APPENDIX I

CONTROLLED AND UNCONTROLLED AVERAGE SUMMER WEEKDAY LOCOMOTIVE INVENTORIES FOR HOUSTON-GALVESTON-BRAZORIA AND DALLAS-FORT WORTH AREAS FOR SELECT YEARS 2012, 2014, 2017, 2020, 2023, 2026, AND 2028

Eastern Research Group, Inc.

Controlled and Uncontrolled Average Summer Weekday Locomotive Inventories for Houston-Galveston-Brazoria and Dallas-Fort Worth Areas for Select Years 2012, 2014, 2017, 2020, 2023, 2026, and 2028

Final

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

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TEXAS RAILROAD SIP EMISSION CONTROLLED AND UNCONTROLLED AVERAGE SUMMER WEEKDAY RAILROAD INVENTORIES FOR HOUSTON-GALVESTON-BRAZORIA AND DALLAS-FORT WORTH AREAS FOR SELECT YEARS 2012, 2014, 2017, 2020, 2023, 2026, AND 2028

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Table of Contents

List of Tables

List of Figures

1.0 Introduction

The objective of this Texas Commission on Environmental Quality (TCEQ) project is to develop volatile organic compound (VOC) and nitrogen oxide (NO_x) controlled and uncontrolled locomotive emissions estimates for years 2012, 2014, 2017, 2020, 2023, 2026, and 2028 to aid in State Implementation Plan (SIP) development for the eight-county Houston-Galveston-Brazoria (HGB), the nine-county Dallas-Fort Worth (DFW) 1997 eight-hour ozone nonattainment areas, and the four-county DFW 1997 one-hour ozone nonattainment area. During project development, activity data for 2014 were not available. Therefore, Eastern Research Group (ERG) obtained activity data from 2013 as this represented the most recent available data at the time the project began. ERG collected activity data for calendar year 2013, updated activity factors for future years, and used those factors to develop ozone season weekday emission inventories for locomotives. ERG developed trend data for both controlled and uncontrolled criteria emissions for years 2008 to 2040.

One improvement of this inventory over previous efforts is its bottom-up approach that integrates significant amounts of locally provided data. While previous efforts have relied partially on a top-down approach adjusting national inventory data to quantify state and county level activity and emissions, recent trends in inventory development have emphasized increased spatial resolution that is not well served by modifying national-level data. For that reason, the TCEQ sought inventory efforts built on detailed, locally-based activity and emissions data.

The Texas Locomotive SIP Emissions Inventory includes Class I, II, and III railroad activity and emissions by rail segment for the following counties: the eight HGB eight-hour ozone nonattainment counties including Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller; the nine DFW eight-hour ozone nonattainment counties including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant; and the four DFW one-hour ozone nonattainment counties including Dallas, Denton, Collin, and Tarrant. This report describes the inventory approach, including initial collection of local data, emissions calculations, and spatial allocations used to develop the Locomotive SIP inventory.

2.0 Data Collection

A primary objective of the Texas Locomotive SIP Emissions Inventory is to include rail companies operating in the state of Texas in the inventory effort. To meet this objective, ERG solicited line-haul and yard data from all Class I, II, and III railroad companies operating in Texas. All railroad members listed in the American Short Line and Regional Railroad Association (ASLRRA) as operating in Texas were included, as well as Class I rail companies Union Pacific (UP), Burlington Northern – Santa Fe (BNSF), and Kansas City Southern (KCS). Additional input was requested from the Texas Department of Transportation and the Texas Transportation Institute (ASLRRA 2011). Approximately 47 different contacts were identified and ERG contacted the organizations via phone and email to solicit quantitative and/or qualitative data.

Table 2-1 identifies the contacts and summarizes the responses received from this outreach effort. The remainder of this section describes the data received.

Table 2-1. Summary of Data Solicitation Effort

Agency/Company Name	Contact Name	Contact Phone	Response
Alamo Gulf Coast Railroad	---	(210) 208-4417	No Response
Alliance Terminal Railroad	Tine Nelson, General Manager, Operations	(817) 224-7152	No Response
Angelina & Neches River Railroad Co.	Laura Ricks, Information Systems	(936) 634-4403	No Response
Austin Western Railroad	---	(512) 246-0738	Received
Blacklands Railroad	Walt Defebaugh, President	(903) 439-0738	No Response
Border Pacific Railroad Co.	---	(956) 487-5606	No Response
Brownsville & Rio Grande Int'l	Norma Porres	(956) 831-7731	No Response
Burlington Northern Santa Fe	Mike Clift, and Laura Fiffick	(800) 795-2673	No Response
Corpus Christi Terminal Railroad	Brent Azzo	(904) 223-1110	No Response
Dallas, Garland & Northeastern	---	(972) 808-9800	No Response
Fort Worth & Western Railroad	Bill Parker	(817) 222-9798, x	No Response
Galveston Railroad, L. P.	Brent Azzo	(904) 223-1110	No Response
Gardendale Railroad, Inc.	Greg Wheeler	(618) 632-4400	No Response
Georgetown Railroad Company	---	(512) 869-1542	No Response
Kansas City Southern	Kevin McIntosh (Government	(816) 983-1987	Received
	Janet Sommerhauser	(816) 983-1603	No Response
Kiamichi Railroad Co.	Seth Rutz, GM	(580) 916-7601	No Response
Moscow, Camden & San Augustine	---	(404) 652-4000	No Response

