cntl	Controls through Tier 1 nonroad diesel engines
Tier2_3_cntl	Controls through Tiers 2 and 3 nonroad diesel engines
smallSprk2_cntl	Controls through Small nonroad SI engines (Phase II)
largeSprk_cntl	Controls through Large nonroad SI engines
Tier4_cntl	Controls through Tier 4 nonroad diesel engines
recMarine_cntl	Controls through Diesel recreational marine engines
smallSI_cntl	Controls through SI marine engines
allRules_cntl	Controls through SI marine engines, includes RFG and TxLED fuel controls

Tables 1, 2, and 3 show results for each RFP scenario for the HGB area, DFW area, and Bexar County, respectively. They include separate line items showing RFG and TxLED benefits as control scenarios number 9 and 10. The final scenario (Fully Controlled) corresponds to the "allRules_cntl" RFP scenario. The Fully Controlled case contains the same values as the prior TxLED line item because TexN2 does not model any further emission controls after RFG and TxLED. It remains in the tables for clarity to indicate the cumulative effect of all controls.

Table 1. NO_X and VOC Emissions for the HGB Six-County Area (Tons/Day)

Emissions Control Scenario	2017 NO_X	2017 VOC	2020 NO_X	2020 VOC	2023 NO_X	2023 VOC	2024 NO_X	2024 VOC
Uncontrolled	124.08	170.42	147.59	184.44	154.40	194.82	156.68	198.39
1. smallSprk1_cntl	130.13	124.37	153.93	135.08	161.13	142.49	163.56	145.02
2. Tier1_cntl	129.34	119.65	153.22	130.06	160.79	137.35	163.29	139.85
3. Tier2_3_cntl	124.67	118.66	149.29	129.25	158.12	136.79	160.78	139.33
4. smallSprk2_cntl	120.34	75.12	144.74	82.72	153.29	87.68	155.86	89.33
5. largeSprk_cntl	81.90	62.48	100.45	67.95	102.36	70.79	102.71	71.74
6. Tier4_cntl	40.93	52.90	40.81	54.73	36.48	56.50	35.97	57.30
7. recMarine_cntl	40.91	52.90	40.79	54.73	36.45	56.50	35.95	57.30
8. smallSI_cntl	36.90	36.63	36.34	36.40	31.62	36.70	31.00	37.05
9. RFG	36.89	36.16	36.34	36.28	31.62	36.57	31.00	36.92
10. TxLED	35.66	36.16	35.11	36.28	30.66	36.57	30.08	36.92
Fully Controlled	35.66	36.16	35.11	36.28	30.66	36.57	30.08	36.92

The NO_X and VOC emissions generally decline from Uncontrolled to Fully Controlled except for small nonroad SI engines Phase 1 (smallSprk1_cntl), which increases NO_X by approximately 6 tons per day in 2017. The minor NO_X increase was allowed under the small SI rule, where some equipment have their standards defined in terms of combined hydrocarbons plus NO_X.

The pre-Tier 4 scenarios all show increased NO_X emissions over 2017 to 2024 within each scenario, whereas the Tier 4 and later controls scenarios show NO_X declines over the same period despite a gradual growth in equipment population. These trends are more apparent in Figures 1 through 3. Figure 1 shows that for NO_X in the HGB area, the two RFP scenarios *largeSprk_cntl* and *Tier4_cntl* are responsible for most of the reductions in all years. The VOC emissions reductions appear more evenly impacted by the successive controls.

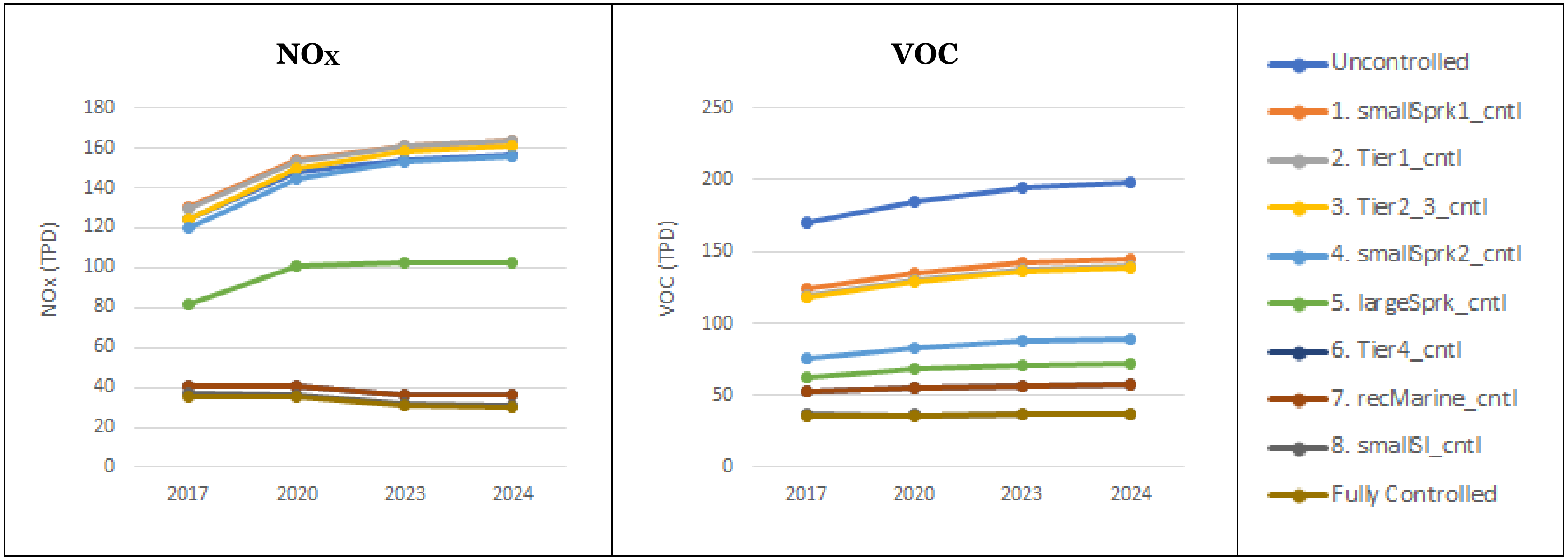

Figure 1. NOx and VOC Emissions for the HGB Six-County Area (Tons/Day)

Table 2 and Figure 2 for the nine-county DFW area show similar trends to the HGB area. NO_X emissions slightly increase with *smallSprk1_cntl*, then decline or stay the same for all other successive controls. Figure 2 trends look similar to Figure 1.

