

**APPENDIX 7**

**DEVELOPMENT OF NONROAD MODEL RFP EMISSIONS  
INVENTORIES FOR THE DFW TEN-COUNTY AND HGB EIGHT-  
COUNTY OZONE NONATTAINMENT AREAS**

Dallas-Fort Worth and Houston-Galveston-Brazoria Severe  
Areas Reasonable Further Progress State Implementation Plan  
Revision for the 2008 Eight-Hour Ozone National Ambient Air  
Quality Standard

Project Number 2023-108-SIP-NR  
SFR-122/2023-108-SIP-NR

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

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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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## Table of Contents

1.0	Overview.....	1
2.0	Background.....	1
3.0	Emissions Inventory Development and Results.....	2
4.0	Quality Assurance .....	7

## List of Tables

Table 1.	NO <sub>x</sub> and VOC Emissions for the HGB Eight-County Area (Tons/Day).....	3
Table 2.	NO <sub>x</sub> and VOC Emissions for the DFW Ten-County Area (Tons/Day).....	5

## List of Figures

Figure 1.	NO <sub>x</sub> and VOC Emissions for the HGB Eight-County Area (Tons/Day).....	4
Figure 2.	NO <sub>x</sub> and VOC Emissions for the DFW Ten-County Area (Tons/Day).....	6

## 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<sup>1</sup> in November of 2020, and TCEQ contracted with ERG to update TexN2 for full compatibility with MOVES3<sup>2</sup>. 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<sub>x</sub>) 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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<sup>1</sup> 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.

<sup>2</sup> 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<sub>x</sub> 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<sub>x</sub> from diesel-fueled equipment. All 18 counties are part of the 110-county TxLED fuel control area.

<b>RFP Scenario Name</b>	<b>Description</b>
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.

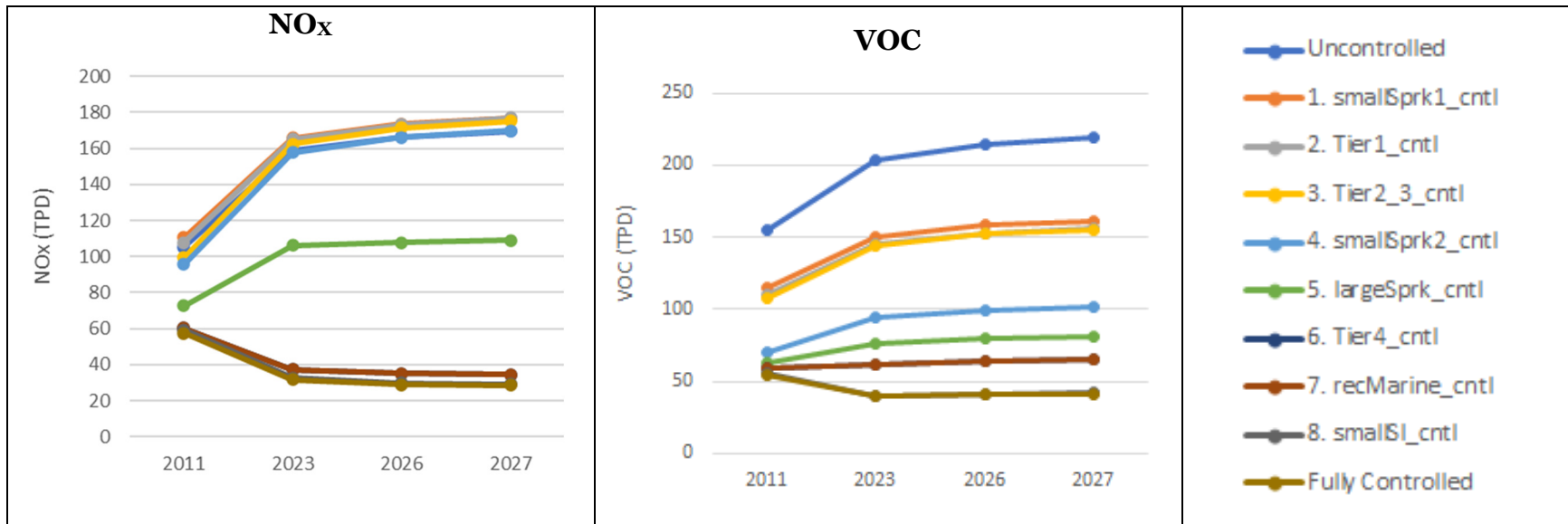
**Table 1. NO<sub>x</sub> and VOC Emissions for the HGB Eight-County Area (Tons/Day)**