Table 2-1. Summary of Data Solicitation Effort

Agency/Company Name	Contact Name	Contact Phone	Response
Panhandle Northern Railroad, LLC	---	(806) 273-3513	No Response
Pecos Valley Southern Railway Co.	Billy Edwards, Operations Mgr	(432) 445-2487	Received
Plainsman Switching Co., Inc.	---	(806) 744-0118	No Response
Point Comfort & Northern Railway	Brent Azzo	(912) 964-5337	No Response
Port Terminal Railroad Association	---	(713) 393-6500	No Response
Rio Valley Switching Company	Greg Wheeler	(956) 971-9111 ext. 117	No Response
Rockdale, Sandow & Southern	Brent Azzo	(912) 964-5337	No Response
Sabine River & Northern Railroad	David Clark	(409) 670-6751	No Response
San Antonio Central Railroad	Larry Jensen	(620) 231-2230	Received
South Plains Lamesa Railroad Ltd.	Shad Wisener	(806) 828-4841	Received
Southern Switching Company	Greg Wheeler	(325) 677-3601	No Response
Temple & Central Texas Railway, Inc.	---	(254) 778-8300	No Response
Texas & Northern Railway Co.	Mr. Tracy Larson Edwards	(903) 656-6762	Received
Texas Central Business Lines	---	(972) 775-1853	No Response
Texas DOT – Rail	Jackie Ploch	(512) 416-2621	Received
Texas DOT - Environmental Affairs	Air Quality contact	(512) 416-2691	No Response
Texas Gonzales & Northern Railway	---	(830) 540-3788	No Response
Texas - New Mexico Railroad Co., Inc.	---	(806) 221-3150	No Response
Texas North Western Railway Co.	---	(972) 386-0117	No Response
Texas Northeastern Railroad	Dave Geraci	(817) 527-4913	No Response
Texas Pacifico Transportation Company Ltd.	Jorge Gonzalez Chozas, VP	(325) 277-3102	No Response
Texas Rock Crusher Railway Co.	Andy Scheriger	(325) 643-5105	No Response
Texas South-Eastern Railroad Co.	---	(859) 881-6588	No Response
Texas Transportation Institute	Les Olson	(979) 862-2846	No Response
Timber Rock Railroad	---	(409) 385-6611	Received
Union Pacific	Jon Germer	(402) 544-2235	Received
West Texas & Lubbock Railway	---	(806) 785-8668; (806) 221-3150 (operating office)	No Response
Western Rail Road Company	Frank Caballero	(830) 625-8084	No Response
Wichita, Tillman & Jackson Railway Co.	Martin Cicalla	(940) 723-1852	No Response

2.1 Union Pacific

Union Pacific (UP) is one of the largest Class I rail companies operating in Texas with over 6,300 miles of track and more than 7,700 employees in Texas alone. In response to ERG's data solicitation, UP provided a 15-page .pdf document that contained line-haul and yard data for all activities in Texas for the year 2013. Line-haul mileage, annual average million gross tons (MGT) per mile, fuel usage, train counts, and emission estimates for HC, CO, NO_x, and PM were provided by county and track segment. The emission estimates were calculated using current U.S. Environmental Protection Agency (EPA) emission factors, and the fuel usage was calculated based on the system-wide average fuel consumption rate for 2013. Yard data were provided by county for 211 "yard job equivalents," which is equal to one switch locomotive operating 24 hours a day. The activity data were then provided in terms of estimated annual fuel use in gallons, based on an EPA activity factor of 226 gallons per day (gal/day) of operation.

2.2 Kansas City Southern

KCS provided 2013 fuel usage and gross ton miles for 13 distinct routes (e.g., Port Arthur to Beaumont, Houston to Beaumont, Corpus Christi to Robstown, etc.) as well as maps of these routes. They also provided number of engines and gallons of fuel pumped at each of seven yard locations in Texas.

2.3 Texas & Northern Railway

Texas & Northern Railway provided information on a single yard location in Lone Star. The data included coordinate locations, annual fuel use, annual hours of operation, and number of engines for 2013.

2.4 South Plains Lamesa Railroad

South Plains Lamesa Railroad provided information on Slaton yard in Lubbock County. Data included coordinates, annual fuel use, annual hours of operation, and number of engines.

2.5 Watco Companies

Watco Companies provided with information on Austin Western, Timber Rock, San Antonio Central, and Pecos Valley Railroads. Data included engine counts, average daily hours of use, and headquarter locations.