Table 2. NO_X and VOC Emissions for the DFW Nine-County Area (Tons/Day)

Emissions Control Scenario	2017 NO_X	2017 VOC	2020 NO_X	2020 VOC	2023 NO_X	2023 VOC	2024 NO_X	2024 VOC
Uncontrolled	131.61	188.84	152.31	204.28	161.11	216.42	163.99	220.57
1. smallSprk1_cntl	138.57	135.83	159.60	147.47	168.85	156.16	171.89	159.12
2. Tier1_cntl	137.29	132.75	158.35	144.19	168.00	152.86	171.13	155.82
3. Tier2_3_cntl	132.28	131.67	154.04	143.31	164.75	152.21	168.03	155.21
4. smallSprk2_cntl	127.31	81.45	148.81	89.65	159.21	95.56	162.37	97.51
5. largeSprk_cntl	88.99	68.51	104.76	74.59	108.62	78.41	109.59	79.67
6. Tier4_cntl	45.04	58.27	44.59	61.11	40.67	63.39	40.33	64.37
7. recMarine_cntl	45.04	58.27	44.59	61.11	40.66	63.39	40.32	64.37
8. smallSI_cntl	40.57	40.26	39.68	40.80	35.38	41.52	34.92	42.02
9. RFG	40.57	39.89	39.69	40.44	35.39	41.14	34.92	41.63
10. TxLED	39.17	39.89	38.31	40.44	34.26	41.14	33.84	41.63
Fully Controlled	39.17	39.89	38.31	40.44	34.26	41.14	33.84	41.63

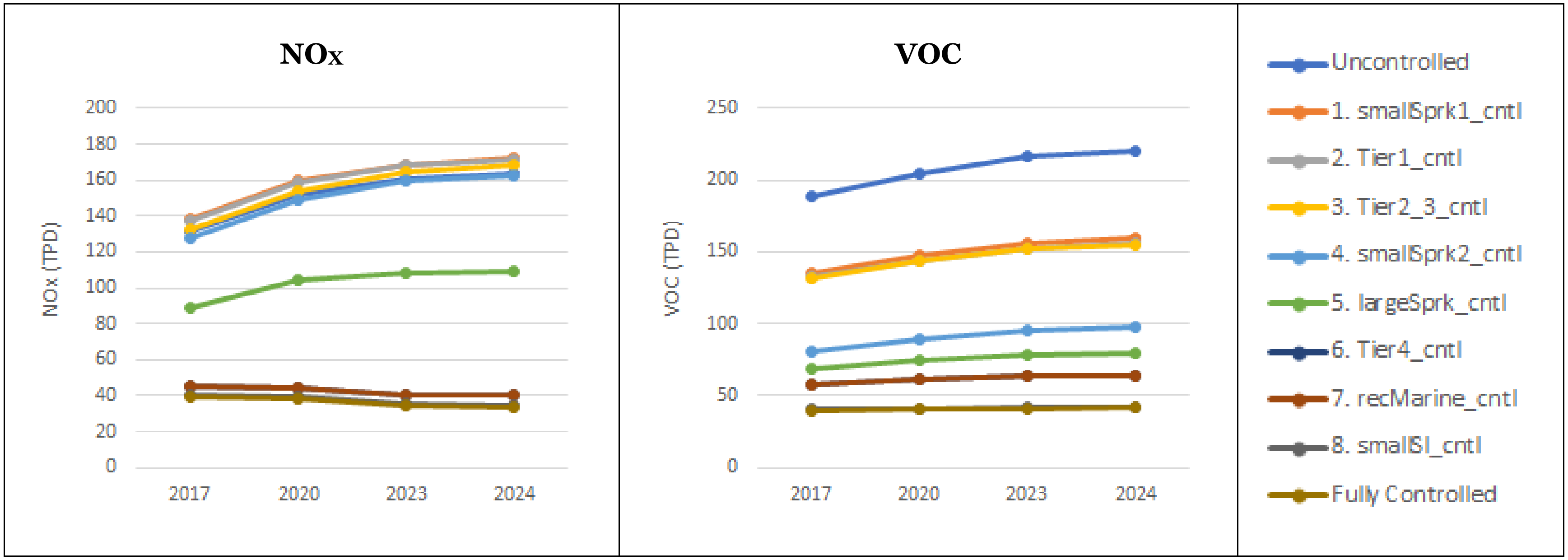

Figure 2. NO_X and VOC Emissions for the DFW Nine-County Area (Tons/Day)

It was somewhat unexpected that Bexar County (Table 3) would have higher VOC emissions than NO_X. In the prior 2017 AERR, the OSD NO_X and VOC were 7.30 and 6.58 TPD[3], respectively. The VOC increase to 11.22 TPD in Table 3 (Fully Controlled) represents a 70 percent increase from the prior estimate, caused by larger gasoline equipment populations in TexN2.2, mostly in the Lawn and Garden category.

Table 3. NO_X and VOC Emissions for Bexar County (Tons/Day)

Emissions Control Scenario	2017 NO_X	2017 VOC	2020 NO_X	2020 VOC	2023 NO_X	2023 VOC	2024 NO_X	2024 VOC
Uncontrolled	23.13	50.79	28.13	54.78	28.49	57.67	28.66	58.67
1. smallSprk1_cntl	25.00	35.80	30.10	38.78	30.57	40.77	30.77	41.46
2. Tier1_cntl	24.73	35.61	29.81	38.59	30.37	40.59	30.59	41.28
3. Tier2_3_cntl	23.77	35.40	28.94	38.41	29.74	40.46	30.00	41.16
4. smallSprk2_cntl	22.41	20.29	27.53	22.33	28.24	23.52	28.48	23.92
5. largeSprk_cntl	17.96	18.24	22.53	19.98	22.63	20.91	22.65	21.22
6. Tier4_cntl	9.21	16.02	9.56	16.92	8.72	17.63	8.65	17.92
7. recMarine_cntl	9.21	16.02	9.56	16.92	8.72	17.63	8.65	17.92
8. smallSI_cntl	7.98	11.22	8.23	11.56	7.30	11.90	7.20	12.07
9. RFG	7.98	11.22	8.23	11.56	7.30	11.90	7.20	12.07
10. TxLED	7.70	11.22	7.94	11.56	7.07	11.90	6.98	12.07
Fully Controlled	7.70	11.22	7.94	11.56	7.07	11.90	6.98	12.07

