Eastern Research Group, Inc.

GROWTH FACTORS FOR AREA AND POINT SOURCES

Final

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division
MC-164, P.O. Box 13087
Austin, TX 78711-3087

September 27, 2016

ERG No. 0345.00.008.006
TCEQ Contract No. 582-15-50416
Work Order No. 582-16-62576-08

GROWTH FACTORS FOR AREA AND POINT SOURCES

Final

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division
MC-164, P.O. Box 13087
Austin, TX 78711-3087
Attn: Mr. Greg Lauderdale

Prepared by:

Eastern Research Group, Inc.
8950 Cal Center Drive, Suite 325
Sacramento, CA 95826

June 30, 2016

TABLE OF CONTENTS

Section **Page**

ES.0 EXECUTIVE SUMMARY 1
1.0 INTRODUCTION 2
2.0 COLLECTED DATA 4
2.1 Economy.com Economic Data and Projections 4
2.2 Texas Industrial Production Index 4
2.3 Annual Energy Outlook 5
2.4 EGAS Model – Surrogate Assignments 5
2.5 Railroad Commission of Texas 5
2.6 U.S. EPA Projections-Related Research 5
2.7 Other Data Sources 6
3.0 DEVELOPMENT OF POINT SOURCE GROWTH FACTORS 7
4.0 DEVELOPMENT OF AREA SOURCE GROWTH FACTORS 8
4.1 Economy.com Data 8
4.2 Annual Energy Outlook Data 8
4.3 Texas-Specific Population Projections 9
4.4 Constant/No Growth Factors 9
4.5 Development of Growth Factors 9
4.6 Adjustments 10
5.0 DATA ANALYSIS 12
6.0 FORMATTED GROWTH FACTORS 22
7.0 CAVEATS ASSOCIATED WITH USE OF GROWTH FACTORS 23
8.0 BACKCASTING FACTORS 24
9.0 REFERENCES 26
APPENDIX A DEVELOPMENT OF OIL AND GAS EXPLORATION AND PRODUCTION AREA SOURCE GROWTH FACTORS A-1
APPENDIX B POINT SOURCE SIC-TO-NAICS CROSSWALK AND GROWTH FACTOR SURROGATE ASSIGNMENTS B-1
APPENDIX C AREA SOURCE GROWTH FACTOR SURROGATE ASSIGNMENTS C-1

Tables **Page**

Table 5-1. Area Source SCC Categories – State-level Totals 13
Table 5-2. Point Source SIC Categories – State-level Totals 13
Table 5-3. Area Source SCC Categories – Attainment Status-level, NO_x 13
Table 5-4. Area Source SCC Categories – Attainment Status-level, CO 14
Table 5-5. Area Source SCC Categories – Attainment Status-level, VOC 14
Table 5-6. Point Source SIC Categories – Attainment Status-level, NO_x 15
Table 5-7. Point Source SIC Categories – Attainment Status-level, CO 15
Table 5-8. Point Source SIC Categories – Attainment Status-level, VOC 15
Table 5-9. Top Five Area Source SCC Categories – NO_x in Nonattainment Counties 17
Table 5-10. Top Five Area Source SCC Categories – NO_x in Special Inventory Counties 17
Table 5-11. Top Five Area Source SCC Categories – VOC in Nonattainment Counties 18

Table 5-12. Top Five Area Source SCC Categories – VOC in Special Inventory Counties 18
Table 5-13. Top Five Point Source SIC Categories – NO_x in Nonattainment Counties 19
Table 5-14. Top Five Point Source SIC Categories – NO_x in Special Inventory Counties 19
Table 5-15. Top Five Point Source SIC Categories – VOC in Nonattainment Counties ... 20
Table 5-16. Top Five Point Source SIC Categories – VOC in Special Inventory Counties 20

ACRONYMS

AEO	*Annual Energy Outlook*
BBL	barrel
BBO	billion (10^9) barrels of oil
BCF	billion (10^9) cubic feet
BTU	British thermal unit
CCTFT	Clean Coal Technology Foundation of Texas
CO	carbon monoxide
CPP	Clean Power Plan
EGAS	Economic Growth Analysis System
EIA	Energy Information Administration
EIIP	Emission Inventory Improvement Program
ERCOT	Electric Reliability Council of Texas
ERG	Eastern Research Group, Inc.
EUR	Estimated Ultimate Recovery
INGAA	Interstate Natural Gas Association of America
MBO	thousand barrels of oil
MCF	thousands cubic feet
mi^2	square miles
NAAQS	National Ambient Air Quality Standard
NAICS	North American Industry Classification System
NGSA	Natural Gas Supply Association
NO_x	nitrogen oxides
RA	Rocky Mountain Power Area
RRC	Railroad Commission of Texas
SERC	Southeastern Electric Reliability Council
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SPE	Society of Petroleum Engineers
SPP	Southwest Power Pool
STARS	State of Texas Air Reporting System
TCC	Texas Chemical Council
TCEQ	Texas Commission on Environmental Quality
TCF	trillion (10^{12}) cubic feet

TexAER	Texas Air Emissions Repository
TIPI	Texas Industrial Production Index
TRR	Technically Recoverable Resources
TSDC	Texas State Data Center
TXOGA	Texas Oil and Gas Association
URR	Ultimately Recoverable Resources
U.S. EPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

ES.0 EXECUTIVE SUMMARY

Eastern Research Group, Inc. (ERG) completed the development of a comprehensive suite of growth factors for point and area sources. The growth factors were based upon a base year of 2014 and were developed for each year between 2015 and 2050. Various demographic and economic data were used to develop the growth factors, including, but not limited to: energy projections from the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook*, economy forecasts from Economy.com, and Texas-specific population projections. In addition, analysis was conducted to investigate growth factor variances.

The developed growth factors were submitted to the Texas Commission on Environmental Quality (TCEQ) along with the final report. The point source growth factors and associated data were provided in Microsoft Excel/Access database format as approved by the TCEQ. The area source growth factors and associated data were provided in text files in Texas Air Emissions Repository (TexAER) loadable format, as well as in a Microsoft Access database. The area source growth factors in TexAER loadable format were uploaded into the TexAER system successfully as a user test.

1.0 INTRODUCTION

Emission inventories are a core component of air quality analyses. Inventories are used to estimate the quantity of emissions generated by a range of source types (i.e., point sources, area sources, on-road motor vehicles, nonroad mobile sources, and natural sources) and pollutants (i.e., criteria air pollutants, hazardous air pollutants, and greenhouse gases). Inventories are used as inputs to air quality models for simulating air quality concentrations based on base case and/or control scenarios for determining future-year compliance with federal National Ambient Air Quality Standards (NAAQS) within State Implementation Plans (SIPs).

The TCEQ uses base year inventories and future year projections to develop SIPs. In general, future year inventory projections are estimated by applying growth and control factors to base year emissions. Over time, growth factors must be reassessed and, if necessary, revised.

This project is the latest of several Texas-specific growth factor development projects that have been conducted. In 2005, ERG developed an initial suite of area source growth factors through 2020 (and backcasting factors for years dating back to 1990) based upon a 2002 base year (ERG, 2006). ERG conducted a follow-up project in 2010 that resulted in the development of point and area source growth factors for 2006 through 2035 based upon a 2005 base year (ERG, 2010). ERG also conducted another related project in 2012 that specifically focused on growth factors for the oil and gas exploration and production sectors (ERG, 2012).

As part of the 2010 project, point source and area source growth factors were primarily developed using data and model inputs from the following sources:

- Output projections from Economy.com;
- Energy projections from *Annual Energy Outlook (AEO)* published by the EIA; and
- Population projections from the Texas State Demographer.

As part of the 2012 oil and gas project, area source growth factors for oil and gas exploration and production were developed using historical oil, gas, and condensate production data and several different projection methodologies. Upon completion of the analysis, a methodology known as the Hubbert's Method was deemed the most appropriate to employ for purposes of growth factor development for the oil and gas sector for areas with hydraulically fractured wells.

The purpose of the current project is the development of growth factors for calendar years 2015 through 2050 based upon a 2014 base year. This project builds upon the methods and data developed for the previous projects.

The remainder of this report describes in detail the steps involved with developing the Texas county-level point and area source growth factors. The report includes the following sections:

- Section 2.0 describes the collection of data used to develop the point and area source growth factors;
- Section 3.0 explains the development of the point source growth factors;
- Section 4.0 explains the development of the area source growth factors;
- Section 5.0 briefly describes the data analysis that was conducted comparing future year inventories, as well as previously estimated growth factors;
- Section 6.0 explains the final growth factor formatting;
- Section 7.0 identifies a number of important caveats associated with the use of growth factors;
- Section 8.0 explains the development of the 2011 area source backcasting factors;
- Section 9.0 lists all references used in the development of the point and area source growth factors;
- Appendix A provides a detailed description of the methodology used to develop oil and gas exploration and production area source growth factors;
- Appendix B presents the point source SIC-to-NAICS crosswalk and growth factor surrogate assignments; and
- Appendix C presents the area source growth factor surrogate assignments.

2.0 COLLECTED DATA

In support of the development of point source and area source category growth factors, data were collected from a number of sources. As indicated in the project work plan, ERG obtained and analyzed data from the following sources: Economy.com economic data and projections, the Texas Industrial Production Index (TIPI), the 2016 *AEO*, and the surrogate assignments from the Economic Growth Analysis System (EGAS) model. For the oil and gas sector, ERG also obtained and analyzed historical oil and gas production data from the Railroad Commission of Texas (RRC) and growth factors from the 2012 oil and gas project.

2.1 Economy.com Economic Data and Projections

Historical economic data and future year economic projections were purchased from Moody's Economy.com in March 2016. The Economy.com future year projections are recalibrated each month based upon the most recent monthly economic indicators. As a result, economic changes are gradually reflected over time in the future year projections. The particular data set purchased from Economy.com was county-level gross product expressed in millions of constant 2009 dollars for 2-, 3-, and 4-digit North American Industry Classification System (NAICS) codes; Economy.com also provided additional gross product data for aggregated NAICS groupings for different types of economic activity that cross over multiple NAICS code (e.g., Office-Using Industries, IT-Using Industries, Manufacturing of Durable Goods) (Economy.com, 2016). Product output data were obtained rather than employment, earnings, or value added data, since both the U.S. Environmental Protection Agency (U.S. EPA) and the Emission Inventory Improvement Program (EIIP) have indicated that the use of product output as a growth indicator is preferable to these other measures of growth (EIIP, 1999).

2.2 Texas Industrial Production Index

The project work plan identified the Texas Industrial Production Index (TIPI) as a potential source of growth data. The TIPI was previously examined in the 2010 projection factor project; however, the TIPI was discontinued soon after that project (in August 2010) by the Federal Reserve Bank of Dallas. Economy.com suggested that the Manufacturing Production Index from the Texas Manufacturing Outlook Survey be used as a replacement information source (Economy.com, 2011). The Texas Manufacturing Outlook Survey maintains monthly historical data dating back to June 2004; however, a brief review of the Texas Manufacturing Outlook Survey confirmed that no projections data are available (FRB, 2016). As a result, no data from TIPI or the Texas Manufacturing Outlook Survey were used to develop growth factors for this project.