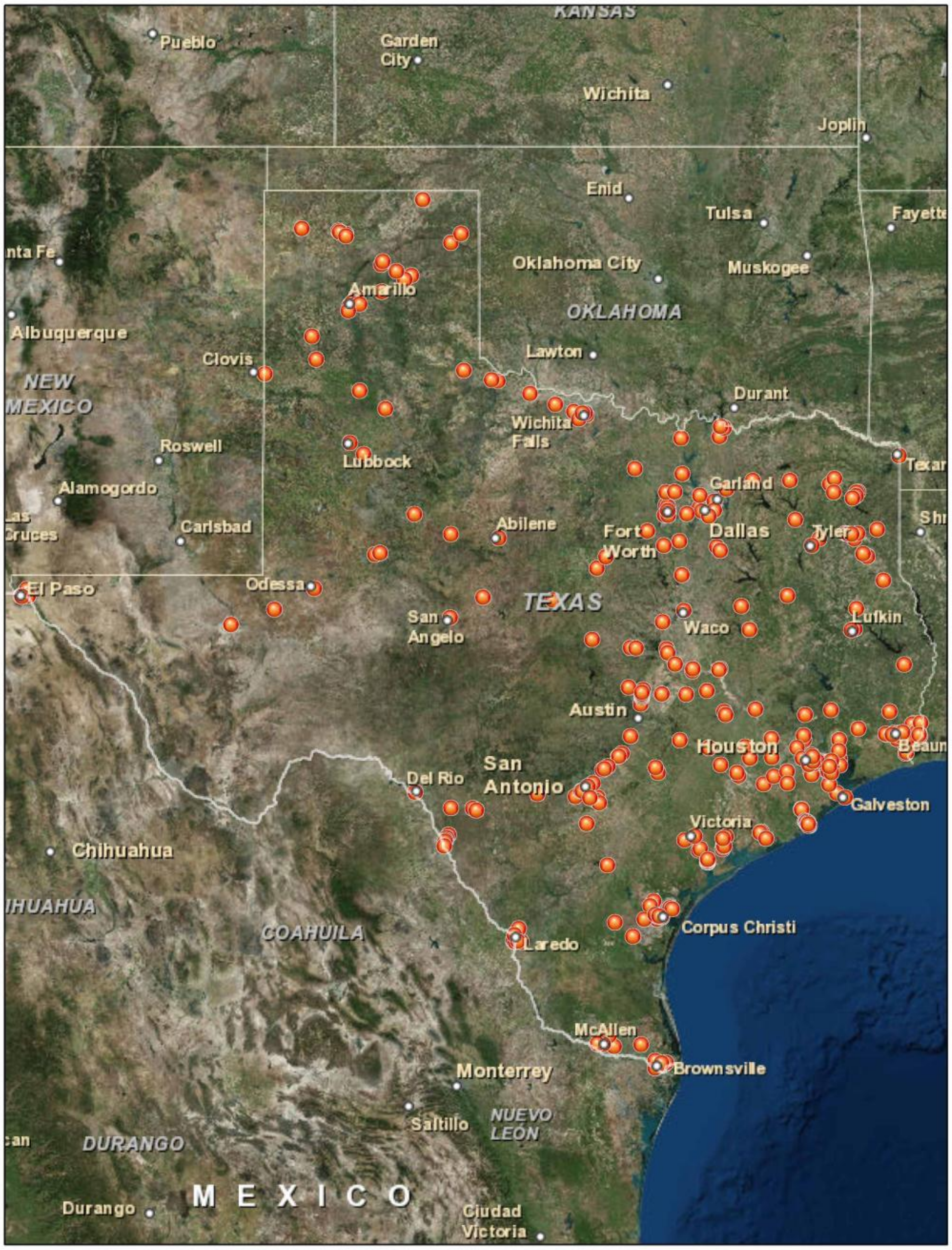
2.6 Switch Yard Locations

Switch yards have historically been under-represented in inventory efforts due to the lack of available data and low response to data requests. Because identifying more yard locations and estimating emissions that were not accounted for in previous inventories was a priority in this project, ERG examined switch yard data carefully.

ERG reviewed previously identified yard locations against rail networks from the Bureau of Transportation Statistics (BTS) and the Texas Natural Resources Information System as well as satellite imagery via Google Earth. Two yards were removed due to lack of substantiation from these related data layers, and some yard coordinates were shifted slightly to better match the network and/or imagery data. Statewide rail networks and satellite imagery were also reviewed systematically to identify potential new yards. Potential new yards were identified as areas with several rail segments parallel to each other and off of the main tracks according to either rail network. In many cases, these yards also had visible train activity in satellite imagery and indications of support equipment or trucking facilities nearby. These potential yard locations were reviewed by several staff members, and those that seemed questionable were removed.

ERG also researched potential and future yards online via websites from transportation departments, trade associations, railroad company websites, as well as industry trends sites as listed in Appendix A. The 334 switch yards identified in Texas for this inventory are shown in Figure 2-1.

Figure 2-1. Class I, II, and III Rail Yard Locations in Texas



3.0 Processing of Local Data

3.1 Line-Haul Data

3.1.1 Union Pacific Railroad Data Processing

ERG converted UP's .pdf data to text using Adobe Acrobat and then imported the data into Microsoft Excel. Line-haul fuel use and emissions data were summarized at the county level and hydrocarbon (HC) was converted to VOC by multiplying by 1.053, and NO_x emissions were estimated using the fuel-based emission factors and methodology described in Section 4.

3.1.2 Kansas City Southern Railroad

KCS provided 2013 fuel usage and gross ton-miles for several distinct routes (e.g., Port Arthur to Beaumont, Houston to Beaumont, Corpus Christi to Robstown, etc.) as well as maps of these routes. ERG compared these maps against rail segment maps in a geographic information system (GIS) to identify the Emission Inventory System (EIS) shapes affiliated with each route. Total route fuel usage was divided among the segments in that route based on segment length, and emissions were calculated using segment-level fuel usage. The route from Ashdown, AR to Shreveport, LA was not processed because it is outside of Texas boundaries.

3.1.3 Burlington Northern Santa Fe

BNSF did not provide updated data for 2013; however, they did respond to a previous data request for the 2011 inventory effort. To maximize use of locally-provided data, their previous 2011 county-level fuel usage was extrapolated to 2013 using a growth factor derived from their R-1 data as described in Section 6. Then the 2013 emission factors were used to recalculate 2013 emissions as described in Section 4.

3.1.4 Class II and Class III Line-Haul Data

No Class II or III Railroad companies provided line-haul data. As a result, ERG used other locally-based data sources to estimate 2014 activity levels. The Eastern Regional Technical Advisory Committee (ERTAC) previously collaborated with the Federal Railroad Administration (FRA), the ASLRRA, and members of the Class II and III Railroad communities to develop activity and emissions profiles for Class II and Class III railroads for 2008 (Bergin et. al, 2009). The ASLRRA compiles data from the Class II and III railroads every few years, including total industry fuel use for locomotives and total Class II/III route miles. Unfortunately, at this time there are no newer data, so the 2008 activity data were grown to represent 2013 activity. ERG used the U.S. Energy Information Administration's (EIA) latest Annual Energy Outlook (AEO) to estimate the fuel usage growth by year and applied this growth rate directly to the fuel usage data before applying emission factors as further described in Section 6.

3.2 Switch Yard Data

The final yard list includes 42 UP yards, 42 BNSF yards, 12 KCS yards, and 238 Class II/III yards for a total of 334 yards. Most respondents provided fuel usage data such that emissions were calculated directly using emission factors in grams/gallon as described in Section 4.0. For data that did not include fuel use, ERG developed the most appropriate surrogates possible to fill in the gaps in activity data. For example, BNSF's previous yard work included emissions but not fuel use. Without supporting data on the activity or emission factors used to develop BNSF's 2011 emissions data, ERG estimated the fuel usage in gallons in 2011 by dividing the emissions by the 2011 emission factors (grams per gallon). The fuel usage data was then projected to 2013. Watco provided engine count and daily hours of operation. To calculate fuel usage, ERG first calculated an average Class II/III fuel usage rate from data provided by Class II/III railroad companies in Texas to get an average value of 10.05 gallons per hour (gal/hr). ERG also used local Class I data to determine that the average railroad company uses 5.39% of their total fuel for switch operations. Assuming that the engines work 365 days per year, the total fuel use was calculated by yard using the following equation:

$$SG = L * DH * 365 \text{ days per year} * FR * S$$

Where

SG	=	total annual fuel use (gal)
L	=	number of locomotives
DH	=	daily hours of use (hr)
FR	=	fuel usage rate (gal/hr) = 10.05 gal/hr
S	=	portion of total fuel that is used in switch operations

Example:

Austin Western Railroad has 13 locomotives with an average daily use of 12 hours each.