[3] 2017 AERR. Available online (as of 6/30/2021) https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821881185013-20181026-erg-texas_statewide_emissions_inventory_nonroad_model_mobile_sources.pdf

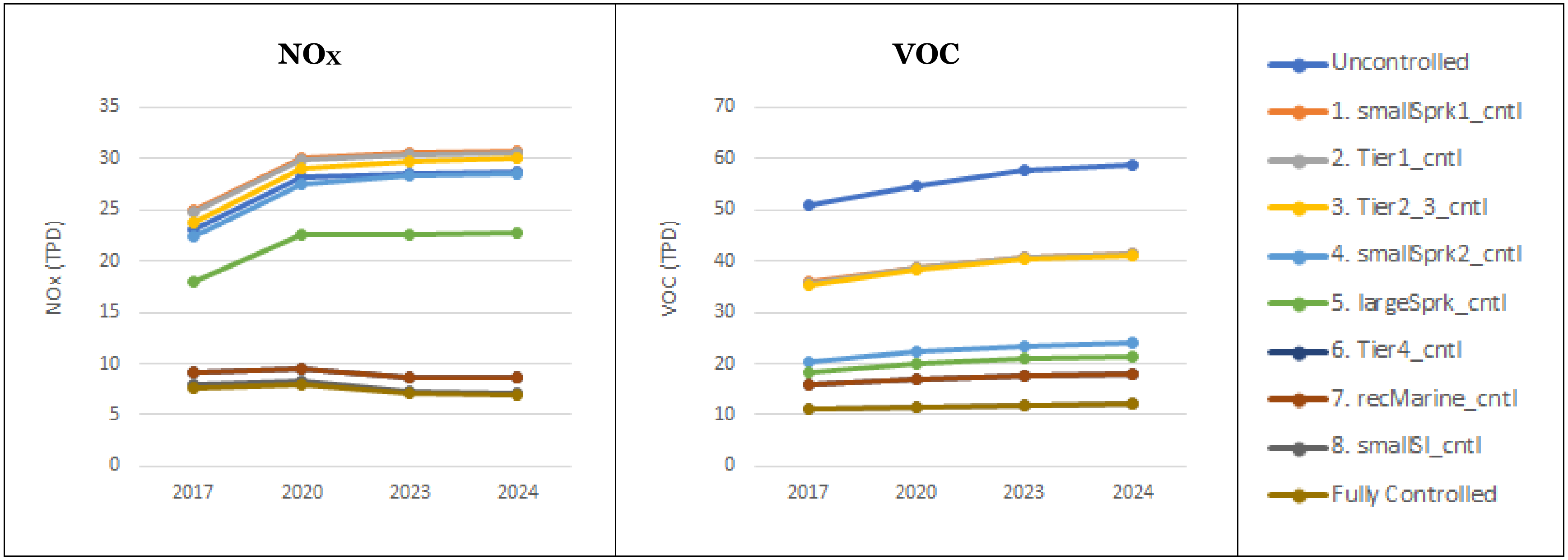

Figure 3. NOx and VOC Emissions for Bexar County (Tons/Day)

4.0 Quality Assurance

The TexN2 "Automated RFP" function prevents much of the potential for human error by automating the creation of MOVES county databases with alternative nonroad equipment engine technologies by model year, while keeping all other modeling inputs constant.

TexN2 Automated RFP runs were performed in a cloud computing environment using Amazon Web Services (AWS). The use of AWS allowed runs to progress much faster by running 16 instances in parallel (corresponding to the 16 counties). ERG performed a subset of the Task 6 runs on both a local PC and on AWS to compare output emissions reports, ensuring that TexN2.2 with MOVES3 generated identical results between computing environments.

ERG retrieved the TexN2 utility logfiles from the cloud and used a script to scan them for error messages associated with the runs. Finally, ERG generated a large PDF containing plots to examine unit-level emissions factors, emissions, and population by county and emissions scenario. ERG reviewed the plots for outliers and did not find any.

To ensure consistency of Task 6 results with other tasks of the project, ERG also compared the fully controlled scenario (allRules_cntl) to the EIs for EPA's Air Emissions Reporting Requirements and separate RFP EIs associated with a potential SIP revision associated with the 2008 eight-hour ozone NAAQS. The emissions trends of pooled results across this project are consistent, steadily declining with advancing calendar years and the small differences in overlapping or neighboring years make sense considering the minor differences in EI inputs, such as the meteorological data year.

Further information on the comparisons between EIs and quality assurance of the TexN2.2 utility in general can be found in Section 5.0 of the final project report, "Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories."

Appendix D: RDM EIs for the City of El Paso 1987 PM_{10} NAAQS

Report begins on the following page.

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Development of the Nonroad Model Mobile Source EI for the City of El Paso PM_{10} Nonattainment Area

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July 28, 2021

ERG No.: 0344.00.003

Development of the Nonroad Model Mobile Source EI for the City of El Paso PM_{10} Nonattainment Area

TCEQ Contract No. 582-19-92744
Work Order No. 582-21-22147-003

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July 28, 2021

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1.0 Overview

This Report is Deliverable 7.2 for the project "Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories" (Contract Number 582-19-92744, Work Order 582-21-22147-003). The sections below describe the work performed under Task 7, which will support a potential City of El Paso redesignation and maintenance (RDM) state implementation plan (SIP) revision for the 1987 24-hour particulate matter (PM) emissions with an aerodynamic diameter equal to or less than 10 microns (PM_{10}) national ambient air quality standard (NAAQS). The document is organized into four sections, including Background, Scalar Adjustment Factors, Emissions Inventory, and Quality Assurance (QA).

2.0 Background

The Texas Commission on Environmental Quality (TCEQ) contracted with Eastern Research Group, Inc. (ERG) to develop Texas NONROAD (TexN) version 1 and subsequent version 2 (TexN2), which are utilities for estimating Texas-specific emissions from nonroad mobile sources, excluding commercial marine vessels, locomotives, drilling rigs, and aircraft. The TexN model used the United States Environmental Protection Agency's (EPA) standalone NONROAD model to calculate emissions, whereas TexN2 uses EPA's MOVES-Nonroad model. MOVES is required by the EPA for SIP revisions, national emissions inventories, and reasonable further progress analyses. Since TexN was first developed, the TCEQ has frequently updated the Texas-specific data and enhanced the utility's functions. The EPA recently updated the MOVES model, releasing MOVES3[1] in November of 2020, and TCEQ contracted with ERG to update TexN2 for full compatibility with MOVES3[2]. States are required to use the most recent version of the MOVES model when developing and submitting emissions estimates from specific nonroad mobile sources to the EPA.