2.3 Annual Energy Outlook

The EIA annually publishes the *AEO*. The *AEO* provides sector-specific consumption projections, as well as production projections, at the regional level. The most recent version of the *AEO* was an early release 2016 version (released May 17, 2016) with projections out to 2040 that addressed two different scenarios: a "reference case" (i.e., a baseline trend estimate with given known technology and technological and demographic trends, including implementation of the Clean Power Plan [CPP]), and a "no CPP" case (i.e., a baseline trend estimate, which differs from the reference case by assuming that CPP is not implemented) (EIA, 2016a). The final release of the 2016 *AEO* is scheduled for July 7, 2016. All relevant energy projections were included in the early release 2016 *AEO*; the final release 2016 *AEO* is expected to provide additional detailed documentation. U.S. EPA staff previously working on emission projections have indicated that *AEO* is considered to be a reliable source of projections data for combustion sources (Chappell and Bollman, 2008; Chappell, 2010).

2.4 EGAS Model – Surrogate Assignments

Although the Economic Growth Analysis System (EGAS) model was not directly used to calculate growth factors, the surrogate assignments of the EGAS Version 5.0 model were previously reviewed as part of the 2010 projection factor project. However, it should be noted that the EGAS model was officially retired by U.S. EPA in July 2013 (U.S. EPA, 2016).

2.5 Railroad Commission of Texas

The RRC publishes monthly oil and gas production data for each county in Texas. These product-specific data include production of gas well gas, gas from oil wells (casinghead gas), oil, and condensate. As described in Appendix A, production data for every county in Texas were compiled for 2000 through January 2016 to assist in the development of growth factors for the processes and operations associated with upstream oil and gas exploration and production (RRC, 2016).

2.6 U.S. EPA Projections-Related Research

The project work plan indicated that any U.S. EPA research into the relationship of energy- and non-energy-based emissions and the potential for growth factor development would also be investigated.

During the 2007-2008 time frame, U.S. EPA analyzed a long-held fundamental assumption that economic growth is an appropriate surrogate for emissions growth by conducting a sector-level analysis of energy (i.e., combustion) emissions versus non-energy (i.e.,

process) emissions for 10 key industries. At the time of the 2010 projection factors project (ERG, 2010), this analysis was reportedly undergoing internal U.S. EPA review. However, it does not appear that the results of this analysis were ever publicly released.

Most recently, U.S. EPA has documented the projections methods used to develop the 2017 and 2025 future year inventories for the 2011 Emissions Modeling Platform (U.S. EPA, 2015). U.S. EPA staff have indicated that the projections methods outlined in the *Technical Support Document for the 2011 Emissions Modeling Platform* should not be considered as official guidance, but may provide useful information related to the projections of emission inventories (Eyth, 2016). Much of the information in the *Technical Support Document for the 2011 Emissions Modeling Platform* addresses controls and is specifically focused on U.S. EPA's future years of 2017 and 2025.

2.7 Other Data Sources

As part of the previous 2010 growth factors project (ERG, 2010), ERG also contacted a number of other sources, including government agencies and industry associations. The contacted industry associations included the following: Texas Energy Group, Texas Alliance of Energy Producers, Society of Petroleum Engineers (SPE), Texas Oil and Gas Association (TXOGA), Texas Chemical Council (TCC), Clean Coal Technology Foundation of Texas (CCTFT), Natural Gas Supply Association (NGSA), and Interstate Natural Gas Association of America (INGAA). Only a few of these sources had any growth factor information. In some cases, the sources were not willing to share their growth factor information citing confidentiality considerations; in other cases, the provided growth factor information had insufficient detail associated with geographic location, time series duration, or coverage of source categories. No useable growth factor information was obtained from these other government agencies and trade associations as part of the 2010 growth factor development project. Additional inquiries conducted under the current project found that it was unlikely that these sources have produced any new growth factor information that could be incorporated into this project's results.

3.0 DEVELOPMENT OF POINT SOURCE GROWTH FACTORS

Based upon previous experience with developing point source growth factors for the 2010 project, ERG developed growth factors for every point source Standard Industrial Classification (SIC) code currently contained in the TCEQ's State of Texas Air Reporting System (STARS).

After analyzing the collected data, the specific growth factor data assignments for point source SICs were developed. These data assignments are presented in Appendix B. Because the Economy.com data were presented in terms of NAICS and the TCEQ requested SIC-level growth factors, a NAICS-to-SIC crosswalk was necessary. ERG reviewed an initial crosswalk provided by TCEQ staff (Muldoon, 2016a). In general, the TCEQ's NAICS-to-SIC assignments in the crosswalk were appropriate and reasonable, but ERG revised a few assignments, which are noted as footnotes in Appendix B.

For each point source SIC, ERG developed county-level growth factors using the Economy.com output data and the following equation:

$$GF_{s,c,y} = \frac{Out_{s,c,y}}{Out_{s,c,2014}}$$

Where:

$GF_{s,c,y}$	=	Growth factor for SIC s, county c, and year y;
$Out_{s,c,y}$	=	Output for SIC s, county c, and year y; and
$Out_{s,c,2014}$	=	Output for SIC s, county c, and year 2014.

4.0 DEVELOPMENT OF AREA SOURCE GROWTH FACTORS

An initial list of the area source Source Classification Codes (SCCs) contained in the TCEQ's TexAER system was obtained from TCEQ staff (Lauderdale, 2016a). The initial SCC list contained 371 unique area source SCCs. Along with the initial SCC list, TCEQ's 2014 area source emissions inventory was also obtained from TCEQ staff (Lauderdale, 2016b). After comparing the SCCs in the initial list with the SCCs in the 2014 area source inventory, ERG identified a single SCC (i.e., 2501055120 – Total evaporative losses from gasoline bulk plants) from the 2014 inventory that was not included in the initial area source SCC list. In addition, ERG identified 15 SCCs (all related to onshore oil and gas activities) that were included in the 2012 project to develop growth factors for oil and gas sources but were not included in the initial area source SCC list. ERG added these 16 additional SCCs to the initial SCC list to develop a comprehensive area source SCC list for TCEQ, containing a total of 387 SCCs.

A comprehensive listing of all area source categories included in the TCEQ's area source inventory is presented in Appendix C. ERG's assignment of growth factor surrogates to specific area source categories was initially based upon the assignments previously developed for the 2010 growth factor development project; however, all assignments were reviewed for appropriateness. Some notes regarding the data used for area source growth factor surrogates are provided below.

4.1 Economy.com Data

Economy.com gross product data were obtained at the 2-, 3-, and 4-digit NAICS level (Economy.com, 2016). Wherever possible, 4-digit NAICS data were used, but if unavailable, then 2- or 3-digit NAICS data were used.

4.2 Annual Energy Outlook Data

The consumption data from *AEO* were not available at the state-level; instead, consumption data for the West South Central census division (i.e., Arkansas, Louisiana, Oklahoma, and Texas) were used (EIA, 2016a). Given the relative size of Texas consumption activity compared to the other three states, the application of data from the West South Central census division to Texas is reasonable.

Offshore production data were available from *AEO* for crude oil production (in units of million barrels per day) and natural gas production (in units of trillion dry cubic feet). Combined crude oil and natural gas production data were calculated by converting both crude oil production and natural gas production to a common British thermal unit (BTU) basis using

representative heat contents. In addition, *AEO* onshore crude production data and offshore crude production data were combined to develop total crude production estimates for 2014 to 2040.

4.3 Texas-Specific Population Projections

The most recent Texas-specific population projections were obtained from the Texas State Demographer at the Texas State Data Center (TSDC) (TSDC, 2014). Compared to other types of activity data used for area source projections, population projections are considered to be among the most accurate. This accuracy is due to birth and death rates being fairly well quantified. In addition, birth and death rates usually have considerable demographic inertia and do not change significantly from year to year. The uncertainty of population projections is primarily due to immigration. The population projections used in this study represent the "One-Half 2000-2010 Migration (0.5) Scenario" which is prepared as an approximate average of the "Zero Migration (0.0) Scenario" (i.e., net migration is zero) and the "2000-2010 Migration (1.0) Scenario" (i.e., continuation of the 2000 to 2010 migration rates into the future). The Texas State Demographer has indicated that the "0.5 scenario continues to be the most appropriate scenario for most counties for use in long-term planning."

4.4 Constant/No Growth Factors

For some source categories, a constant/no growth factor (i.e., 1.0000) was assigned. These included a number of categories that either were not expected to vary significantly from year to year or where appropriate activity data could not be reasonably assigned. Some examples included forest wildfires, catastrophic/accidental releases, and ammonia emissions from wild animals. A constant/no growth factor was also assigned to all of the agricultural source categories (SCC 2801xxxxxx) and livestock ammonia categories (SCC 2805xxxxxx). This assignment was made because total agricultural acreage does not significantly change over time. In addition, various types of livestock vary from year to year, but these variations are often cyclical in nature and are in response to market forces. As a result, a flat factor was also assigned to the livestock ammonia categories.

4.5 Development of Growth Factors

After analyzing the collected data, specific data assignments for each area source category were developed. These data assignments are presented in Table 4-1.

ERG used data from Economy.com, *AEO*, and population estimates to develop the area source growth factors. The equation used to develop point source growth factors (presented in

Section 3.0) incorporated output projections from Economy.com, energy projections from *AEO*, and population projections to develop area source growth factors for sectors other than onshore oil and gas. A detailed discussion of the methodology used to develop onshore oil and gas exploration and production area source growth factors is provided in Appendix A.

4.6 Adjustments

The area source growth factors were reviewed and a number of adjustments were made, including but not limited to:

- Economy.com gross product data for some categories in certain counties for the base year 2014 were zero. This resulted in a "#DIV/0!" error in the calculation of future year growth factors. In these cases, ERG set the growth factor value to 1.00 (i.e., no growth scenario).

- Population projections data were available through 2050, but Economy.com gross product data were only available through the year 2045. Similarly, *AEO* consumption data (by fuel, by sector) and production data (onshore and offshore oil and gas) were only available through 2040. In these cases, ERG extrapolated data to 2050 (from 2046 to 2050 in case of Economy.com data and from 2041 to 2050 in case of *AEO* data) using linear extrapolation based on data from the later years of the time-series. ERG reviewed the time series data from Economy.com (2014-2045) and from *AEO* (2014-2040). In both cases, the 2014-2020 data exhibited variability, while the data from 2025 onwards were approximately linear with comparably less variability year to year. Therefore, ERG used 2025-2045 data to linearly extrapolate Economy.com data up to year 2050 and similarly used 2025-2040 data to linearly extrapolate *AEO* data to year 2050.

- Economy.com gross product data resulted in very high growth factors (i.e., greater than 4.00) for some categories in certain counties (mainly small rural counties). The highest calculated growth factor was 83. In most of these cases, the base year 2014 gross product value was very low. In the case of growth factor value of 83, the 2014 gross product value was 0.01 (i.e., $10,000) and the 2045 gross product value was 0.83 (i.e., $830,000) and the resulting growth factor for 2045 was 83. In such cases where the 2014 gross product data was less than $1 million, ERG used county-level "Total GDP" data as a surrogate. Economy.com data consisted of a "Total GDP" category for each county which is a summation of all gross product value for each county (i.e., NAICS 1XX thru NAICS 9XX).