$$SG = 13 * 12 \text{ hr/day} * 365 \text{ days/yr} * 10.05 \text{ gal/hr} * 0.0539$$
$$\text{Switch (gal)} = 30{,}844$$

For yard locations that were identified during searches but that did not match any of the locally-submitted data, a more general approach to activity and emissions estimates was needed. First, because ERG received relatively comprehensive data submittals from the Class I rail lines in the past, we assumed that these other switch yards were likely related to small Class II and III rail lines. Per the 2011 TCEQ Locomotive inventory and current GIS calculations, there are 2,247.66 miles of Class II and III rail lines in Texas. Using a Class II/III fuel use factor of 2,797.74 gallons per mile, obtained from the ASLRR and 2011 TCEQ Inventory, ERG calculated the total Class II/III fuel use as follows:

$$2{,}247.66 \text{ mi} * 2{,}797.74 \text{ gal/mi} = 6{,}288{,}368 \text{ gallons of fuel}$$

Using the previously defined value of 5.39% of total fuel being consumed by switch operations, ERG estimated a statewide switch fuel use of 338,850 gallons for Class II/III yards. Because we had total fuel estimates from six small line-haul companies, we estimated their switch fuel use as 5.39% of the total and subtracted this “known” fuel use from the statewide total to avoid double-counting. The result was a statewide total of 262,509 gallons for Class II/III switch operations. Given there are 220 Class II/III yards, this fuel usage data equates to roughly 1,193 gallons of fuel per year per yard. This equates to about 120 operating hours a year or only a couple of hours a week at each of these switching yards.

4.0 Emission Factors

With fuel usage estimates established for all activity data, ERG could apply fuel-based emission factors to estimate emissions. ERG compiled emission factors for Class I and Class II/III line-haul and yard locomotives from various references. This section provides the source documents and calculations involved in identifying emission factors for the listed pollutants.

The EPA Technical Highlights publication, "Emission Factors for Locomotives" (EPA 2009) provides emission factors on a gram per brake horsepower-hour (g/bhp hr) basis and then converts them to a grams per gallon basis with a factor based on the usable power of the locomotive engine. The conversion requires a factor of 20.8 bhp hr/gal for large line-haul locomotives, 18.2 bhp hr/gal for small line-haul locomotives, and 15.2 bhp hr/gal for yard locomotives. The g/gal emission factors can also be converted to an energy basis for use if the heating value of diesel fuel is known. The conversion to grams emitted per ton-mile of freight hauled (g/ton-mile) is calculated based on data collected by the Association of American Railroads for revenue ton-miles and fuel consumption, which shows approximately one gallon of diesel fuel hauls 400 ton-miles of freight.

4.1 VOC and NO_x by Tier

The 2009 EPA Technical Highlights publication includes emission rates for hydrocarbons (HC) and nitrogen oxide (NO_x) for line-haul and yard locomotives in g/bhp-hr. ERG converted these emission rates to g/gal by locomotive type. These emission factors were used to develop the uncontrolled emissions inventory. The 2009 EPA Technical Highlights publication also lists expected fleet average emission factors for NO_x and HC by calendar year and locomotive type, which are listed in Section 4.4.

ERG applied conversion factors to develop the emission factors as needed. Volatile organic compounds (VOC) emissions are estimated to be 1.053 times the HC emissions provided (EPA, 2009). Table 4-1 shows the uncontrolled emission factors in g/gal for the criteria pollutants that were used to develop uncontrolled emission estimates for all SIP years.

Table 4-1. Uncontrolled Emission Factors from 2009 EPA Technical Highlights Publication(g/gal)*

Uncontrolled	Source Category Code (SCC)	VOC	NO_x
Large Line-Haul	2285002006	10.5	270.4
Small Line-Haul	2285002007	9.2	236.6
Yard	2285002010	16.2	264.5

*EPA 2009

4.2 VOC and NO_x by Year

The 2009 EPA Technical Highlights publication (EPA 2009) lists expected fleet average emission factors that account for fleet turnover for NO_x and HC by calendar year and locomotive type. ERG included these emission factors for large line-haul, small line-haul, and large yard for the various inventories.

The conversion factors listed in Section 4.1 apply for VOC. VOC emissions are estimated to be 1.053 times the HC emissions provided (EPA 2009).

Tables 4-3 through Table 4-9 list the emission factors by year from 2006 to 2040 for NO_x and VOC. The emission factors are in g/gal and in each table the emission factors are desegregated by large line-haul, large switch, and small railroads.

Table 4-2. NO_x Emission Factors by Year (g/gal)*

Calendar Year	Large Line- haul SCC 2285002006	Large Switch SCC 2285002010	Small Railroads SCC 2285002007
2006	180	250	242
2007	175	249	242
2008	169	243	242
2009	165	241	242
2010	157	236	242
2011	149	235	242
2012	144	227	242
2013	139	225	242
2014	135	217	242
2015	129	215	240
2016	121	208	239
2017	114	206	237
2018	108	202	236
2019	103	200	233
2020	99	187	231
2021	94	185	228
2022	89	177	225
2023	84	172	223
2024	79	162	220
2025	74	150	217
2026	69	144	215
2027	65	138	212
2028	61	132	209
2029	57	126	206
2030	53	119	203
2031	49	112	200
2032	46	105	197
2033	43	98	193
2034	40	91	190
2035	37	84	187
2036	35	77	184
2037	33	71	180
2038	31	67	177
2039	29	63	174
2040	28	60	171

* EPA 2009

Table 4-3. VOC Emission Factors by Year (g/gal)*

Calendar Year	Large Line- Haul SCC 2285002006	Large Switch SCC 2285002010	Small Railroads SCC 2285002007
2006	10.00	15.80	12.32
2007	9.79	15.80	12.32
2008	9.48	15.27	12.32
2009	9.16	15.27	12.32
2010	8.74	14.85	12.32
2011	8.11	14.74	12.32
2012	7.48	14.00	12.32
2013	6.84	14.00	12.32
2014	6.42	13.37	12.32
2015	6.00	13.27	12.32
2016	5.37	12.64	12.32
2017	4.84	12.43	12.32
2018	4.42	12.11	12.32
2019	4.11	12.00	12.32
2020	3.79	11.06	12.32
2021	3.58	10.95	12.32
2022	3.37	10.32	12.32
2023	3.16	10.00	12.32
2024	2.95	9.37	12.32
2025	2.74	8.42	12.32
2026	2.63	8.00	12.32
2027	2.42	7.69	12.32
2028	2.21	7.27	12.32
2029	2.11	6.84	12.32
2030	2.00	6.53	12.32
2031	1.79	6.11	12.32
2032	1.68	5.79	12.32
2033	1.58	5.37	12.32
2034	1.47	4.95	12.32
2035	1.37	4.63	12.32
2036	1.26	4.21	12.32
2037	1.26	3.90	12.32
2038	1.16	3.79	12.32
2039	1.16	3.58	12.32
2040	1.05	3.37	12.32