The purpose of Task 7 of this project is to support the TCEQ with a potential redesignation request and associated SIP revision to demonstrate maintenance of the EPA's 1987 24-hour PM_{10} NAAQS for the City of El Paso PM_{10} nonattainment area. The inventory includes annual and daily estimates of PM_{10}. The RDM EIs include the base year 2017 and future years 2023, 2029, and 2035. The RDM EIs were generated using

[1] US EPA, 2020. "MOVES3: Latest Version of Motor Vehicle Emission Simulator." https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves. Accessed 17 February 2020.

[2] ERG, 2021. "TexN2.2 Utility Updates for Compatibility with the US EPA MOVES3 Model." Prepared for the Texas Commission on Environmental Quality, Air Quality Division, Austin, TX 78711-3087. April 23.

MOVES3 code version 3.0.1 with database version 'movesdb20210209' and TexN2 code version 2.2.0 with the TexN2 database last updated May 24, 2021.

The City of El Paso PM_{10} nonattainment area is a subset of El Paso County shown in Figure 1 below. ERG developed scalar adjustment factors to estimate the nonattainment area PM_{10} emissions as a fraction of the county total PM_{10} emissions in El Paso County.

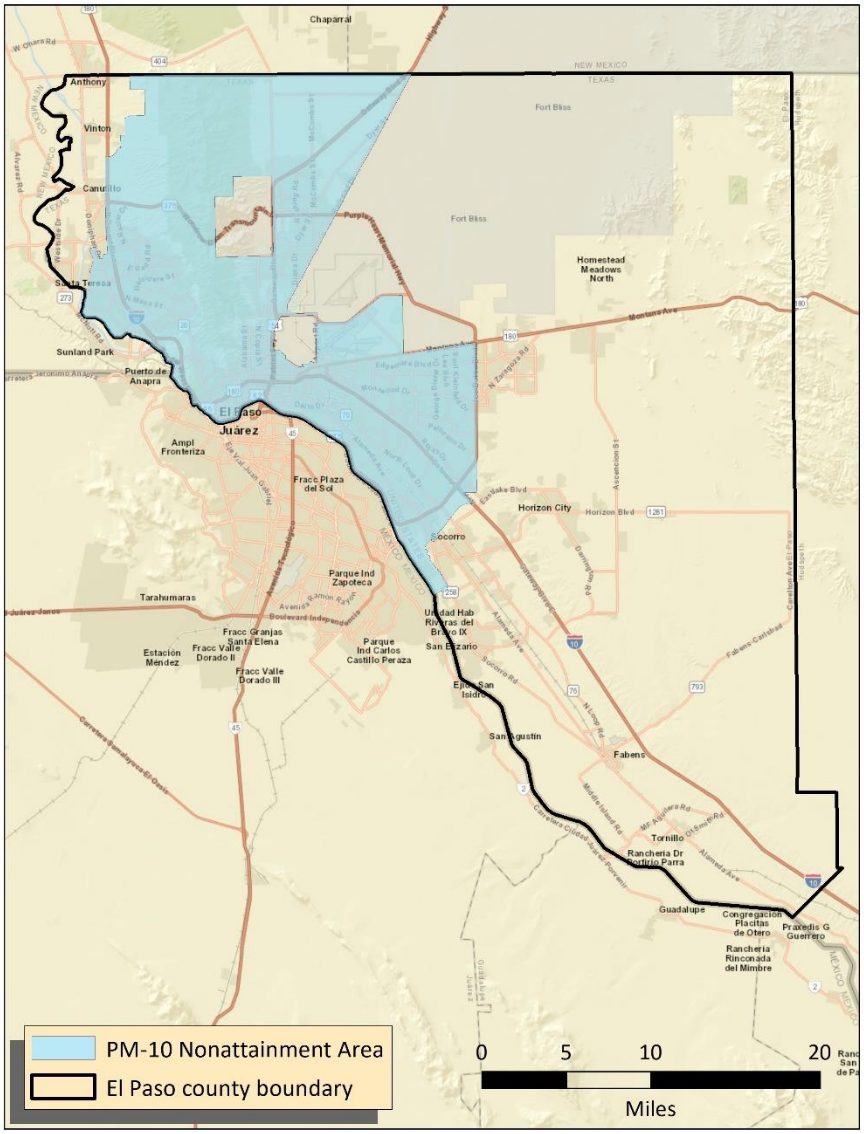

Figure 1. El Paso County and the PM_{10} Nonattainment Area

3.0 Scalar Adjustment Factors

ERG assigned geographic allocation surrogates to each of the 25 diesel construction equipment (DCE) subsectors in Table 1. ERG then calculated a 2017 scalar adjustment factor for each allocation surrogate (Table 2). A brief explanation of how each scalar adjustment factor in Table 2 was developed is provided below. Insufficient information was available to differentiate separate scalar adjustment factors for the future years of 2023, 2029, and 2035.

Table 1. Assignment of Allocation Surrogates to DCE Subsectors

#	DCE Subsector	Allocation Surrogate
0	Non-DCE	Population
1	Agricultural Activities	Farm/Range land acreage
2	Boring & Drilling Equipment	Population
3	Brick & Stone Operations	Population
4	City and County Road Construction	Roadway Miles (City + County)
5	Commercial Construction	Population
6	Concrete Operations	Population
7	County-Owned Construction Equipment	Population (unincorporated areas)
8	Cranes	Population
9	Heavy-Highway Construction	Roadway Miles (On-System + Off-System)
10	Landfill Operations	State landfill permit records
11	Landscaping Activities	Population
12	Manufacturing Operations	Population
13	Municipal-Owned Construction Equipment	Population (incorporated areas)
14	Transportation/Sales/Services	Population
15	Residential Construction	Population
16	Rough Terrain Forklifts	Population
17	Scrap Recycling Operations	State recycling facility permit records
18	Skid Steer Loaders	Population
19	Special Trades Construction	Population
20	Trenchers	Population
21	TxDOT Construction Equipment	Roadway Miles (On-System)
22	Utility Construction	Population
23	Mining & Quarry Operations	State APO* registration records
25	Off-Road Tractors, Misc. Equipment, and all Equipment < 25 hp	Population

*APO stands for Aggregate Production Operations (e.g., quarries)

Table 2. 2017 Scalar Adjustment Factors by Allocation Surrogate

Allocation Surrogate	2017 Scalar Adjustment Factors
Farm/Range land acreage	0.061
Population	0.705
Population (incorporated areas)	0.808
Population (unincorporated areas)	0.001
Roadway Miles (City + County)	0.615
Roadway Miles (On-System + Off-System)	0.614
Roadway Miles (On-System)	0.644
State APO* registration records	0.261
State landfill permit records	0.636
State recycling facility permit records	0.545

3.1 Population Data

ERG obtained population data from the U.S. Census Bureau's 2015-2019 American Community Survey (ACS) 5-Year Estimates file.[3] While there are several sources of population data, the most recent 5-year ACS was selected as the authoritative data source with the most geographically refined and statistically reliable values for the year 2017.[4] ERG extracted the total population value for each census tract within El Paso County (Figure 2).