- For NAICS 2211 (Electricity Generating Units), data were available from both Economy.com and from *AEO*. Economy.com data consists of gross product for the electric power generation, transmission, and distribution segments. The *AEO* data consisted of power generation projections by fuel type for coal, petroleum, and natural gas. The *AEO* data were projected for individual electricity market module regions – the primary region covering most counties is the Electric Reliability Council of Texas (ERCOT); however, the Southwest Power Pool (SPP) covers portions of the Panhandle and northeast Texas, the Southeastern Electric Reliability Council (SERC) covers portions of east Texas, and the Rocky Mountain Power Area (RA) includes far west Texas. ERG could not use the fuel-

based *AEO* data for developing annual growth factors at the SIC level, since SIC codes do not contain information on fuel types. After consultation with TCEQ, it was decided to develop three different profiles for each of the four electricity market module regions, based on fuel type (i.e., coal, petroleum fuels, and natural gas). The preliminary growth factors developed under Task 2 were initially based upon 2015 *AEO* data (EIA, 2015a); however, the Early Release 2016 *AEO* data were published on May 17, 2016. Based on consultation with TCEQ, it was decided to replace the 2015 *AEO* data with the Early Release 2016 *AEO* data (including both the CPP and no CPP scenarios). ERG then obtained a listing of the Texas counties that are located within each of the four electricity market module regions (ERCOT, SPP, SERC, and RA) (Texas Almanac, 2012). ERG mapped each county to its corresponding electricity market module region, resulting in three different profiles for each county based on fuel type (coal, petroleum fuels, and natural gas).

5.0 DATA ANALYSIS

After developing preliminary growth factors for Texas point and area sources as described in Sections 3.0 and 4.0, ERG conducted two types of data analysis under Task 3 (Data Analysis). Information gained from these analyses were used to quality assure the preliminary growth factors.

The first analysis applied the compiled growth factors to the point source and area source 2014 base year emissions inventories (provided by TCEQ and used "as is" with no changes) to develop future year emissions inventories for 2017, 2026, 2029, 2032, and 2050. ERG analyzed the future emissions inventories by comparing and contrasting differences between the 2014 base year inventory and the five future year inventories. The analysis included comparisons at the following levels of disaggregation: statewide, county, attainment status area (i.e., attainment, ozone nonattainment, and ozone precursor special inventory counties), SIC (for point sources only), and SCC (for area sources only).

Based on conversations with TCEQ project staff, it was decided to limit the analysis to nitrogen oxides (NO_x), volatile organic compounds (VOC), and carbon monoxide (CO). The analysis identified the top five SCC and SIC codes (excluding SIC 4911 [Electric Services]) that had the greatest and least emissions variation expressed in units of tons per day and percent change. ERG calculated the difference between the 2014 base year emissions inventory and the five future year inventories in a spreadsheet and submitted these to TCEQ for review. Tables 5-1 through 5-8 show the source categories with the highest increase in emissions, by pollutant (based on the 2014-2050 difference in emissions, TPD, and % change), at the state-level and attainment status-level for area and point sources.

Based upon TCEQ staff's review of the analysis results, the following revision was made to the point source projection factors:

- For NAICS 4226 (Special Warehousing and Storage) point sources, replacement of Economy.com output data for NAICS 4931 (Warehousing and Storage) with output data for NAICS 4247 (Petroleum and Petroleum Products Merchant Wholesalers).
- For SICs 1311 (Crude Petroleum and Natural Gas) and 1321 (Natural Gas Liquids), the original growth factors were based on Economy.com output data for NAICS 2111 (Oil and Gas Extraction). Based on discussions with TCEQ staff, growth factor profiles developed for area source SCC 2310000000 (Oil and Gas Exploration and production – Total, All Processes) were used to develop the final growth factors (2015-2050) for point source SICs 1311 and 1321.

Since these updates were made after TCEQ staff's review of the Task 3 analysis results, these changes are not reflected in Tables 5-1 through 5-8.

Table 5-1. Area Source SCC Categories – State-level Totals

SCC	Description	Pollutant	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2102005000	Industrial fuel combustion – Residual oil	NO_x	10.5	324.4%
2610000500	Open burning – Land clearing debris, except logging debris	CO	74.1	67.3%
2102005000	Industrial fuel combustion – Residual oil	CO	0.9	324.4%
2401050000	Surface coating – Miscellaneous finished metals, total all solvent types	VOC	83.7	110.9%
2515040000	Organic chemical transport – Pipelines, total all products	VOC	12.7	366.5%

Table 5-2. Point Source SIC Categories – State-level Totals

SIC	Description	Pollutant	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	NO_x	90.5	229.6%
3672	Printed circuit boards	NO_x	0.004	854.1%
3241	Cement, hydraulic	CO	65.9	182.2%
3672	Printed circuit boards	CO	0.004	854.1%
2869	Industrial organic chemicals, NEC	VOC	46.1	117.4%
3672	Printed circuit boards	VOC	0.3	854.1%

Table 5-3. Area Source SCC Categories – Attainment Status-level, NO_x

SCC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2102005000	Industrial fuel combustion – Residual oil	Attainment areas	2.6	324.4%
2102005000	Industrial fuel combustion – Residual oil	Ozone non-attainment areas	5.7	324.4%
2102005000	Industrial fuel combustion – Residual oil	Ozone special inventory counties	2.3	324.4%

Table 5-4. Area Source SCC Categories – Attainment Status-level, CO

SCC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2610000500	Open burning – Land clearing debris, except logging debris	Attainment areas	8.0	29.5%
2102005000	Industrial fuel combustion – Residual oil	Attainment areas	0.2	324.4%
2610000500	Open burning – Land clearing debris, except logging debris	Ozone non-attainment areas	38.8	79.1%
2102005000	Industrial fuel combustion – Residual oil	Ozone non-attainment areas	0.5	324.4%
2610000500	Open burning – Land clearing debris, except logging debris	Ozone special inventory counties	27.4	80.6%
2102005000	Industrial fuel combustion – Residual oil	Ozone special inventory counties	0.2	324.4%

Table 5-5. Area Source SCC Categories – Attainment Status-level, VOC

SCC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2461850000	Commercial products – Pesticides – Herbicides, all processes	Attainment areas	15.2	29.1%
2401065000	Surface coating – Electronic and other electrical, total all sovent types	Attainment areas	0.2	344.3%
2401050000	Surface coating – Miscellaneous finished metals, total all solvent types	Ozone non-attainment areas	59.2	138.5%
2401065000	Surface coating – Electronic and other electrical, total all sovent types	Ozone non-attainment areas	0.5	454.4%
2401050000	Surface coating – Miscellaneous finished metals, total all solvent types	Ozone special inventory counties	13.7	81.7%
2102005000	Industriall fuel combustion – Residual oil	Ozone special inventory counties	0.01	324.4%

Table 5-6. Point Source SIC Categories – Attainment Status-level, NO_x

SIC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	Attainment areas	74.2	211.5%
3299	Nonmetallic mineral products	Attainment areas	0.2	408.1%
2869	Industrial organic chemicals, NEC	Ozone non-attainment areas	47.0	138.5%
3672	Printed circuit boards	Ozone non-attainment areas	0.004	854.1%
3241	Cement, hydraulic	Ozone special inventory counties	62.9	238.8%
4619	Pipelines, NEC	Ozone special inventory counties	0.7	961.6%

Table 5-7. Point Source SIC Categories – Attainment Status-level, CO

SIC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	Attainment areas	25.3	244.6%
3299	Nonmetalic mineral products	Attainment areas	0.8	408.1%
2869	Industrial organic chemicals, NEC	Ozone non-attainment areas	32.7	144.5%
3672	Printed circuit boards	Ozone non-attainment areas	0.004	854.1%
3241	Cement, hydraulic	Ozone special inventory counties	47.3	212.7%
4619	Pipelines, NEC	Ozone special inventory counties	0.4	961.6%

Table 5-8. Point Source SIC Categories – Attainment Status-level, VOC

SIC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	Attainment areas	13.0	238.0%
3299	Nonmetallic mineral products	Attainment areas	0.2	408.1%
2869	Industrial organic chemicals, NEC	Ozone non-attainment areas	29.3	142.7%
3672	Printed circuit boards	Ozone non-attainment areas	0.3	854.1%
2869	Industrial organic chemicals, NEC	Ozone special inventory counties	15.9	102.7%
4619	Pipelines, NEC	Ozone special inventory counties	0.3	961.6%

The second data analysis compared the growth factors developed in previous projects (ERG, 2010; ERG, 2012). The analysis tested the performance of growth factors developed in these projects against actual historical emission trends. The analysis was limited to VOC and NO_x emissions within the ozone nonattainment and ozone precursor special inventory counties. In addition, the analysis focused on the top five SCC categories for VOC and NO_x for area sources and the top five SIC categories (excluding SIC 4911 [Electric Services]) for VOC and NO_x for point sources.

The current 2014 Texas point and area source inventory, along with the historical 2008 and 2011 Texas point and area source inventories, were provided by TCEQ staff (Muldoon, 2016b; Lauderdale, 2016b). ERG identified the top five area source SCC categories and the top five point source SIC categories by summing up the individual 2014 SCC/SIC VOC and NO_x emission totals for the 16 ozone nonattainment counties (i.e., Brazoria, Chambers, Dallas, Denton, Ellis, Fort Bend, Galveston, Harris, Johnson, Liberty, Montgomery, Parker, Rockwall, Tarrant, Waller, and Wise counties) and the 21 ozone precursor special inventory counties (i.e., Bastrop, Bexar, Caldwell, Comal, El Paso, Gregg, Hardin, Harrison, Hays, Henderson, Hood, Jefferson, McLennan, Nueces, Orange, Rusk, San Patricio, Smith, Upshur, Victoria, and Wilson counties). Based on the screening of the 2014 area source inventories, the top five area source SCC categories are presented in Tables 5-9 through 5-12. Likewise, based on the screening of the 2014 point source inventories, the top five point source SIC categories are presented in Tables 5-13 through 5-16. In Tables 5-9 through 5-16, 2014 actual inventory NO_x and VOC emissions were compared against 2014 projected NO_x and VOC emissions. The 2014 projected emissions were developed using 2008 base year inventories (Lauderdale, 2016b; Muldoon, 2016b) combined with projection factors developed under a previous project (ERG, 2010). Tables 5-9 through 5-16 present both actual and projected emissions for the ozone nonattainment counties and the ozone precursor special inventory counties. The difference of emissions (i.e., projected relative to actual) is also included in terms of tons per year and percentage.