* EPA 2009

5.0 Allocation of Class I Line-Haul Emissions

The yard activity/emissions data received were specific to individual yard locations, therefore, no further spatial allocation was needed. For yards for which ERG had no locally-provided data, ERG divided the statewide fuel use evenly among the 231 yard locations. For line-haul data, to facilitate processing and to protect confidential business information (CBI), ERG aggregated line-haul rail activity and emissions to the county level and then reallocated the activity and emissions back to rail segments within each county to meet format requirements of the NEI. This was necessary because railroad track identification information was limited to mile markers and segment IDs that are specific to individual rail lines' networks and do not relate to any publically available railway networks to allow for accurate spatial mapping of rail activities.

ERG allocated Class I line-haul emissions to rail segments based on segment-specific railroad traffic data (ton miles) obtained from the Department of Transportation (BTS, 2009). The BTS dataset categorizes the segments' level of activity into ranges of million gross ton miles (MGTM) and was populated by the Federal Railroad Administration (FRA). ERG divided emissions between all mainline segments using these activity ranges as a proxy to allocate more emissions to segments with higher Class I activity.

ERG reallocated the county emission sums to the segments by multiplying the county emissions by the segment's allocation value divided by the sum of the allocation values for all links within the county as follows:

$$E_{iL} = E_{iC} * \frac{A_L}{\sum_{C=1}^{N} A_{LC}}$$

Where:

E_{iL}	=	emissions of pollutant i per link L (tons/year).
E_{iC}	=	emissions of pollutant i per county C (tons/year).
A_L	=	allocation value for link L per activity category from public BTS dataset.
A_{LC}	=	sum of allocation values for all links in county C from public BTS dataset.

The spatial inventory was developed from confidential data from FRA very similar to the publically-available BTS rail dataset, so segment IDs were generally consistent with those used in EIS, thus facilitating later data processing.

5.1 Class II/III Line-Haul Emissions Allocation

The ERTAC Rail paper (Bergin 2011) extracted links that were identified as owned or operated by specific Shortline or Regional Railroads from the FRA-provided proprietary shapefile to create a shapefile of Class II/III mainline rail segments. Because Class II/III railroads are less likely to use rail segments that are heavily traveled by Class I railroads, the activity-based approach used for Class I lines is not appropriate for small line-haul rail activities. Instead, Class II/III line-haul emissions were allocated to rail segments using segment length as a proxy.

The county emission sums were reallocated to the segments by multiplying the county emissions by the segment's length divided by the sum of the length for all links within the county as follows:

$$E_{iL} = E_{iC} * \frac{l_L}{\sum_{C=1}^{N} l_{LC}}$$

Where:

E_{iL}	=	emissions of pollutant i per link L (tons/year).
E_{iC}	=	emissions of pollutant i per county C (tons/year).
l_L	=	allocation value for link L per activity category from public BTS dataset.
l_{LC}	=	sum of allocation values for all links in county C from public BTS dataset.

6.0 Projection Factors

Because activity data were requested for only 2013, projection factors were required to backcast and forecast activity data from 2012 to 2028 using 2013 as the baseline. ERG obtained data for UP, BNSF, and KCS from the Federal Railroad Administration's Complete Class I Railroad Annual Reports (R-1) for years 2008 through 2013. By creating a ratio of annual fuel use in gallons, company-specific percent change values were calculated and used to adjust provided 2013 or 2011 data to backcasted 2008 activity levels. For Class II and III lines and for forecasted years for all companies, actual fuel use is not available, and a different approach is required. ERG used U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) for year 2013 (EIA 2014) as the baseline year to backcast activity to 2008 and to forecast (project) future activity levels through 2040. The AEO provides detailed annual projections in billion ton miles traveled through year 2040. These future projections show little to no growth in rail industry over the time period of interest. ERG verified the trend data in EIA AOE using the historic and projected data published by the Association of American Railroads (AAR 2014) and the U.S. Bureau of Transportation Statistics (BTS 2000).

ERG matched the projected activity to the appropriate future year emission factors provided in Table 6-1. The AEO-based growth factors account for implementation of federal rules that occur relative to the year that the locomotive engine was originally manufactured, such that the full benefit of the rule would occur in the future once fleet turnover was completed. Additional adjustments were made to future year emission estimates to account for compliance with emission control area sulfur standards and Texas Emissions Reduction Plan (TERP) investments. The TERP program provides grants to eligible businesses to reduce emissions from polluting vehicles and equipment. For rail applications, this typically involves repowering or replacing switch engines. A complete list of control programs addressed in this inventory is presented in Appendix B. As BNSF, KCS, and UP provided data for Texas inventory use, the TERP reductions were already included in their estimates. The remaining TERP projects were for smaller Class II and III rail lines. ERG used the TERP project data to sum the NO_x reductions over time for each project and then summed by year to get total annual tons of NO_x avoided due to TERP projects. The NO_X tonnage was then added to the uncontrolled inventory to correctly account for the increased emissions that would be present were it not for the TERP projects.

For the controlled emissions, ERG also applied reductions related to the Texas Low Emission Diesel Program (TxLED). The TxLED Program is implemented to reduce emissions of nitrogen oxides from diesel-powered motor vehicles and non-road equipment and involves a6.2% NO_x reduction in the 110 central and eastern counties that are impacted by this regulation, which include all of the counties examined in this SIP effort.