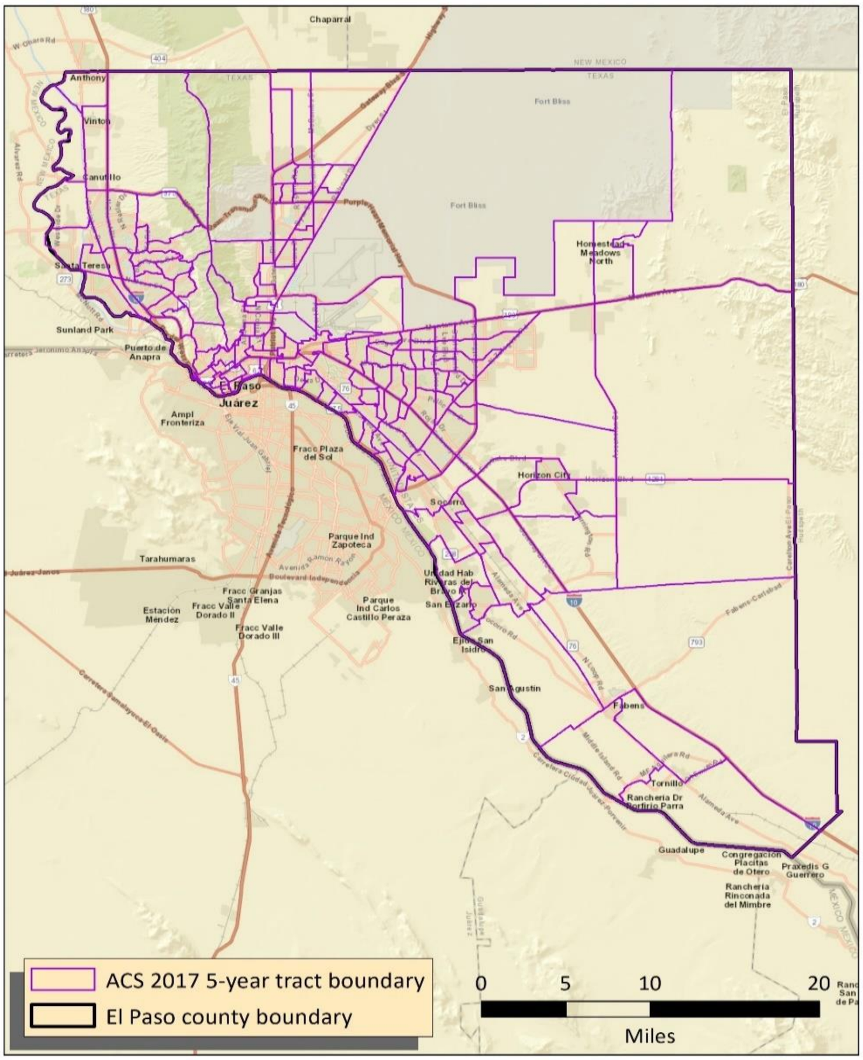

Figure 2. El Paso County Census Tracts

[3] U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates, Table S0101, S0101_C01_001E – Estimated Total Population.

[4] https://www.census.gov/content/dam/Census/library/publications/2018/acs/acs_general_handbook_2018_ch03.pdf. Accessed 28 April 2021.

The census tract boundaries and associated population values were intersected with two geospatial boundary files, the first representing the PM_{10} nonattainment area[5] (NAA) of the City of El Paso and the second representing the USA Census Populated Places Areas[6]. The U.S. Census Populated Places Areas represents populated areas of the United States that include both incorporated places and census designated places identified by the U.S. Census Bureau.

In cases where a census tract crossed the PM_{10} NAA boundary, the population of that tract was divided based on the percentage of tract area on each side of the PM_{10} NAA. The same approach was used for census tracts that are both inside and outside an incorporated place. This approach allowed for more accurate 2017 population counts in the areas of interest (Table 3) without double-counting values.

Table 3. El Paso County Areas of Interest

Name	Description	2017 Population
Outside NAA	Incorporated	139,861
Outside NAA	Unincorporated	107,118
Inside NAA	Incorporated	588,956
Inside NAA	Unincorporated	127
Total	Incorporated	728,817
Total	Unincorporated	107,245
Total	PM NAA	589,083
Total	El Paso County	836,062

The portion of the population that fell within the PM_{10} NAA as a fraction of the total county population was used as the surrogate for 16 DCE subsectors (listed previously in Table 1). ERG used the same approach for unincorporated and incorporated populations for the County-Owned Construction Equipment (DCE subsector 7) and Municipal-Owned Construction Equipment (DCE subsector 13), respectively.

3.2 Roadway Miles

ERG extracted roadway miles from the Texas Department of Transportation (TxDOT) Roadways polyline dataset[7] by area of interest and further refined it for application in three DCE subsectors. For City and County Road Construction (DCE subsector 4), only

[5] U.S. EPA's Green Book, https://www3.epa.gov/airquality/greenbook/shapefile/pm10_1987std_naa_shapefile.zip. Accessed 28 April 2021.
[6] USA Census Populated Places Areas, https://www.arcgis.com/home/item.html?id=4e75a4f7daaa4dfa8b9399ea74641895. Accessed 28 April 2021.
[7] Texas Department of Transportation (TxDOT), Transportation Planning and Programming Division. Geospatial Roadway Inventory Database, https://gis-txdot.opendata.arcgis.com/datasets/d4f7206d27af4358acb70cb1cc819d10_0. Accessed 28 April 2021.

the roadway miles from country roads and city streets were assessed. For Heavy-Highway Construction (DCE Subsector 9), both TxDOT On-System and Off-System road types were included, while for TxDOT Construction Equipment (DCE Subsector 21), only TxDOT On-System road types were included as indicated below (Table 4).