Table 5-9. Top Five Area Source SCC Categories – NO_x in Nonattainment Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2102006000	Industrial Fuel Combustion – Natural Gas	5,113.8	5,412.3	298.5	5.8%
2104006000	Residential Fuel Combustion – Natural Gas	4,644.6	4,236.6	-408.0	-8.8%
2103006000	Commercial/Institutional Fuel Combustion – Natural Gas	3,803.5	3,848.0	44.5	1.2%
2310021302	On-Shore Gas Production – Natural Gas-Fired 4-Cycle Rich Burn Compressor Engines (50 to 499 HP)	3,562.2	38,785.2	35,223.0	988.8%
2102007000	Industrial Fuel Combustion – Liquefied Petroleum Gas (LPG)	999.7	367.2	-632.5	-63.3%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-10. Top Five Area Source SCC Categories – NO_x in Special Inventory Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2310021302	On-Shore Gas Production – Natural Gas-Fired 4-Cycle Rich Burn Compressor Engines (50 to 499 HP)	6,607.6	7,760.1	1,152.5	17.4%
2104006000	Residential Fuel Combustion – Natural Gas	2,652.9	2,353.7	-299.2	-11.3%
2310000330	Oil and Gas Exploration and Production – Artificial Lift (Pumpjack)	2,618.7	4,205.8	1,587.2	60.6%
2102006000	Industrial Fuel Combustion – Natural Gas	1,960.7	2,128,4	167.8	8.6%
2103006000	Commercial/Institutional Fuel Combustion – Natural Gas	1,794.2	2,018.9	224.7	12.5%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-11. Top Five Area Source SCC Categories – VOC in Nonattainment Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2401050000	Surface Coating – Miscellaneous Finished Metals	15,608.1	15,608.2	0.1	0.0%
2460100000	Consumer/Commercial Products – All Personal Care Products	12,381.7	10,470.6	-1,911.0	-15.4%
2401001000	Surface Coating – Architectural Coatings	12,251.8	16,369.8	4,118.0	33.6%
2460200000	Consumer/Commercial Products – All Household Products	11,730.0	9,920.9	-1,809.1	-15.4%
2460800000	Consumer/Commercial Products – All FIFRA-Related Products	11,599.7	9,810.5	-1,789.2	-15.4%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-12. Top Five Area Source SCC Categories – VOC in Special Inventory Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2310021010	On-Shore Gas Production – Condensate Storage Tanks (including Flash)	18,013.9	110,096.0	92,082.1	511.2%
2310011020	On-Shore Oil Production – Crude Tanks (including Flash)	8,527.2	13,268.0	4,740.8	55.6%
2310011450	On-Shore Oil Production – Wellhead	6,922.5	8,427.0	1,504.5	21.7%
2501060101	Gasoline Service Stations – Stage 2 Displacement Loss (Uncontrolled)	6,897.4	6,897.5	0.1	0.0%
2460100000	Consumer/Commercial Products – All Personal Care Products	6,317.0	5,455.0	-861.9	-13.6%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-13. Top Five Point Source SIC Categories – NO_x in Nonattainment Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	12,399.3	16,148.8	3,749.4	30.2%
2911	Petroleum Refining	7,706.6	9,450.5	1,743.8	22.6%
1311	Crude Petroleum and Natural Gas	3,319.5	4,985.8	1,666.3	50.2%
3241	Cement (Hydraulic)	3,210.2	11,855.8	8,654.6	269.3%
1321	Natural Gas Liquids	1,812.2	2,815.9	1,003.7	55.4%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-14. Top Five Point Source SIC Categories – NO_x in Special Inventory Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	11,710.7	12,894.7	1,184.0	10.1%
2911	Petroleum Refining	9,901.2	13,079.0	3,177.7	32.1%
3241	Cement (Hydraulic)	9,619.0	14,817.8	5,198.8	54.0%
1321	Natural Gas Liquids	2,853.9	3,447.5	593.6	20.8%
4922	Natural Gas Transmission	1,089.1	1,681.2	592.1	54.4%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-15. Top Five Point Source SIC Categories – VOC in Nonattainment Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	7,481.9	11,961.2	4,479.4	59.9%
2911	Petroleum Refining	7,317.8	10,996.6	3,678.9	50.3%
1311	Crude Petroleum and Natural Gas	4,195.3	9,210.9	5,015.6	119.6%
4226	Special Warehousing and Storage (Not Elsewhere Classified)	2,660.4	3,972.6	1,312.2	49.3%
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2,137.8	3,689.3	1,551.5	72.6%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-16. Top Five Point Source SIC Categories – VOC in Special Inventory Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2911	Petroleum Refining	7,650.8	8,632.5	981.8	12.8%
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	5,650.3	6,046.2	395.8	7.0%
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	1,839.7	2,213.6	373.9	20.3%
2822	Synthetic Rubber (Vulcanizable Elastomers)	1,695.0	1,987.8	292.8	17.3%
1311	Crude Petroleum and Natural Gas	886.3	773.2	-113.1	-12.8%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

The area source and point source calculations and results were submitted to TCEQ in Excel spreadsheet format (area_2008-2014_top5_analysis_ 052516.xlsx and point_2008-2014_top5_analysis_052516.xlsx).

In Tables 5-9 through 5-16, a positive difference represents the situation where the projected emissions were greater than the actual emissions. A likely reason for this is that the projection factor simply represents growth, while the actual emissions are subject to control devices, regulatory controls, facility closures, facility maintenance and repairs, etc., which will tend to reduce actual emissions. Conversely, a negative difference in Tables 5-9 through 5-16 represents the situation where the projected emissions were less than the actual emissions; a potential reason for this may include the use of a growth factor surrogate that does not adequately represent growth behavior with a particular source. Finally, a zero or neglible difference in Tables 5-9 through 5-16 most likely represents a situation where the actual inventory was generated using the growth factors developed during the previous project (ERG, 2010).

Another issue that should be noted with the growth factors from the previous project was that the point and area source growth factors were developed in 2010 for the years 2006 through 2035 based upon a 2005 base year. At that time, the growth factor surrogates from Economy.com and *AEO* were likely a bit more uncertain due to the severity of the recession of 2007 through 2009, as well as the subsequent recovery.

6.0 FORMATTED GROWTH FACTORS

The final step of the project was the development of the formatted growth factors under Task 4 (Develop Formatted Growth Factors) of the project scope. The formatted growth factors were submitted to the TCEQ along with the final report. ERG provided the growth factors and associated data in Microsoft Access and Excel format for point sources. For area sources, ERG provided the growth factors in TexAER loadable format input file as well as in Microsoft Access format, with all fields complete and all mandatory fields quality assured.

ERG also conducted an upload test of the area source TexAER input file and corrected all errors identified during the upload. During the upload the TexAER system flagged 15 SCCs as "Not Valid." All 15 SCCs were related to onshore oil and gas operations and were identified as not included in TCEQ's area source SCC list under Task 2 of this project (refer to Section 4.0). These 15 SCCs are:

- 2310000230
- 2310011600
- 2310021011
- 2310021310
- 2310021410
- 2310021411
- 2310021601
- 2310021602
- 2310021604
- 2310021605
- 2310021700
- 2310030230
- 2310030300
- 2310030400
- 2310030401

7.0 CAVEATS ASSOCIATED WITH USE OF GROWTH FACTORS

Although a comprehensive suite of point and area source growth factors were developed under this project, there are a number of caveats that should be considered when using these growth factors to develop projected emission inventories. These caveats include the following:

- Growth factors developed under this project do not account for the effects of future controls (e.g., regulation control, rule effectiveness, rule penetration, fuel switching, technology improvements, etc.). As part of the development of future emissions, the effects of controls should also be considered.
- Growth factors developed under this project are based upon the most recent data projections available (i.e., spring/summer 2016) from Economy.com, *AEO*, Texas state demographics, etc. In the future, these data projections will be updated based upon newly available data and/or revised projections. Therefore, as these growth factors "age" over time, increased care and consideration should be exercised when using them.
- Growth factors developed under this project were developed relative to a 2014 base year. Use of these growth factors for a base year other than 2014 requires the use of growth factor ratioing. For instance, the 2019 growth factor for a 2016 base year inventory would be the ratio of the 2019 growth factor (2014 base year) divided by the 2016 growth factor (2014 base year).
- Growth factors developed under this project were based upon national- or regional-level data that were extrapolated to individual counties. Care should be exercised when applying growth factors to point sectors with a small number of facilities or area source categories in smaller counties. Local conditions (e.g., new construction, expansion, closings, etc.) may not be accurately represented. Information regarding local "on-the-ground" conditions should take precedence over this project's growth factors.
- Growth factors developed under this project may not fully represent short-term and/or regional disruptions, such as economic recessions, natural disasters, commodity price changes, etc. The full effect of these events typically takes time to permeate through the data projections.
- Growth factors developed under this project are intended to be used to project future year emissions estimates at the county- or regional-level. The factors should not be used to project future year emissions estimates for individual sites or sources.

8.0 BACKCASTING FACTORS

An additional task to develop county-level area source backcasting factors for 2011 was added to this project after project initiation (i.e., Task 7). The backcasting factors were developed for all area source categories that were previously identified under Task 2. Under Task 4, growth factors for the future years of 2015 through 2050 were developed for 388 SCCs. ERG's assignment of growth factor surrogates to specific area source categories was based upon the assignments previously developed under Task 2 and revised under Task 3; these assignments are presented in Appendix C. The backcasting factors were developed using similar historical data that were used to develop the future year growth factors (i.e., population, energy consumption, and economic statistics). For each area source SCC, ERG developed county-level backcasting factors using the relevant surrogate data and the following equation:

$$BF_{s,c} = \frac{Out_{s,c,2011}}{Out_{s,c,2014}}$$

Where:

$BF_{s,c}$	=	2011 Back casting factor for SCC *s*, and county *c*;
$Out_{s,c,2011}$	=	Output for SCC *s*, county *c*, and year *2011*; and
$Out_{s,c,2014}$	=	Output for SCC *s*, county *c*, and year 2014.

Some notes additional notes regarding the data used for area source backcasting factor surrogates are provided below:

- Historical 2011 Economy.com gross product data were obtained at the 2-, 3, and 4-digit NAICS level (Economy.com, 2016). Wherever possible, 4-digit NAICS data were used, but if unavailable, then 2- or 3-digit NAICS data were used.
- Historical state-level energy consumption data were obtained from the EIA (EIA, 2015b; EIA, 2015c; EIA, 2015d; EIA, 2016b; EIA, 2016c; EIA, 2016d; EIA, 2016e; EIA, 2016f; EIA, 2016g; EIA, 2016h).
- Historical population estimates were obtained from the Texas State Demographer at the Texas State Data Center (TSDC) (TSDC, 2014).

Backcasting factors were developed for the nonpoint oil- and gas-related SCCs using the 2011 to 2014 ratio of oil, gas, or condensate production (or well counts as appropriate) for the Barnett Shale, Haynesville Shale, Eagle Ford Shale, and Permian Basin plays. Production and well count data were obtained from the Railroad Commission of Texas (RRC) for the years 2000 through January 2016 (RRC, 2016). The resultant backcasting factors for each play and commodity type were then assigned to each SCC based on the use of oil, gas, or condensate production or well counts as a scaling variable. For example, the ratio of 2011 to 2014 oil

production was used as the scaling variable for SCC 2310011020 "On-Shore Oil Production /Storage Tanks: Crude Oil". Table A-24 in Appendix A identified the scaling variable (i.e., oil, gas, or condensate production or well counts) used to assign the backcasting factors to each SCC. Tables 8-1 and 8-2 show the final oil and gas backcasting factors developed using the methodology described above for production and well counts, respectively, for each commodity and play.

Table 8-1. Final Oil, Gas, and Condensate Production Backcasting Factors

	Barnett			Eagle Ford			Haynesville			Permian			Statewide		
Year	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.
2011	1.168	1.110	0.430	0.120	0.440	0.245	0.938	1.048	0.851	0.617	0.781	0.253	0.711	0.845	0.445

Table 8-2. Final Oil and Gas Well Count Backcasting Factors

	Barnett		Eagle Ford		Haynesville		Permian		Statewide	
Year	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas	Oil	Gas
2011	0.971	0.913	0.576	0.815	1.057	1.010	0.812	1.029	0.854	0.942

Values in Tables 8-1 and 8-2 less than 1 indicate a higher level of activity in 2014 than in 2011, while values greater than 1 indicate a higher level of activity in 2011 than in 2014. As with the growth factors developed for the 2015-2050 period, backcasting factors for counties in Texas outside of the four study areas were estimated by averaging oil, gas, and condensate growth factors across each of the four study areas for each commodity. Note that there are no condensate wells in Table 8-2 as all condensate is produced at gas wells.