Table 6-1. AEO-based Growth Factors for Locomotive Activities

Year	Change from Baseline 2013
2012	1.136752
2013	1.000000
2014	1.021696
2017	1.023011
2020	1.067719
2023	1.107824
2026	1.130178
2028	1.132807

ERG also investigated whether the recent reduction in gasoline prices would change oil and gas activity in the United States and Texas in future years. Given that this change in price occurred recently, no studies or reports addressing this issue were found. In researching the topic using Google searches and Google scholar searches, news articles mentioning possible impacts were found. However the articles were speculative and failed to give any actual data that could be utilized to create or adjust growth factors.

7.0 Results

The results of implementing the emission estimation methodology and emission projection procedures for the years 2012, 2014, 2017, 2020, 2023, 2026, and 2028 are presented in Table 7-1 through Table 7-12. In these tables, all locomotive emissions have been summed up to the county level. Tables 7-1 through 7-4 present the daily controlled and uncontrolled NO_x and VOC emissions by the nine DFW counties. Tables 7-5 through 7-8 present the daily controlled and uncontrolled NO_X and VOC emissions by the four DFW counties. Tables 7-9 through 7-12 present the daily controlled and uncontrolled NO_x and VOC emissions for the eight HGB counties.

Table 7-1. Ozone Season Daily Controlled NO_X Emissions (tons)by Year for the Dallas/ Fort Worth - 9 County Area

	Daily NO_X Emissions (tons/day)						
County Name	**2012**	**2014**	**2017**	**2020**	**2023**	**2026**	**2028**
Collin	0.364	0.365	0.319	0.298	0.272	0.239	0.219
Dallas	1.685	1.652	1.487	1.388	1.283	1.101	1.002
Denton	2.144	2.089	1.769	1.606	1.416	1.190	1.056
Ellis	1.052	1.018	0.864	0.784	0.693	0.581	0.515
Johnson	1.650	1.620	1.396	1.277	1.142	0.966	0.864
Kaufman	0.519	0.498	0.421	0.382	0.336	0.281	0.249
Parker	0.789	0.758	0.641	0.581	0.511	0.429	0.380
Rockwall	0.024	0.025	0.025	0.025	0.025	0.025	0.024
Tarrant	6.136	6.010	5.317	4.914	4.479	3.801	3.429
Total	14.362	14.035	12.239	11.254	10.157	8.611	7.738

Table 7-2. Ozone Season Daily Uncontrolled NO_X Emissions (tons) by Year for the Dallas/ Fort Worth - 9 County Area

County Name	Daily NO_X Emissions (tons/day)						
	2012	**2014**	**2017**	**2020**	**2023**	**2026**	**2028**
Collin	0.656	0.694	0.695	0.725	0.753	0.768	0.770
Dallas	4.484	4.572	2.963	3.084	3.195	3.255	3.121
Denton	4.290	4.461	4.462	4.655	4.829	4.926	4.937
Ellis	2.190	2.256	2.156	2.249	2.333	2.380	2.385
Johnson	3.468	3.602	3.261	3.403	3.530	3.601	3.610
Kaufman	1.038	1.063	1.064	1.111	1.153	1.176	1.179
Parker	1.579	1.617	1.619	1.690	1.754	1.789	1.793
Rockwall	0.025	0.026	0.026	0.027	0.028	0.029	0.029
Tarrant	15.517	15.895	10.983	11.462	11.892	12.131	12.160
Total	33.247	34.186	27.230	28.407	29.467	30.054	29.984

Table 7-3. Ozone Season Daily Controlled VOC Emissions (tons) by Year for the Dallas/ Fort Worth - 9 County Area

County Name	Daily VOC Emissions (tons/day)						
	2012	**2014**	**2017**	**2020**	**2023**	**2026**	**2028**
Collin	0.020	0.019	0.015	0.013	0.012	0.011	0.010
Dallas	0.101	0.095	0.082	0.073	0.067	0.057	0.051
Denton	0.119	0.106	0.080	0.066	0.057	0.049	0.041
Ellis	0.059	0.052	0.040	0.033	0.028	0.024	0.020
Johnson	0.093	0.085	0.067	0.057	0.050	0.043	0.037
Kaufman	0.029	0.025	0.019	0.016	0.013	0.011	0.010
Parker	0.044	0.038	0.029	0.024	0.021	0.017	0.015
Rockwall	0.001	0.001	0.001	0.001	0.001	0.002	0.002
Tarrant	0.361	0.336	0.280	0.244	0.221	0.185	0.163
Total	0.826	0.759	0.613	0.526	0.472	0.400	0.349

Table 7-4. Ozone Season Daily Uncontrolled VOC Emissions (tons) by Year for the Dallas/ Fort Worth - 9 County Area

County Name	Daily VOC Emissions (tons/day)						
	2012	**2014**	**2017**	**2020**	**2023**	**2026**	**2028**
Collin	0.025	0.027	0.027	0.028	0.029	0.030	0.030
Dallas	0.126	0.130	0.130	0.136	0.141	0.144	0.144
Denton	0.166	0.172	0.173	0.180	0.187	0.191	0.191
Ellis	0.082	0.084	0.084	0.088	0.091	0.093	0.093
Johnson	0.126	0.132	0.132	0.138	0.143	0.146	0.146
Kaufman	0.040	0.041	0.041	0.043	0.045	0.046	0.046
Parker	0.061	0.063	0.063	0.066	0.068	0.069	0.070
Rockwall	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Tarrant	0.469	0.486	0.487	0.508	0.527	0.537	0.539
Total	1.097	1.137	1.138	1.188	1.232	1.257	1.260

Table 7-5. Ozone Season Daily Controlled NO_X Emissions (tons) by Year for the Dallas/ Fort Worth - 4 County Area

County Name	Daily NO_X Emissions (tons/day)						
	2012	**2014**	**2017**	**2020**	**2023**	**2026**	**2028**
Collin	0.364	0.365	0.319	0.298	0.272	0.239	0.219
Dallas	1.685	1.652	1.487	1.388	1.283	1.101	1.002
Denton	2.144	2.089	1.769	1.606	1.416	1.190	1.056
Tarrant	6.136	6.010	5.317	4.914	4.479	3.801	3.429
Total	10.328	10.116	8.893	8.205	7.450	6.330	5.705

Table 7-6. Ozone Season Daily Uncontrolled NO_X Emissions (tons) by Year for the Dallas/ Fort Worth - 4 County Area