Emissions Control Scenario	2011		2023		2026		2027	
	NO <sub>x</sub>	VOC	NO <sub>x</sub>	VOC	NO <sub>x</sub>	VOC	NO <sub>x</sub>	VOC
<b>Uncontrolled</b>	105.39	155.18	158.94	203.54	166.31	214.59	169.52	218.55
<b>1. smallSprk1_cntl</b>	110.50	114.45	165.61	150.30	173.38	158.27	176.73	161.15
<b>2. Tier1_cntl</b>	107.60	110.10	165.24	144.87	173.34	152.78	176.77	155.64
<b>3. Tier2_3_cntl</b>	99.32	107.77	162.43	144.30	171.26	152.37	174.91	155.28
<b>4. smallSprk2_cntl</b>	95.75	69.73	157.65	94.35	166.20	99.75	169.75	101.73
<b>5. largeSprk_cntl</b>	72.54	62.30	106.24	76.67	107.82	79.86	108.89	81.09
<b>6. Tier4_cntl</b>	60.20	58.79	37.42	62.07	35.02	64.60	34.63	65.57
<b>7. recMarine_cntl</b>	60.20	58.79	37.40	62.06	34.99	64.60	34.59	65.57
<b>8. smallSI_cntl</b>	59.38	55.07	32.61	40.19	29.85	41.29	29.35	41.79
<b>9. RFG</b>	59.41	54.62	32.61	39.89	29.85	40.98	29.35	41.47
<b>10. TxLED</b>	57.32	54.62	31.59	39.89	29.03	40.98	28.57	41.47
<b>Fully Controlled</b>	57.32	54.62	31.59	39.89	29.03	40.98	28.57	41.47

The NO<sub>x</sub> and VOC emissions generally decline from Uncontrolled to Fully Controlled except for small nonroad SI engines Phase 1 (smallSprk1\_cntl), which increases NO<sub>x</sub> by approximately 5 tons per day in 2011. The minor NO<sub>x</sub> increase was allowed under the small SI rule, where some equipment have their standards defined in terms of combined hydrocarbons plus NO<sub>x</sub>.

Generally, the uncontrolled and the earlier control scenarios show increased NO<sub>x</sub> emissions over the RFP years of 2011 to 2027 within the scenario, whereas the later controls scenarios show NO<sub>x</sub> 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<sub>x</sub>, 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.