Table 4. TxDOT Road Types in El Paso County and Assignment to DCE Subsector

Road Type	DCE Subsector 4	DCE Subsector 9	DCE Subsector 21
Business US Highways		✓	✓
Country Road	✓	✓	
City Streets	✓	✓	
Federal Road		✓	
Farm to Market Road		✓	✓
Interstate Highway		✓	✓
Principal Arterial State System		✓	✓
Park Road		✓	✓
Ranch to Market Road		✓	✓
State Highway		✓	✓
State Highway Loop		✓	✓
State Highway Spur		✓	✓
Toll Road		✓	
United States Highway		✓	✓

3.3 Farm and Range Land Acreage

Acreage of farm and range lands were identified as a reasonable allocation surrogate for agricultural activities (DCE subsector 1). The National Land Cover Database (NLCD) 2016 Land Cover (CONUS)[8] is the most consistent, reliable, and spatially explicit land cover dataset currently available for El Paso county. The area of coverage includes two NLCD classes, Pasture/Hay and Cultivated Crops. According to the NLCD classification[9], these two NLCD classes are defined as follows:

- **Pasture/Hay** – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crop, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.

[8] Dewitz, J., 2019, National Land Cover Database (NLCD) 2016 Products: U.S. Geological Survey data release, https://doi.org/10.5066/P96HHBIE. Available at https://www.mrlc.gov/data/nlcd-2016-land-cover-conus. Accessed 28 April 2021.
[9] National Land Cover Database 2016 (NLCD2016) Legend, https://www.mrlc.gov/data/legends/national-land-cover-database-2016-nlcd2016-legend. Accessed 28 April 2021.

- **Cultivated Crops** – Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

Figure 3 shows that the NLCD dataset lays mostly outside the El Paso PM_{10} NAA.

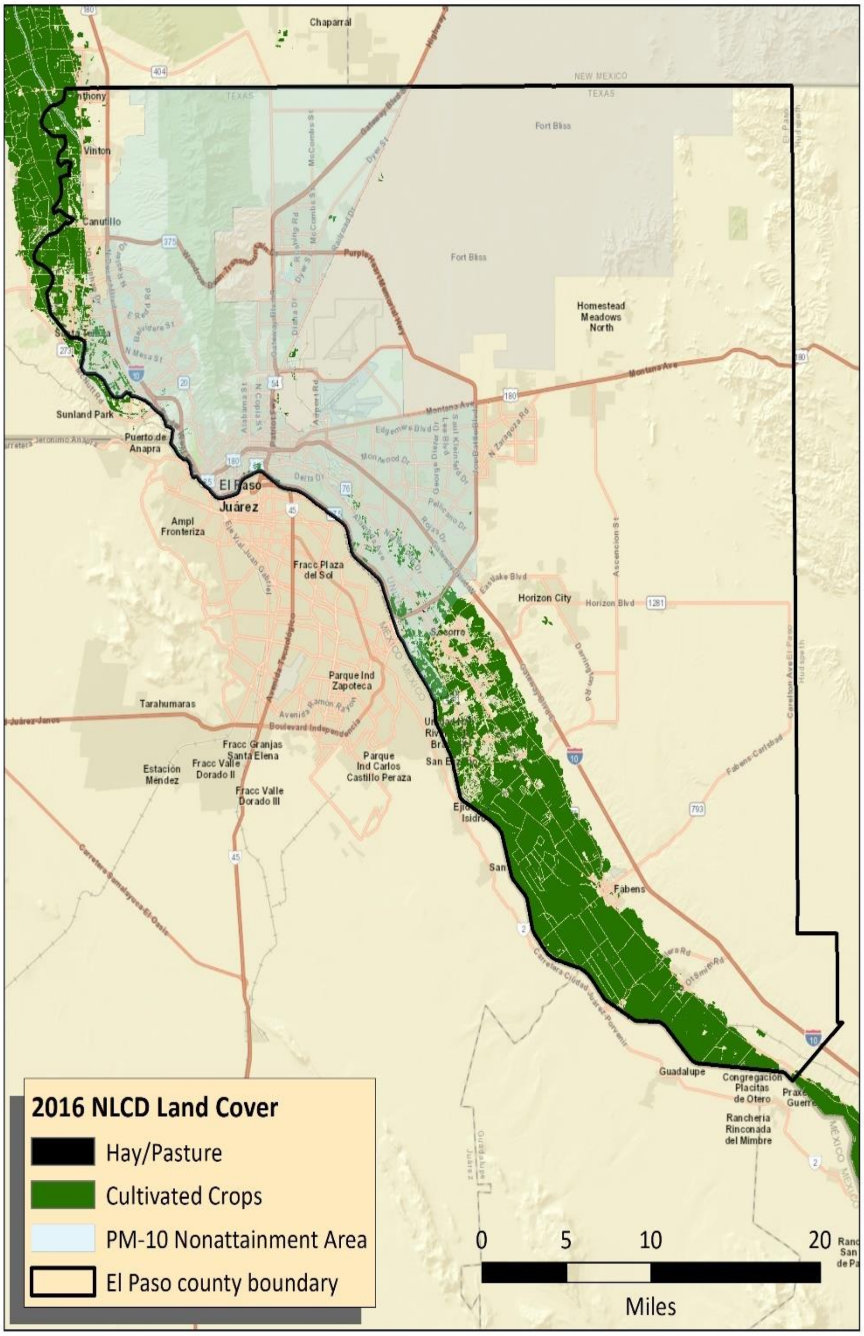

Figure 3. El Paso County and Hay/Pasture and Cultivated Crops Land Cover

3.4 State Landfill Permit Records

State landfill permit records were obtained from the TCEQ Municipal Solid Waste Permits Section's "Data on Municipal Solid Waste Facilities in Texas"[10]. A total of 11 active landfill-related facilities were identified in El Paso County, including:

- 2 landfills (as designated by Facility Type Code "1")
- 1 solid waste transfer station (as designated by Facility Type Code "5TS")
- 8 citizen collections stations (as designated by Facility Type Code "5CC")

Based upon a Geographic Information System (GIS) comparison of the landfill-related facility locations with the boundaries of the PM_{10} NAA, a total of 7 of the 11 landfill-related facility locations were determined to be inside the NAA boundary. Lacking detailed information regarding specific nonroad equipment or other surrogate activity levels at these 11 landfills, it was assumed that activity was equal at all facilities. Therefore, the scalar adjustment factor was estimated to be 0.6364 (i.e., 7 NAA facilities/11 El Paso County facilities) and was applied to Landfill Operations (DCE subsector 10).