County Name	Daily NO_X Emissions (tons/day)						
	2012	**2014**	**2017**	**2020**	**2023**	**2026**	**2028**
Collin	0.656	0.694	0.695	0.725	0.753	0.768	0.770
Dallas	4.484	4.572	2.963	3.084	3.195	3.255	3.121
Denton	4.290	4.461	4.462	4.655	4.829	4.926	4.937
Tarrant	15.517	15.895	10.983	11.462	11.892	12.131	12.160
Total	24.947	25.622	19.103	19.927	20.669	21.080	20.988

Table 7-7. Ozone Season Daily Controlled VOC Emissions (tons) by Year for the Dallas/ Fort Worth - 4 County Area

County Name	Daily VOC Emissions (tons/day)						
	2012	2014	2017	2020	2023	2026	2028
Collin	0.020	0.019	0.015	0.013	0.012	0.011	0.010
Dallas	0.101	0.095	0.082	0.073	0.067	0.057	0.051
Denton	0.119	0.106	0.080	0.066	0.057	0.049	0.041
Tarrant	0.361	0.336	0.280	0.244	0.221	0.185	0.163
Total	0.601	0.556	0.457	0.396	0.358	0.302	0.266

Table 7-8. Ozone Season Daily Uncontrolled VOC Emissions (tons) by Year for the Dallas/ Fort Worth - 4 County Area

County Name	Daily VOC Emissions (tons/day)						
	2012	2014	2017	2020	2023	2026	2028
Collin	0.025	0.027	0.027	0.028	0.029	0.030	0.030
Dallas	0.126	0.130	0.130	0.136	0.141	0.144	0.144
Denton	0.166	0.172	0.173	0.180	0.187	0.191	0.191
Tarrant	0.469	0.486	0.487	0.508	0.527	0.537	0.539
Total	0.786	0.815	0.816	0.852	0.884	0.902	0.904

Table 7-9. Ozone Season Daily Controlled NO_X Emissions (tons) by Year for the Houston/Galveston/Brazoria Area

County Name	Daily NO_X Emissions (tons/day)						
	2012	2014	2017	2020	2023	2026	2028
Brazoria	1.201	1.167	0.998	0.908	0.807	0.677	0.603
Chambers	0.023	0.023	0.020	0.019	0.018	0.016	0.014
Fort Bend	2.563	2.503	2.126	1.931	1.707	1.435	1.275
Galveston	0.688	0.675	0.587	0.542	0.489	0.419	0.378
Harris	8.691	8.444	7.408	6.822	6.181	5.232	4.705
Liberty	2.844	2.788	2.451	2.259	2.050	1.737	1.563
Montgomery	1.061	1.037	0.886	0.811	0.723	0.616	0.552
Waller	0.194	0.187	0.158	0.143	0.126	0.106	0.094
Total	17.265	16.823	14.634	13.435	12.100	10.236	9.183

Table 7-10. Ozone Season Daily Uncontrolled NO_X Emissions (tons) by Year for the Houston/Galveston/Brazoria Area

County Name	Daily NO_X Emissions (tons/day)						
	2012	2014	2017	2020	2023	2026	2028
Brazoria	2.381	2.473	2.464	2.565	2.660	2.711	2.717
Chambers	0.064	0.071	0.065	0.065	0.067	0.067	0.068
Fort Bend	5.087	5.297	5.300	5.530	5.737	5.851	5.865
Galveston	1.267	1.316	1.316	1.373	1.425	1.453	1.456
Harris	15.626	16.123	16.101	16.785	17.408	17.751	17.792
Liberty	5.022	5.205	5.211	5.439	5.643	5.756	5.770
Montgomery	2.063	2.142	2.144	2.237	2.320	2.367	2.372
Waller	0.395	0.406	0.405	0.422	0.437	0.446	0.447
Total	31.906	33.033	33.005	34.415	35.697	36.402	36.488

Table 7-11. Ozone Season Daily Controlled VOC Emissions (tons) by Year for the Houston/Galveston/Brazoria Area

County Name	Daily VOC Emissions (tons/day)						
	2012	2014	2017	2020	2023	2026	2028
Brazoria	0.068	0.061	0.047	0.039	0.034	0.029	0.025
Chambers	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Fort Bend	0.142	0.128	0.097	0.080	0.070	0.060	0.051
Galveston	0.039	0.036	0.029	0.025	0.022	0.019	0.017
Harris	0.506	0.464	0.380	0.328	0.295	0.248	0.217
Liberty	0.166	0.154	0.127	0.110	0.099	0.083	0.073
Montgomery	0.059	0.053	0.041	0.034	0.030	0.027	0.023
Waller	0.011	0.009	0.007	0.006	0.005	0.004	0.004
Total	0.992	0.906	0.729	0.623	0.557	0.470	0.410

Table 7-2. Ozone Season Daily Uncontrolled VOC Emissions (tons) by Year for the Houston/Galveston/Brazoria Area

County Name	Daily VOC Emissions (tons/day)						
	2012	2014	2017	2020	2023	2026	2028
Brazoria	0.093	0.096	0.097	0.101	0.105	0.107	0.107
Chambers	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Fort Bend	0.198	0.206	0.207	0.216	0.224	0.228	0.229
Galveston	0.052	0.053	0.054	0.056	0.058	0.059	0.059
Harris	0.667	0.686	0.687	0.717	0.744	0.759	0.761
Liberty	0.218	0.226	0.227	0.236	0.245	0.250	0.251
Montgomery	0.080	0.083	0.083	0.087	0.090	0.092	0.092
Waller	0.015	0.015	0.015	0.016	0.017	0.017	0.017
Total	1.324	1.369	1.371	1.431	1.484	1.514	1.518

8.0 References

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Appendix A. Internet Research for Existing and Potential Yard Locations