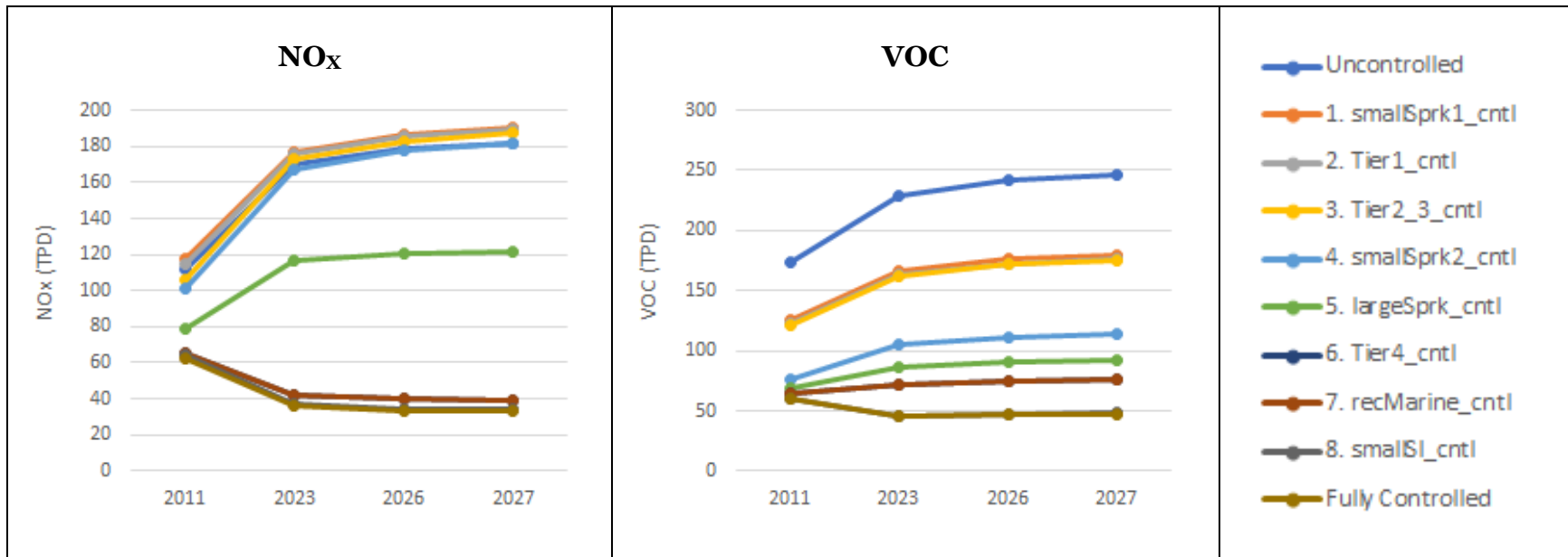


**Figure 1. NO<sub>x</sub> and VOC Emissions for the HGB Eight-County Area (Tons/Day)**

Table 2 and Figure 2 for the ten-county DFW area show similar trends to the HGB area. NO<sub>x</sub> 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<sub>x</sub> and VOC Emissions for the DFW Ten-County Area (Tons/Day)**

Emissions Control Scenario	2011		2023		2026		2027	
	NO <sub>x</sub>	VOC	NO <sub>x</sub>	VOC	NO <sub>x</sub>	VOC	NO <sub>x</sub>	VOC
<b>Uncontrolled</b>	111.93	173.23	169.59	228.32	178.44	241.25	182.11	245.84
<b>1. smallSprk1_cntl</b>	117.60	126.13	176.99	166.81	186.29	176.15	190.11	179.49
<b>2. Tier1_cntl</b>	114.45	123.05	176.06	163.25	185.79	172.61	189.72	175.95
<b>3. Tier2_3_cntl</b>	105.62	120.65	172.49	162.59	182.98	172.11	187.16	175.50
<b>4. smallSprk2_cntl</b>	101.65	76.57	167.19	104.77	177.36	111.19	181.44	113.50
<b>5. largeSprk_cntl</b>	78.57	68.77	116.79	87.02	120.18	91.25	121.84	92.81
<b>6. Tier4_cntl</b>	65.29	65.20	42.43	71.70	39.94	74.91	39.47	76.10
<b>7. recMarine_cntl</b>	65.29	65.20	42.42	71.70	39.93	74.90	39.46	76.10
<b>8. smallSI_cntl</b>	64.41	60.71	37.36	46.03	34.54	47.59	33.96	48.23
<b>9. RFG</b>	64.43	60.09	37.37	45.17	34.55	46.69	33.97	47.31
<b>10. TxLED</b>	62.08	60.09	36.14	45.17	33.52	46.69	32.99	47.31
<b>Fully Controlled</b>	62.08	60.09	36.14	45.17	33.52	46.69	32.99	47.31



**Figure 2. NO<sub>x</sub> 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.”