3.5 State Recycling Facility Permit Records

State recycling facility permit records were obtained from the TCEQ Municipal Solid Waste Permits Section's "Data on Municipal Solid Waste Facilities in Texas". [11]

A total of 11 active recycling-related facilities were identified in El Paso County, including:

- 9 recycling facilities (as designated by Facility Type Code "5RR")
- 2 composting facilities (as designated by Facility Type Code "5RCX")

Based on a GIS comparison of the recycling facility locations with the boundaries of the PM_{10} NAA, a total of 6 of the 11 recycling facility locations were determined to be inside the NAA boundary. Lacking detailed information regarding specific nonroad equipment or other surrogate activity levels at these 11 recycling facilities, it was assumed that activity was equal at all facilities. Therefore, the scalar adjustment factor was estimated to be 0.5455 (i.e., 6 NAA facilities/11 El Paso County facilities) and was applied to Scrap Recycling Operations (DEC subsector 17).

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[10] Texas Commission on Environmental Quality (TCEQ) Municipal Solid Waste Permits Section. "Data on Municipal Solid Waste Facilities in Texas". Landfill data. Internet address: https://www.tceq.texas.gov/permitting/waste_permits/msw_permits/msw-data. Accessed 5 April 2021.

[11] Texas Commission on Environmental Quality (TCEQ) Municipal Solid Waste Permits Section. "Data on Municipal Solid Waste Facilities in Texas". Recycling facility data. Internet address: https://www.tceq.texas.gov/permitting/waste_permits/msw_permits/msw-data. Accessed 5 April 2021.

3.6 State Mine and Quarry Permit Records

State aggregate production operations (APO) registration data were obtained from the TCEQ's "APO Registration Search".[12] APO facilities include quarries, sand pits, gravel pits, and other aggregate production operations. A total of 23 active APO facilities were identified in El Paso County. Based upon a GIS comparison of the active APO facilities with the boundaries of the PM_{10} NAA, a total of 6 of the 23 APO facilities were determined to be inside the NAA boundary. Lacking detailed information regarding specific nonroad equipment or other surrogate activity levels at these 23 active APO facilities, it was assumed that activity was equal at all facilities. Therefore, the scalar adjustment factor was estimated to be 0.2609 (i.e., 6 NAA facilities/23 El Paso County facilities) and was applied to Mining and Quarry Operations (DEC subsector 23).

4.0 Emissions Inventory

ERG developed annual emissions (Table 5) and annual average daily PM_{10} emissions (Table 6) by performing one hundred (100) separate TexN2 runs (separate runs for each of the 25 DCE subsectors for each of the four calendar years). Table 5 shows that the "Non-DCE" subsector is the largest contributor to nonroad PM_{10} emissions, accounting for nearly 75% of the total.

[12] Texas Commission on Environmental Quality (TCEQ). "APO Registration Search. Internet address: https://www2.tceq.texas.gov/apo_dpa/. Data accessed April 22, 2021.

Table 5. Annual PM_{10} Emissions (TPY) by Calendar Year

		El Paso County Total				City of El Paso PM_{10} Nonattainment Area			
DCE Subsector Description	**DCE #**	**2017**	**2023**	**2029**	**2035**	**2017**	**2023**	**2029**	**2035**
Non-DCE	0	74.46	71.23	72.64	77.55	52.47	50.19	51.18	54.64
Agricultural Activities	1	0.43	0.15	0.03	0.01	0.03	0.01	0.00	0.00
Boring & Drilling Equipment	2	0.20	0.21	0.10	0.05	0.14	0.15	0.07	0.03
Brick & Stone Operations	3	0.15	0.07	0.02	0.01	0.11	0.05	0.02	0.01
City and County Road Construction	4	0.10	0.10	0.05	0.03	0.06	0.06	0.03	0.02
Commercial Construction	5	0.57	0.58	0.29	0.15	0.40	0.41	0.20	0.10
Concrete Operations	6	0.17	0.12	0.04	0.03	0.12	0.08	0.03	0.02
County-Owned Construction Equipment	7	0.22	0.19	0.10	0.05	0.00	0.00	0.00	0.00
Cranes	8	0.94	0.90	0.37	0.17	0.66	0.64	0.26	0.12
Heavy-Highway Construction	9	0.49	0.43	0.16	0.08	0.30	0.26	0.10	0.05
Landfill Operations	10	0.20	0.06	0.02	0.02	0.13	0.04	0.01	0.01
Landscaping Activities	11	1.23	0.70	0.21	0.11	0.87	0.49	0.15	0.08
Manufacturing Operations	12	0.20	0.09	0.03	0.02	0.14	0.06	0.02	0.01
Municipal-Owned Construction Equipment	13	1.19	0.53	0.26	0.17	0.96	0.43	0.21	0.14
Transportation/Sales/ Services	14	3.33	2.52	0.52	0.17	2.35	1.78	0.37	0.12
Residential Construction	15	0.68	0.36	0.15	0.07	0.48	0.25	0.10	0.05
Rough Terrain Forklifts	16	4.03	2.59	0.76	0.29	2.84	1.82	0.54	0.21
Scrap Recycling Operations	17	0.59	0.21	0.06	0.05	0.32	0.11	0.03	0.03
Skid Steer Loaders	18	3.89	0.58	0.27	0.27	2.74	0.41	0.19	0.19
Special Trades Construction	19	1.52	1.59	0.80	0.44	1.07	1.12	0.56	0.31
Trenchers	20	1.89	0.81	0.24	0.16	1.33	0.57	0.17	0.11
TxDOT Construction Equipment*	21	0.12	0.12	0.06	0.03	0.08	0.07	0.04	0.02
Utility Construction	22	0.27	0.38	0.20	0.10	0.19	0.27	0.14	0.07
Mining & Quarry Operations	23	2.06	0.58	0.13	0.05	0.54	0.15	0.03	0.01
Off-road tractors, Miscellaneous, and all Equipment < 25 hp	25	1.01	0.94	0.60	0.48	0.71	0.66	0.42	0.34
Total		**99.94**	**86.03**	**78.13**	**80.55**	**69.03**	**60.09**	**54.90**	**56.69**

ERG calculated daily PM_{10} emissions by dividing the annual totals by 365 days. Table 6 shows the Non-DCE subtotal and the Grand Total in tons per day out to two decimal places, while DCEs 1-25 are shown in scientific notation due to small values.