After development of the 2011 backcasting factors at the county-level and by SCC, ERG developed and submitted a Microsoft Access database that contains the results. In addition, ERG also developed and submitted to TCEQ an input file in TexAER loadable format. The TexAER input file containing the 2011 backcasting factors was developed in a similar fashion as the 2015-2050 growth factor file was developed under Task 4. Since the format and file structure was tested under Task 4 of this project by conducting a successful test upload with the TexAER system, ERG did not duplicate the test upload for Task 7.

9.0 REFERENCES

Chappell, 2010. Personal communication between Linda Chappell (U.S. EPA) and Marty Wolf (ERG). June 11.

Chappell, L.M. and A. Bollman, 2008. *Improving EPA Emissions Forecasts*. Presentation presented at the 17th Annual Emission Inventory Conference, Portland, Oregon. June 4. Internet address: https://www3.epa.gov/ttnchie1/conference/ei17/session6/ chappell_pres.pdf

Economy.com, 2011. "Discontinued Data: U.S. – Texas IPI". Data News and Information. Moody's Economy.com, West Chester, Pennsylvania. March 31. Internet address: https:// www.economy.com/support/blog/buffet.aspx?did=6B1AAE17-FEE6-41D0-BFA3-40411BA047D4

Economy.com, 2016. Texas county-level historical data and future year projections. Moody's Economy.com, West Chester, Pennsylvania. March 16.

EIA, 2015a. *Annual Energy Outlook 2016 with Projections to 2040*. DOE/EIA-0383(2015). U.S. Energy Information Administration. April 14. Internet address: http://www.eia.gov/ forecasts/archive/aeo15/

EIA, 2015b. *State Energy Data System (SEDS): 1960-2013 (Complete)*. U.S. Energy Information Administration. July 24. Internet address: http://www.eia.gov/state/seds/ seds-data-complete.cfm?sid=US

EIA, 2015c. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Jet Fuel*. U.S Energy Information Administration. October 23. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2015d. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Motor Gasoline*. U.S Energy Information Administration. December 18. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2016a. *Annual Energy Outlook 2016 Early Release: Annotated Summary of Two Cases*. DOE/EIA-0383er(2016). U.S. Energy Information Administration. May 17. Internet address: http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf

EIA, 2016b. Petroleum & Other Liquids Statistics. U.S. Energy Information Administration. Internet address: http://www.eia.gov/petroleum/data.cfm#crude

EIA, 2016c. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Distillate Fuel Oil*. U.S Energy Information Administration. January 29. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2016d. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Residual Fuel Oil*. U.S Energy Information Administration. January 29. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2016e. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Kerosene*. U.S Energy Information Administration. January 29. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2016f. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Liquefied Petroleum Gases*. U.S Energy Information Administration. March 25. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2016g. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Natural Gas*. U.S Energy Information Administration. February 19. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIA, 2016h. *State Energy Data System (SEDS): 2014 (Updates by Energy Source) – Wood and Biomass Waste*. U.S Energy Information Administration. April 29. Internet address: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

EIIP, 1999. *Emission Projections*. Volume X. Emission Inventory Improvement Program. December.

ERG, 2006. *Development of County-Level Growth Factors for 1990 through 2020*. Prepared for the Texas Commission on Environmental Quality (TCEQ) by Eastern Research Group, Inc. (ERG), Sacramento, California. February.

ERG, 2010. *Projection Factors for Point and Area Sources*. Final Report. Prepared for the Texas Commission on Environmental Quality (TCEQ) by Eastern Research Group, Inc. (ERG), Sacramento, California. August 16.

ERG, 2012. *Forecasting Oil and Gas Activities*. Final Report. Prepared for the Texas Commission on Environmental Quality (TCEQ) by Eastern Research Group, Inc. (ERG), Morrisville, North Carolina. August 31.

Eyth, 2016. Personal communication between Alison Eyth (U.S. EPA) and Marty Wolf (ERG). April 20.

FRB, 2016. *Texas Manufacturing Outlook Survey*. Federal Reserve Bank of Dallas. Internet address: https://dallasfed.org/microsites/research/surveys/tmos/index.cfm.

Hubbert, M., 1956. "Nuclear energy and fossil fuels." In: Meeting of the Southern District, Division of Production, American Petroleum Institute. San Antonio, Texas: Shell Development Company.

Hubbert, M., 1980. "Techniques of prediction as applied to the production of oil and gas." In: Symposium on oil and gas supply modeling. Washington, D.C.: Department of Commerce, National Bureau of Standards.

Lauderdale, 2016a. Initial list of area source SCCs provided by Greg Lauderdale (TCEQ). March 9.

Lauderdale, 2016b. 2008, 2011, and 2014 Texas area source inventories provided by Greg Lauderdale (TCEQ). March.

Muldoon, 2016a. Initial SIC-NAICS crosswalk provided by Mark Muldoon (TCEQ). March 15.

Muldoon, 2016b. 2008, 2011, and 2014 Texas point source inventories provided by Mark Muldoon (TCEQ). March.

RRC, 2016. Production data. Railroad Commission of Texas, Oil and Gas Research and Statistics.

Texas Almanac, 2012. Map of Texas Electric Power Grids. Texas Almanac. Internet address: http://texasalmanac.com/topics/business/texas-electric-grids-demand-and-supply

TSDC, 2014. *Projections of the Population of Texas and Counties in Texas by Age, Sex and Race/Ethnicity for 2010-2050*. Texas State Data Center. The Office of the State Demographer. November.

U.S. EPA, 2015. *Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform*. Technical Support Document. U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Air Quality Assessment Division. August. Internet address: https://www.epa.gov/sites/production/ files/2015-10/documents/ 2011v6_2_2017_2025_emismod_tsd_aug2015.pdf

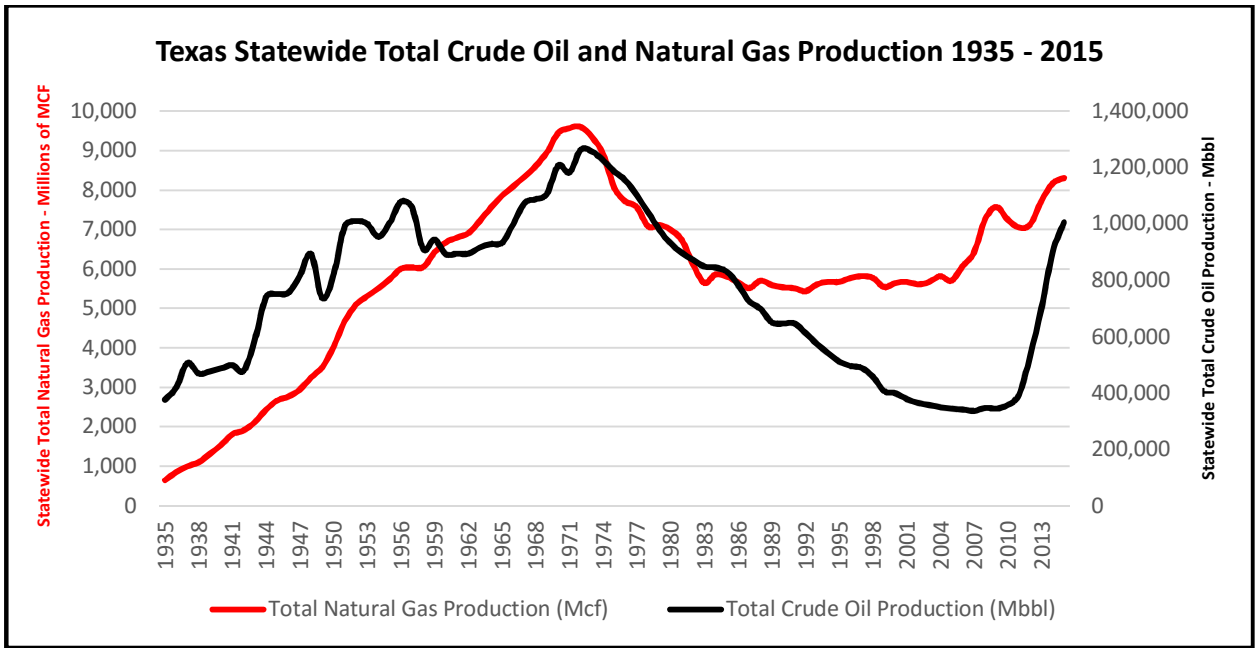
U.S. EPA, 2016. "Emission Growth Factors Models/Tools". U.S. Environmental Protection Agency, Technology Transfer Network, Economics and Cost Analysis Support. Internet address: https:// www3.epa.gov/ttn/ecas/gfmodels.html

APPENDIX A
DEVELOPMENT OF OIL AND GAS EXPLORATION AND PRODUCTION AREA SOURCE GROWTH FACTORS

A.0 DEVELOPMENT OF OIL AND GAS EXPLORATION AND PRODUCTION AREA SOURCE GROWTH FACTORS

The increasing use of horizontal drilling and hydraulic fracturing in the past 10 years has led to increases in the statewide production of oil and natural gas as shown in Figure A-1.

Figure A-1. Texas Statewide Oil and Gas Production, 1935 – 2015



The most significant production increases in the past ten years have occurred in four regions. These four regions are the Barnett, Haynesville, and Eagle Ford Shales; and the Permian Basin. Initially, the Barnett Shale in north-central Texas was the focal point of shale gas development, followed by an increase in gas development activity in the Haynesville Shale. More recently, horizontal drilling and hydraulic fracturing techniques have been used to develop the liquids-rich areas of the Eagle Ford Shale area in south-central Texas and in the Permian Basin in west Texas. These four areas currently account for approximately 80 to 90 percent of total oil, gas, and condensate production in Texas.