Location	Yard Name	Railroad	Status	Links
Beaumont	Beaumont Yard	UP	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Fort Worth	Davidson Yard	UP	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Houston	Englewood Yard	UP	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Kendleton	Kendleton Yard	KCS	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Slaton	Slaton Yard	BNSF/South Plains Lamesa Railroad	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
La Porte	Strang Yard	UP	Existing	http://iaspub.epa.gov/enviro/fii_query_detail.disp_program_facility?p_registry_id=110035015079
Dallas	Miller Yard	UP	Existing	http://iaspub.epa.gov/enviro/fii_query_detail.disp_program_facility?p_registry_id=110035273398
Eagle Ford	San Antonio	UP	New	http://missionrailpark.com/
San Antonio	Southton Rail Yard	UP & BNSF	Existing	http://southtonrailyard.com/about.html
Dallas	KCS Rail Yard	KCS	Existing	http://wikimapia.org/10547329/Kansas-City-Southern-Rail-Yard
San Antonio	Alamo Junction Rail Park	UP & BNSF	Proposed	http://www.alamojunction.com/
Big Spring		UP	Proposed	http://www.bigspringherald.com/content/rail-yard-could-be-possibility
Port Corpus Christi Commission (PCCA)		BNSF/KCS/UP	Proposed	http://www.progressiverailroading.com/intermodal/news/Texas-port-awards-rail-yard-contract--36514
Between Hearne and Mumford, Texas		UP	Proposed	http://www.progressiverailroading.com/union_pacific/news/Union-Pacific-Railroad-proposes-to-build-one-of-Texas-largest-classification-yards-Hearne-mayor-says--31785
Houston	Port Terminal Railroad (PTRA) North Yard	KCS, NS, BNSF	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html http://www.usa.com/frs/union-pacific-railroad-settegast-yard.html
Houston	PTRA Manchester Yard	UP/BNSF	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html

Appendix A. Internet Research for Existing and Potential Yard Locations

Location	Yard Name	Railroad	Status	Links
Houston	PTRA Pasadena Yard	UP/BNSF	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html
Houston	PTRA Storage Yard	UP	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html
Houston	Settsgast Yard	UP	Existing	http://www.railfanguides.us/tx/houston/map1/index.htm
Dallas	KCS Dallas Yard	KCS	Existing	http://www.railroadforums.com/forum/showthread.php?12220-KCS-yard-near-dallas-or-fort-worth
Wylie	KCS Wylie Yard	KCS, NS, BNSF	Existing	http://www.railroadforums.com/forum/showthread.php?12220-KCS-yard-near-dallas-or-fort-worth
Dallas	Dallas Garland & Northeastern (DGNO) at Mockingbird yard	BNSF, KCS, TNER, and UP	Existing	http://www.railroadforums.com/photos/showphoto.php/photo/23775/title/dgno-at-mockingbird-yarddallas-tx/cat/562
Dallas	Mockingbird yard	DGNO	Existing	http://www.railroadforums.com/photos/showphoto.php/photo/23775/title/dgno-at-mockingbird-yarddallas-tx/cat/562
Galveston	Texas International Terminals	UP	Existing	http://www.up.com/customers/coal/ports-docks/tx-terminals/index.htm
Robertson County		UP	Proposed	http://www.uprr.com/newsinfo/releases/capital_investment/2014/1002_tx-railyard.shtml
Blue Mound	Alliance Railyard	BNSF	Existing	http://www.waymarking.com/waymarks/WM73KD_BNSF_Alliance_Railyard_Blue_Mound_Texas

Appendix B. Locomotive Emission Control Programs in Texas, 2008-2040*

Rail 2008 to 2040 Control Programs				
Year	**Programs**	**Application**	**Notes**	**Source**
2008 to 2040	TxLED	110 Counties	6.2% Reduction in NO_x	https://www.tceq.texas.gov/assets/public/legal/rules/rule_lib/adoptions/09001114_aex.pdf
2008	TERP	Statewide	NO_x reduced by 4507 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	More stringent PM and NO_x standards for remanufactured locomotives starting in 2008. - Full implementation of the rule will result in PM reductions of 90% and NO_x reductions of 80% compared to current 2008 standards.	http://www.epa.gov/nonroad/420f08004.pdf
2008 to 2011	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	More stringent PM and NO_x standards for new locomotives starting in 2008.	http://www.epa.gov/nonroad/420f08004.pdf
2009	TERP	Statewide	NO_x reduced by 4392 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2010	TERP	Statewide	NO_x reduced by 4509 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2011	TERP	Statewide	NO_x reduced by 4327 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2012	Fuel Sulfur limit	Nationwide, Incorporated into EPA's EF's already	Sulfur content of diesel fuel limited to 15 ppm starting in June. Included in EPA's Diesel fuel emission factors for locomotives.	http://www.epa.gov/OTAQ/fuels/dieselfuels/index.htm

Appendix B. Locomotive Emission Control Programs in Texas, 2008-2040*

Rail 2008 to 2040 Control Programs				
Year	**Programs**	**Application**	**Notes**	**Source**
	TERP	Statewide	NO_x reduced by 3,225 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2012 to 2014	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	New locomotives required to apply Tier 3 standards to remanufactured and new locomotives to reduce PM and NO_x emissions. Also creates new idle reduction requirement for new and remanufactured locomotives.	http://www.epa.gov/nonroad/420f08004.pdf
2013	TERP	Statewide	NO_x reduced by 3,349 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2014	TERP	Statewide	NO_x reduced by 3,349 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2015 to 2040	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	New locomotives required to use Tier 4 high-efficiency catalytic after treatment technology.	http://www.epa.gov/nonroad/420f08004.pdf
2015	TERP	Statewide	NO_x reduced by 1,473 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2016	TERP	Statewide	NO_x reduced by 649 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2017	TERP	Statewide	NO_x reduced by 638 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2018	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2019	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf

Appendix B. Locomotive Emission Control Programs in Texas, 2008-2040*

Rail 2008 to 2040 Control Programs				
Year	**Programs**	**Application**	**Notes**	**Source**
2020	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2021	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2022	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2023	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2024	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2025	TERP	Statewide	NO_x reduced by 598 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2026	TERP	Statewide	NO_x reduced by 534 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2027	TERP	Statewide	NO_x reduced by 482 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2028	TERP	Statewide	NO_x reduced by 482 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2029	TERP	Statewide	NO_x reduced by 324 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2030	TERP	Statewide	NO_x reduced by 149 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2031	TERP	Statewide	NO_x reduced by 149 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2032	TERP	Statewide	NO_x reduced by 149 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf

*Note: only the NO_x and VOC reductions were used in the development of future emissions estimates for this report.