Table 6. Daily PM_{10} Emissions (TPD) by Calendar Year

		El Paso County Total				City of El Paso PM_{10} Nonattainment Area			
DCE Subsector Description	**DCE #**	**2017**	**2023**	**2029**	**2035**	**2017**	**2023**	**2029**	**2035**
Non-DCE	0	0.20	0.20	0.20	0.21	0.14	0.14	0.14	0.15
Agricultural Activities	1	1.2E-03	4.1E-04	8.1E-05	3.4E-05	7.2E-05	2.5E-05	5.0E-06	2.1E-06
Boring & Drilling Equipment	2	5.4E-04	5.7E-04	2.6E-04	1.3E-04	3.8E-04	4.0E-04	1.9E-04	9.2E-05
Brick & Stone Operations	3	4.1E-04	1.9E-04	6.2E-05	3.4E-05	2.9E-04	1.3E-04	4.4E-05	2.4E-05
City and County Road Construction	4	2.7E-04	2.8E-04	1.5E-04	7.8E-05	1.7E-04	1.7E-04	9.1E-05	4.8E-05
Commercial Construction	5	1.6E-03	1.6E-03	8.0E-04	4.0E-04	1.1E-03	1.1E-03	5.6E-04	2.8E-04
Concrete Operations	6	4.7E-04	3.2E-04	1.2E-04	7.2E-05	3.3E-04	2.3E-04	8.7E-05	5.0E-05
County-Owned Construction Equipment	7	5.9E-04	5.3E-04	2.7E-04	1.4E-04	7.0E-07	6.2E-07	3.2E-07	1.7E-07
Cranes	8	2.6E-03	2.5E-03	1.0E-03	4.7E-04	1.8E-03	1.7E-03	7.2E-04	3.3E-04
Heavy-Highway Construction	9	1.3E-03	1.2E-03	4.5E-04	2.1E-04	8.2E-04	7.2E-04	2.8E-04	1.3E-04
Landfill Operations	10	5.5E-04	1.5E-04	6.4E-05	4.7E-05	3.5E-04	9.7E-05	4.1E-05	3.0E-05
Landscaping Activities	11	3.4E-03	1.9E-03	5.7E-04	3.1E-04	2.4E-03	1.4E-03	4.0E-04	2.2E-04
Manufacturing Operations	12	5.4E-04	2.5E-04	8.5E-05	4.4E-05	3.8E-04	1.8E-04	6.0E-05	3.1E-05
Municipal-Owned Construction Equipment	13	3.2E-03	1.4E-03	7.0E-04	4.6E-04	2.6E-03	1.2E-03	5.7E-04	3.7E-04
Transportation/Sales/ Services	14	9.1E-03	6.9E-03	1.4E-03	4.6E-04	6.4E-03	4.9E-03	1.0E-03	3.2E-04
Residential Construction	15	1.9E-03	9.9E-04	4.1E-04	1.8E-04	1.3E-03	7.0E-04	2.9E-04	1.3E-04
Rough Terrain Forklifts	16	1.1E-02	7.1E-03	2.1E-03	8.0E-04	7.8E-03	5.0E-03	1.5E-03	5.6E-04
Scrap Recycling Operations	17	1.6E-03	5.7E-04	1.6E-04	1.3E-04	8.8E-04	3.1E-04	8.9E-05	7.0E-05
Skid Steer Loaders	18	1.1E-02	1.6E-03	7.4E-04	7.4E-04	7.5E-03	1.1E-03	5.2E-04	5.2E-04
Special Trades Construction	19	4.2E-03	4.3E-03	2.2E-03	1.2E-03	2.9E-03	3.1E-03	1.5E-03	8.6E-04
Trenchers	20	5.2E-03	2.2E-03	6.6E-04	4.3E-04	3.6E-03	1.6E-03	4.7E-04	3.1E-04
TxDOT Construction Equipment*	21	3.3E-04	3.2E-04	1.7E-04	9.3E-05	2.1E-04	2.0E-04	1.1E-04	6.0E-05
Utility Construction	22	7.5E-04	1.0E-03	5.5E-04	2.9E-04	5.3E-04	7.4E-04	3.9E-04	2.0E-04
Mining & Quarry Operations	23	5.7E-03	1.6E-03	3.6E-04	1.4E-04	1.5E-03	4.1E-04	9.3E-05	3.5E-05
Off-road tractors, Miscellaneous, and all Equipment < 25 hp	25	2.8E-03	2.6E-03	1.6E-03	1.3E-03	2.0E-03	1.8E-03	1.2E-03	9.2E-04
Total		**0.27**	**0.24**	**0.21**	**0.22**	**0.19**	**0.16**	**0.15**	**0.16**

5.0 Quality Assurance

The dominance of non-DCE equipment (DCE subsector 0) in the PM_{10} inventory was initially unexpected and therefore warranted a closer review. Table 7 shows the DCE subsector PM_{10} emissions, Fuel Consumption, and NO_X emissions by fuel type. ERG found that nearly half (36.45 TPY) of the Non-DCE PM_{10} emissions are attributed to 2-stroke gasoline equipment (Table 7), the vast majority of which are under 6 horsepower.

Table 7. Non-DCE PM_{10}, Fuel Consumption, and NO_X in El Paso County, Year 2017

Engine/Fuel Type	PM_{10} (TPY)	Fuel Consumption	NO_X (TPY)
2-Stroke Gasoline	36.45	1,564.00	9.75
4-Stroke Gasoline	10.31	22,611.06	139.18
LPG	3.14	10,147.27	68.66
CNG	0.40	1,269.71	10.42
Diesel	24.17	17,978.46	362.09
Total	**74.46**	**53,570.50**	**590.10**

These two-stroke gasoline equipment are responsible for a disproportionately high amount of the subsector PM_{10} (49%) emissions while contributing less than 3% and 2% of the Non-DCE fuel consumption and NO_X emissions, respectively.

To ensure consistency of Task 7 EI results with other tasks of the project, ERG also compared the El Paso County total emissions to the EIs for EPA's Air Emissions Reporting Requirements. The emissions trend of pooled results across this project are consistent, steadily declining with advancing calendar years. Further information on the comparisons between EIs and QA of the TexN2.2 utility in general can be found in Section 5.0 of the final project report, "Development of Texas Nonroad Model Mobile Source Air Emissions Reporting Requirements, Reasonable Further Progress, and Redesignation and Maintenance Emissions Inventories."