Area-specific growth factors were developed to forecast oil and gas activities for these four regions. Monthly production data were obtained from the Railroad Commission of Texas (RRC) for the years 2000 through January 2016 (RRC, 2016a). These data were obtained at the county level, and included gas well gas production in thousands of cubic feet per month (MCF/month), oil production in barrels per month (BBL/month), casinghead gas production in MCF/month, and condensate production in BBL/month. ERG segregated the monthly

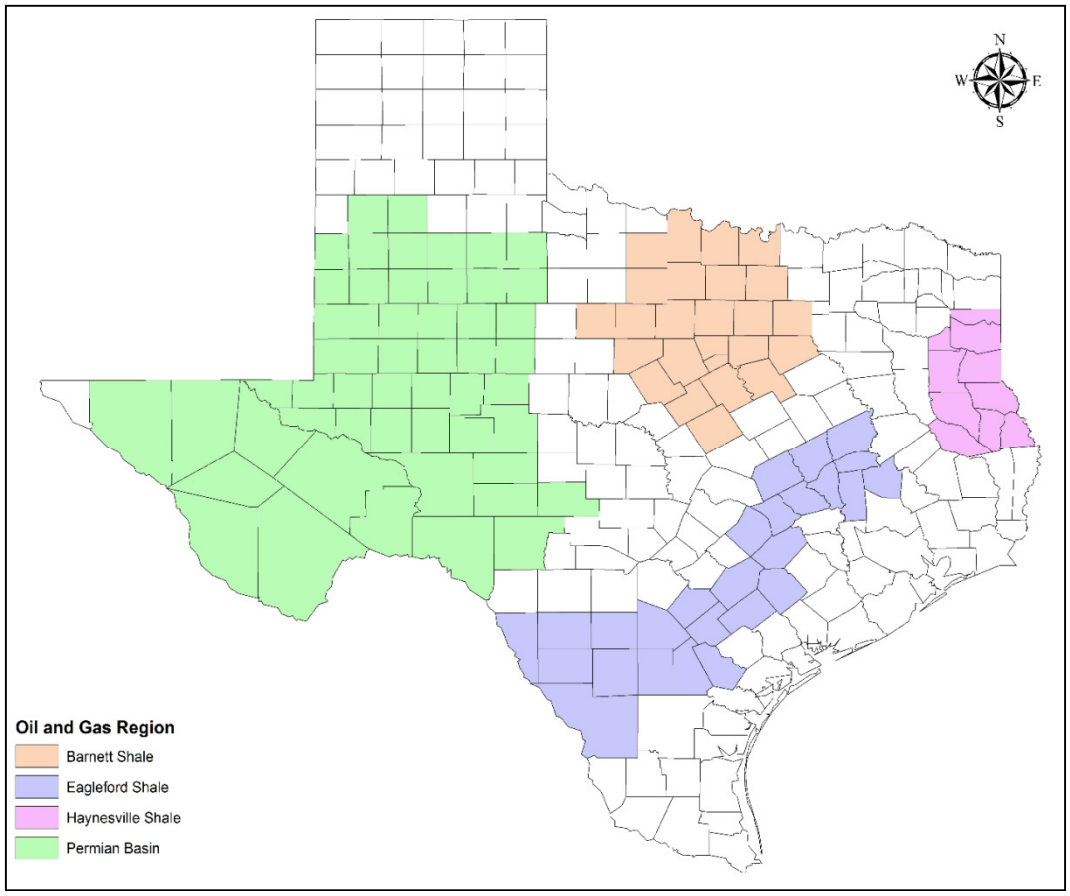
production data into four data sets based on the counties that compose the Barnett, Haynesville, Eagle Ford, and Permian regions, and used these data to project future production activity for oil, condensate, and gas based on Hubbert's model. Growth factors for Texas counties outside of the Barnett Shale, Haynesville Shale, Eagle Ford Shale, and Permian Basin plays were estimated using the average of the factors developed for these four areas.

Determining the growth factors depends upon an understanding of the geography, historical production, and estimates of recoverable oil and gas reserves in each of the four regions. Commodity prices also have an impact on oil and gas exploration and production activities. Information on current reserves and production trends are utilized in Hubbert's Model to forecast future production activity.

A.1 Oil and Gas Plays

Development of shale gas and shale (tight) oil across the United States has increased dramatically in the last 15 years due to technological advances in drilling and well completion activities. In particular, horizontal drilling and hydraulic fracturing have allowed for development of shale gas and tight oil deposits. Numerous counties in Texas compose the four oil and gas plays covered under this study as illustrated by Figure A-2. Additional details on each of these areas is provided below.

Figure A-2. Texas Oil and Gas Plays



Barnett Shale Gas Play

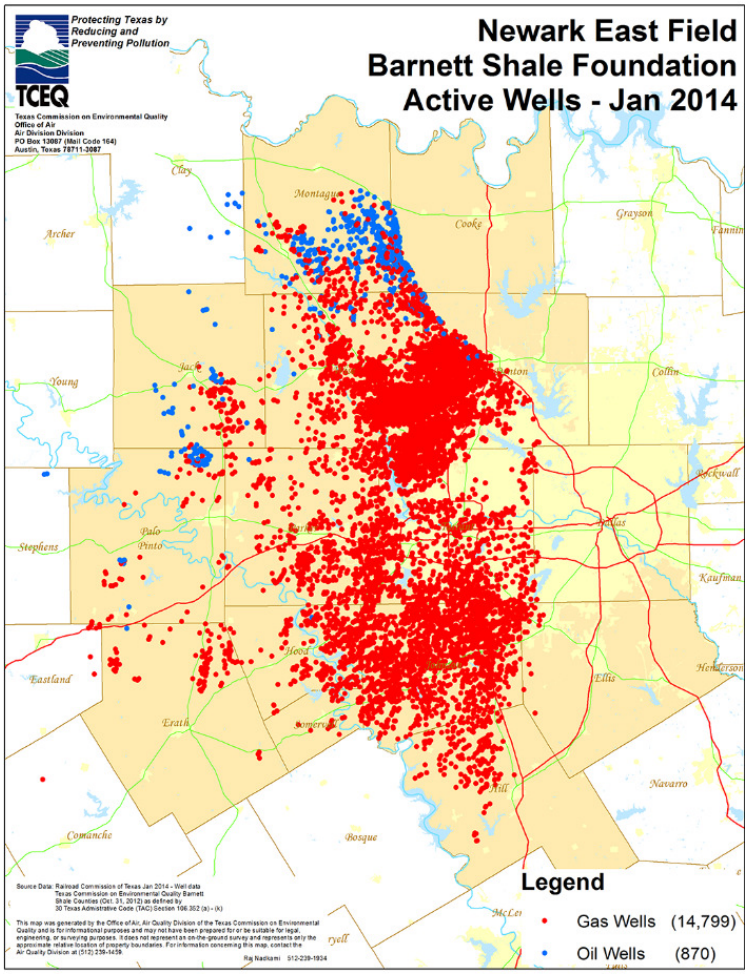
The Barnett Shale gas play is situated around the Dallas-Fort Worth metropolitan area and covers approximately 7,000 square miles (mi^2). Table A-1 identifies the 25 counties in Texas that comprise the Barnett Shale play region.

Table A-1. Texas Counties Comprising the Barnett Shale Gas Play Region

Archer	Denton	Hood	Shackelford
Bosque	Eastland	Jack	Somervell
Clay	Ellis	Johnson	Stephens
Comanche	Erath	Montague	Tarrant
Cooke	Hamilton	Palo Pinto	Wise
Coryell	Hill	Parker	Young
Dallas			

Figure A-3 shows the location of oil and gas wells in the Barnett Shale. The presence of oil wells in the northern and western areas of the Barnett Shale indicate wet gas formations, where hydrocarbon liquids may be found along with natural gas.

Figure A-3. Barnett Shale Gas Play, Fort Worth Basin, Texas



Production in the Barnett Shale play region began to increase around 2001 with the advent of horizontal drilling and hydraulic fracturing, with significant production increases seen in the region over the last ten years. The Barnett Shale play was the first area in Texas to experience increased development with these new drilling technologies.

A report by the U.S. Department of Energy, Energy Information Administration (EIA) reviewed key statistics and resource estimates for the Barnett Shale gas play (EIA, 2011; EIA, 2015a), which are listed in Table A-2 below.

Table A-2. Barnett Shale Gas Play Statistics and Resource Estimates

	Active	Undeveloped
Area (square miles)	4,075	2,383
Estimated Ultimate Recovery (BCF/well)	1.6	1.2
Well Spacing (wells/square mile)	5.5	8
Technically Recoverable Resources (TCF)	24.3	

BCF – billion cubic feet
TCF – trillion cubic feet

Eagle Ford Shale Oil and Gas Play

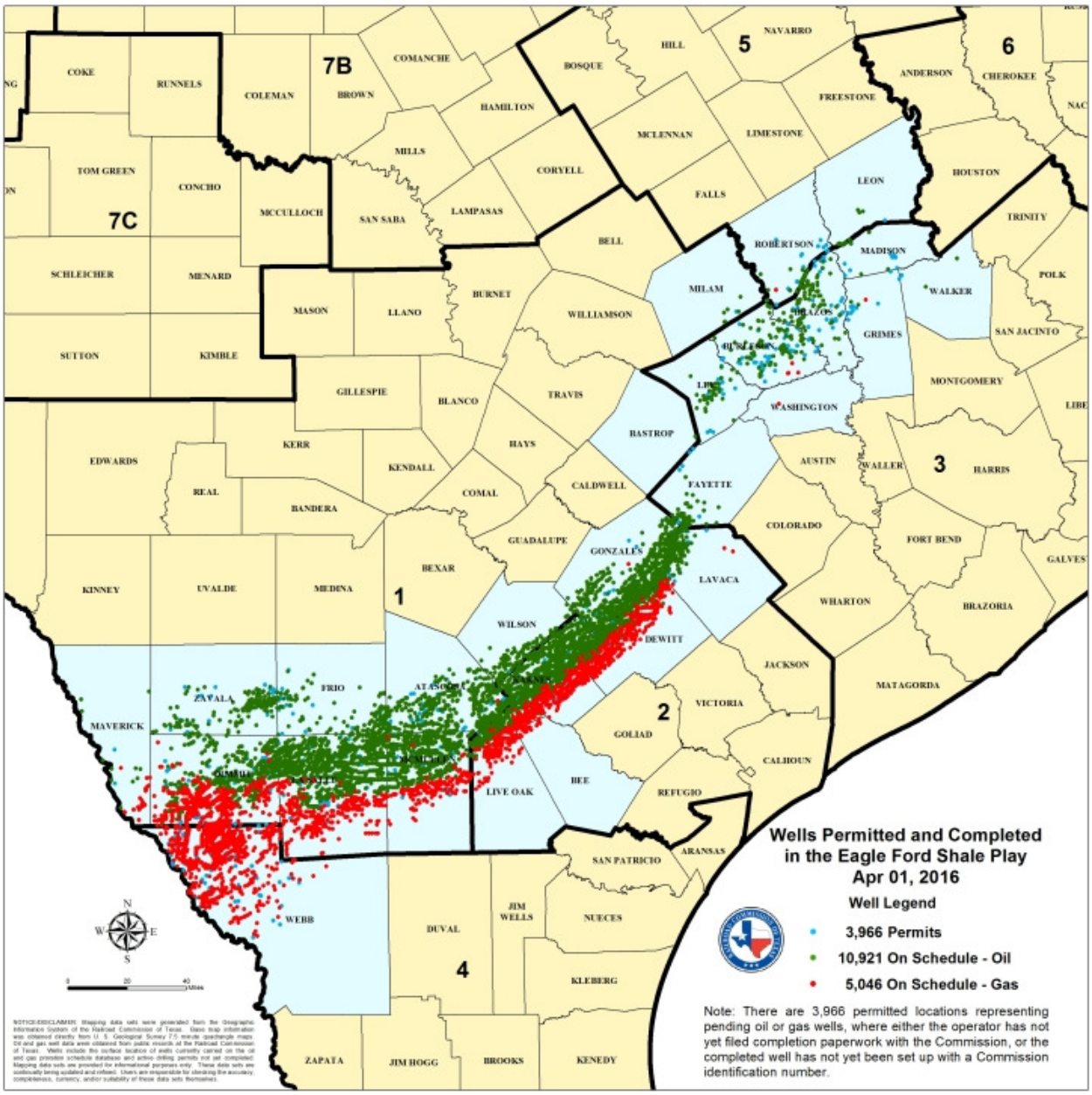
The Eagle Ford Shale is a hydrocarbon producing formation of significant importance due to its capability of producing gas, condensate, and more oil than other traditional shale plays. The Eagle Ford Shale is situated in south Texas and is roughly 50 miles wide and 400 miles long. The area of the dry gas zone is estimated at 200 mi^2; the area of the condensate zone is estimated at 890 mi^2; and the area of the oil zone is estimated at 2,233 mi^2. The Eagle Ford Shale is located in the Western Gulf basin within the RRC Districts 1 through 6. Table A-3 identifies the 26 counties in the Eagle Ford Shale region.

Table A-3. Texas Counties Comprising the Eagle Ford Shale Oil and Gas Play Region

Atascosa	Fayette	Lee	Milam
Bastrop	Frio	Leon	Robertson
Bee	Gonzales	Live Oak	Walker
Brazos	Grimes	Madison	Webb
Burleson	Karnes	Maverick	Wilson
De Witt	La Salle	McMullen	Zavala
Dimmit	Lavaca		

Figure A-4 shows the location of oil and gas wells in the Eagle Ford Shale; note the north to south trend changing from oil wells to gas wells.

Figure A-4. Eagle Ford Shale Oil and Gas Play, South Texas



Source: RRC, 2016a, http://www.rrc.state.tx.us/media/33182/eaglefordshaleplay2016-04-lg.jpg

The first of the Eagle Ford Shale wells was drilled in 2008, using horizontal drilling and multi-stage hydraulic fracturing. The number of wells drilled in this region has increased steadily since then. The number of producing gas wells has increased from 67 in 2009 to over 11,000 in 2016. The number of producing oil wells has increased from 40 in 2009 to over 18,000 in 2016.

A report by the EIA reviewed key statistics and resource estimates for the Eagle Ford Shale play, which are listed in Table A-4 below (EIA, 2011; EIA, 2015a).

Table A-4. Eagle Ford Shale Gas Play Statistics and Resource Estimates

	Dry Gas Zone	Condensate Zone	Oil Zone
Area (square miles)	200	890	2,233
Estimated Ultimate Recovery (BCF/well)	5.5	4.5	
Estimated Ultimate Recovery (MBO/well)			300
Well Spacing (wells/square miles)	4	8	5
Technically Recoverable Resources (BBO)	5.17		
Technically Recoverable Resources (TCF)	23.7		

BBO – billion barrels of oil
MBO – thousand barrels of oil

Haynesville Shale Gas Play

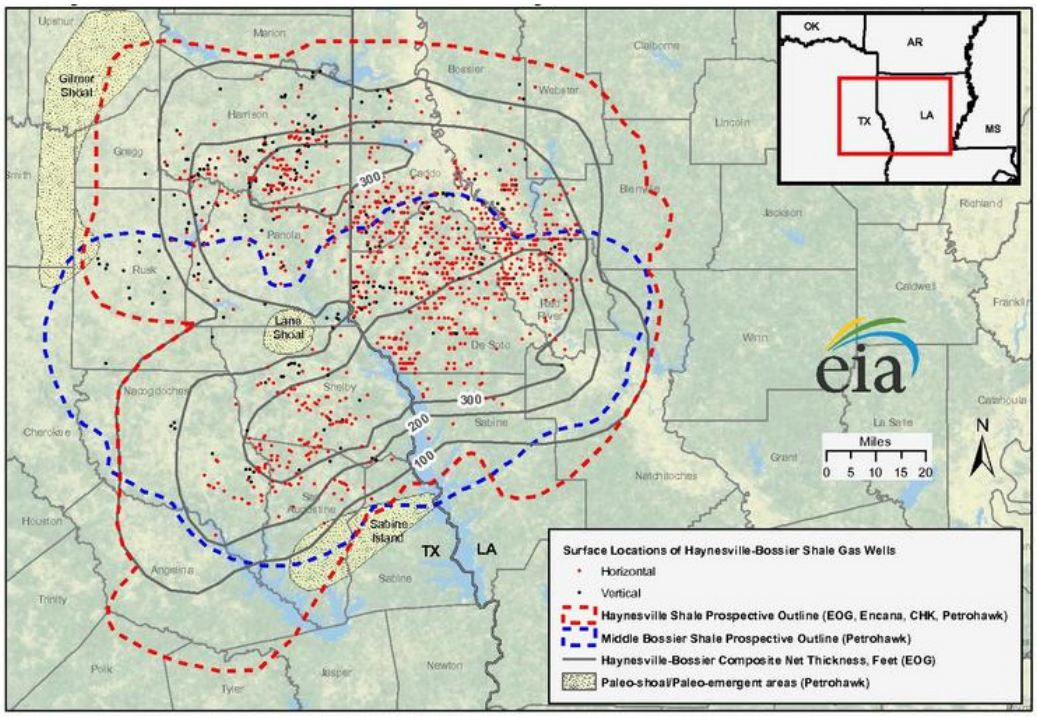
The Haynesville Shale gas play (also known as the Haynesville-Bossier Shale play), is located in east Texas and western Louisiana. The Haynesville Shale has a total area of approximately 9,000 square miles. Table A-5 identifies the 10 counties that compose the Texas portion of the Haynesville Shale play region.

Table A-5. Texas Counties Comprising the Haynesville Shale Gas Play Region

Angelina	Marion	Rusk	Shelby
Gregg	Nacogdoches	Sabine	
Harrison	Panola	San Augustine	

Figure A-5 shows the location of oil and gas wells in the Haynesville Shale.

Figure A-5. Haynesville Shale Gas Play, Eastern Texas



Source: Energy Information Administration based on data from HPDI, TX Railroad Commission, LA Dept. of Natural Resources, Operators.
Updated May 26, 2011

Production in the Haynesville Shale play region has doubled in the past ten years with the introduction of directional drilling and hydraulic fracturing techniques and the higher natural gas prices which occurred from 2005 to 2008 (over $5 per thousand cubic feet [MCF]). The combination of these factors made extraction of the gas economically feasible. With the recent decline in natural gas prices, drilling activity and production have been curtailed. Key statistics and resource estimates from the EIA for the Haynesville Shale gas play are listed in Table A-6 below (EIA, 2011; EIA, 2015a).

Table A-6. Haynesville Shale Gas Play Statistics and Resource Estimates

	Active	Undeveloped
Area (square miles)	3,574	5,426
Estimated Ultimate Recovery (BCF/well)	6.5	1.5
Well Spacing (wells/square miles)	8	8
Technically Recoverable Resources (TCF)	53.30	19.41

Permian Basin Oil Play

The Permian Basin oil play is located in West Texas and Eastern New Mexico and is approximately 250 miles wide and 300 miles long. It is the largest crude oil producing region in the

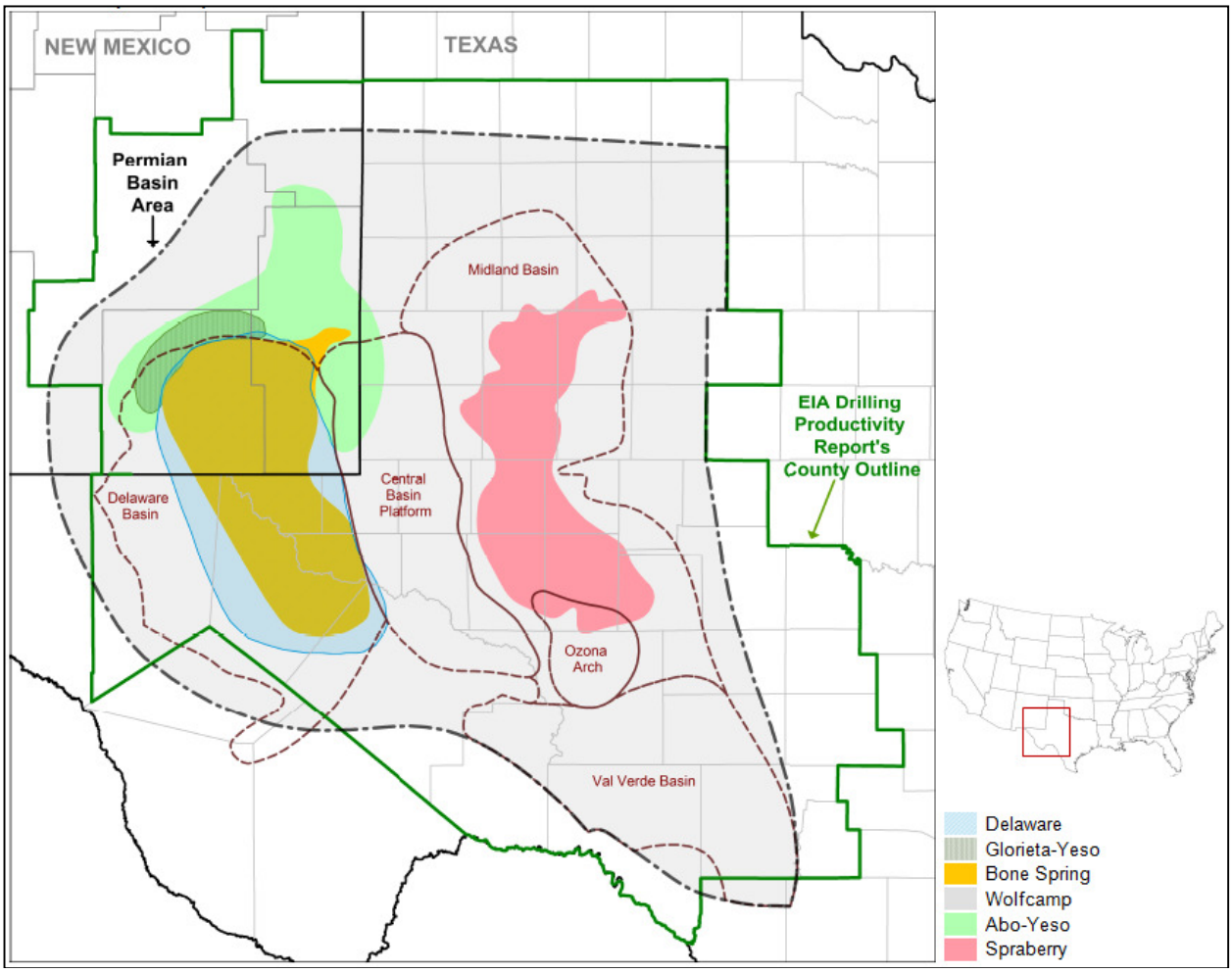
United States with an estimated production of over 1,300,000 barrels per day in 2013. The Permian Basin covers a large geographic area and is comprised of a large number of oil and gas-bearing formations of varying porosity and depth. The majority of the increase in oil production in the Permian Basin since 2007 has come from development of six low-porosity (tight oil) formations (i.e., the Spraberry, Wolfcamp, Bone Spring, Glorieta, Yeso, and Delaware formations) (EIA, 2014a). Table A-7 identifies the 51 counties in Texas that compose the Texas portion of the Permian Basin oil play region.

Table A-7. Texas Counties Comprising the Permian Basin Oil Play Region

Andrews	Hale	Pecos
Borden	Hockley	Presidio
Brewster	Howard	Reagan
Cochran	Hudspeth	Reeves
Coke	Irion	Schleicher
Crane	Jeff Davis	Scurry
Crockett	Kent	Sterling
Crosby	Kimble	Stonewall
Culberson	King	Sutton
Dawson	Lamb	Terrell
Dickens	Loving	Terry
Ector	Lubbock	Tom Green
Edwards	Lynn	Upton
Fisher	Martin	Val Verde
Gaines	Midland	Ward
Garza	Mitchell	Winkler
Glasscock	Nolan	Yoakum

Figure A-6 shows the location of the Permian Basin oil play and the primary producing formations.

Figure A-6. Permian Basin Oil Play, West Texas



Source: U.S. Energy Information Administration, 2014, https://www.eia.gov/todayinenergy/detail.cfm?id=17031

Oil production in the Permian Basin region has doubled in the past six years with the introduction of directional drilling and hydraulic fracturing techniques and spurred on by the higher oil prices which occurred from 2011 to 2014 (with prices over this time period often exceeding $100 per barrel). The combination of these factors made extraction of oil from the six tight oil plays in the Permian Basin economically feasible. With the recent decline in oil prices, drilling activity has been curtailed, while production continues near peak levels as existing wells continue to produce.

Key statistics and resource estimates from the EIA for the Permian Basin oil play are listed in Table A-8 below (EIA, 2014b, RRC, 2016b).

Table A-8. Permian Basin Oil Play Statistics and Resource Estimates

	Active	Undeveloped

Area (square miles)	58,250	
Number of Producing Wells	82,000	
Technically Recoverable Resources (BBO)	7.022	22

BBO – billion barrels of oil

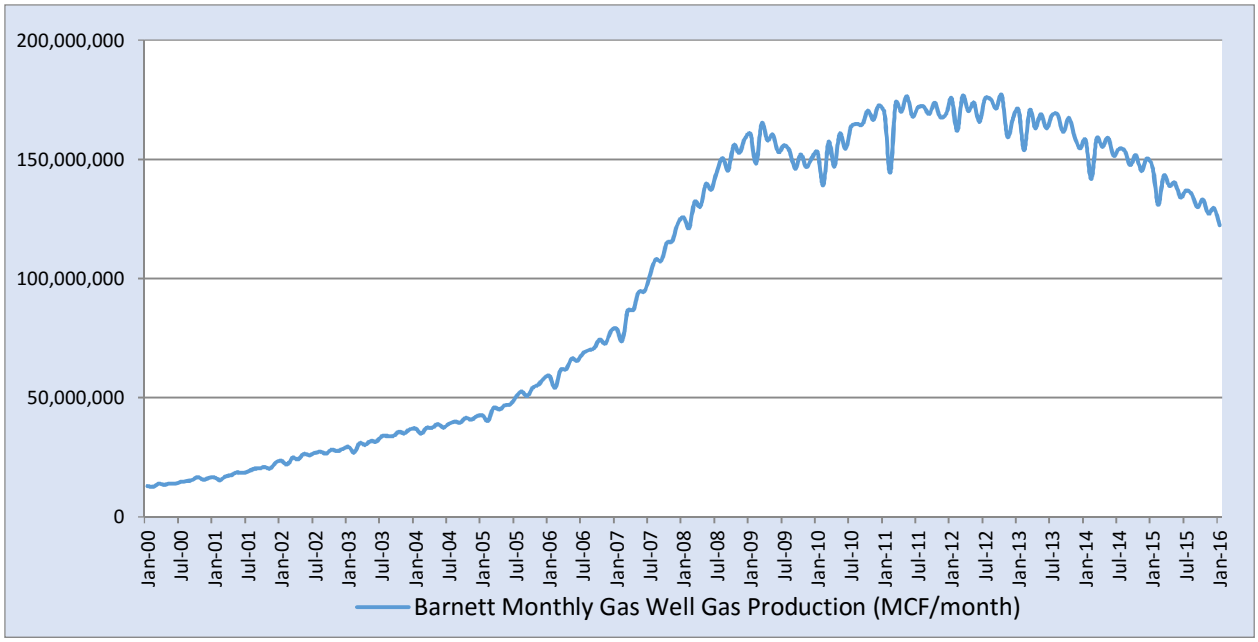
A.2 Historical Production

Historical monthly production data were obtained from the RRC for the years 2000 through January 2016. These data were obtained at the county level, and included gas well gas production (MCF/month), oil production (BBL/month), casinghead gas production (MCF/month), and condensate production (BBL/month). ERG segregated the monthly production data into four parts based on the listing of counties that compose the Barnett, Eagle Ford, and Haynesville Shale play regions and the Permian Basin oil play (see Tables A-1, A-3, A-5, and A-7, above).

Barnett Shale Gas Play

The Barnett Shale play is predominantly a gas well gas play. As shown in Figure A-7, total gas well gas production rates from all counties in the Barnett Shale play generally increased from around 2006 until the play reached its peak production in 2012. The highest gas well gas producing counties remain Tarrant and Johnson counties, but production in both counties is markedly diminished over the last few years, particularly in Johnson County where production is currently less than half what it was during its peak in 2011. The gas produced in the Barnett Shale is dry, so very little condensate is produced relative to the volume of gas.

Figure A-7. Barnett Shale Gas Play, Gas Production 2000 - 2016



Eagle Ford Shale Oil and Gas Play

The Eagle Ford Shale is unique among Texas shale plays in that it contains regions that are rich in oil, condensate, and gas. With the introduction of horizontal drilling and hydraulic fracturing in early 2008, production of both oil and condensate increased by a factor of 40 between 2009 and 2015 (see Figures A-8 and A-9), and as shown in Figure A-10, gas production nearly doubled between 2011 and 2015 when gas production in the Eagle Ford Shale matched the gas production from the Barnett Shale. Liquids production has decreased markedly since March 2015 with current oil and condensate production down over 25 percent in the last year.

Figure A-8. Eagle Ford Shale, Condensate Production 2000 - 2016

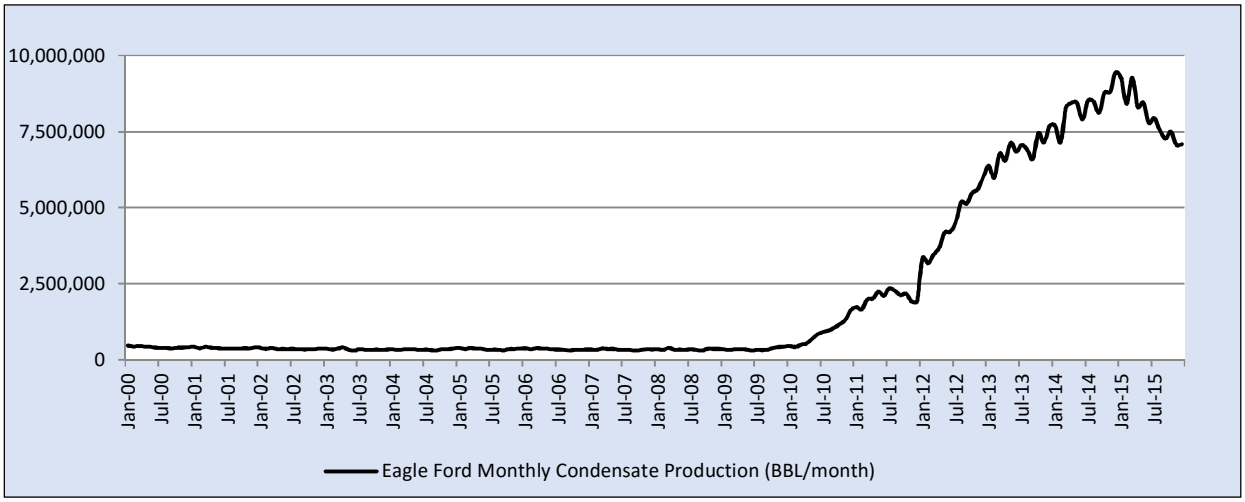


Figure A-9. Eagle Ford Shale, Oil Production 2000 - 2016

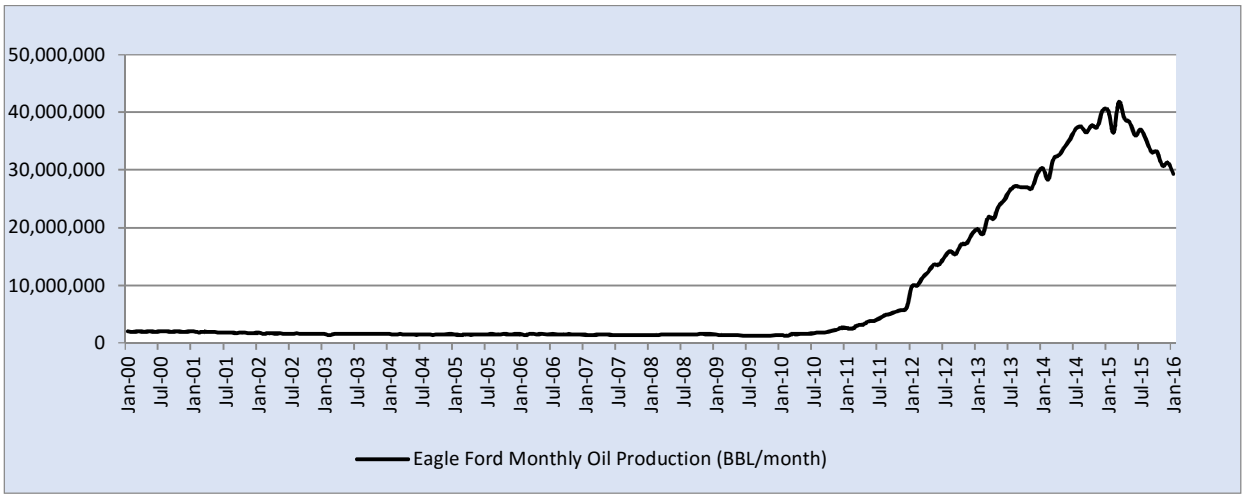
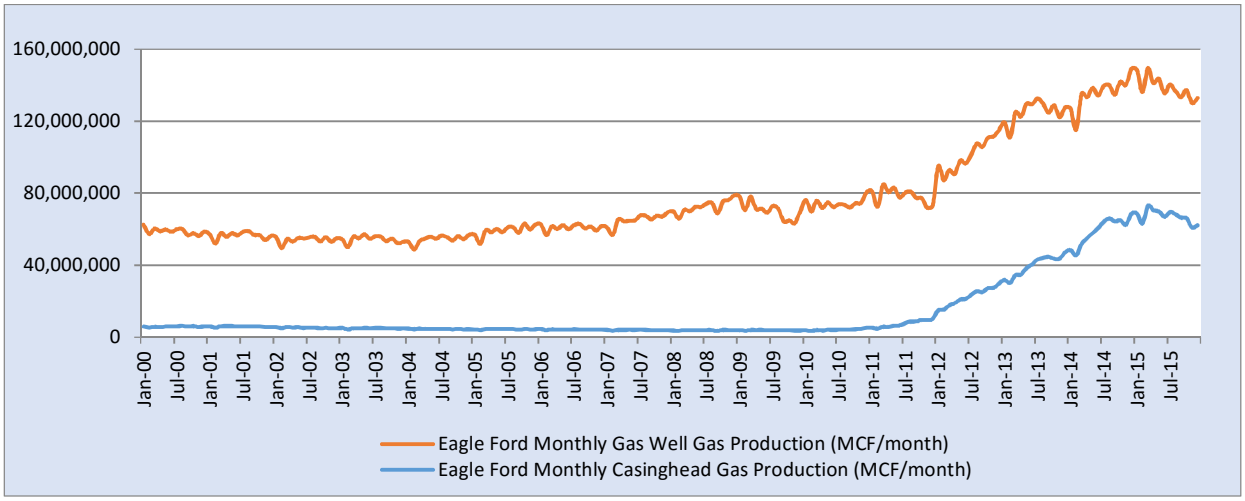


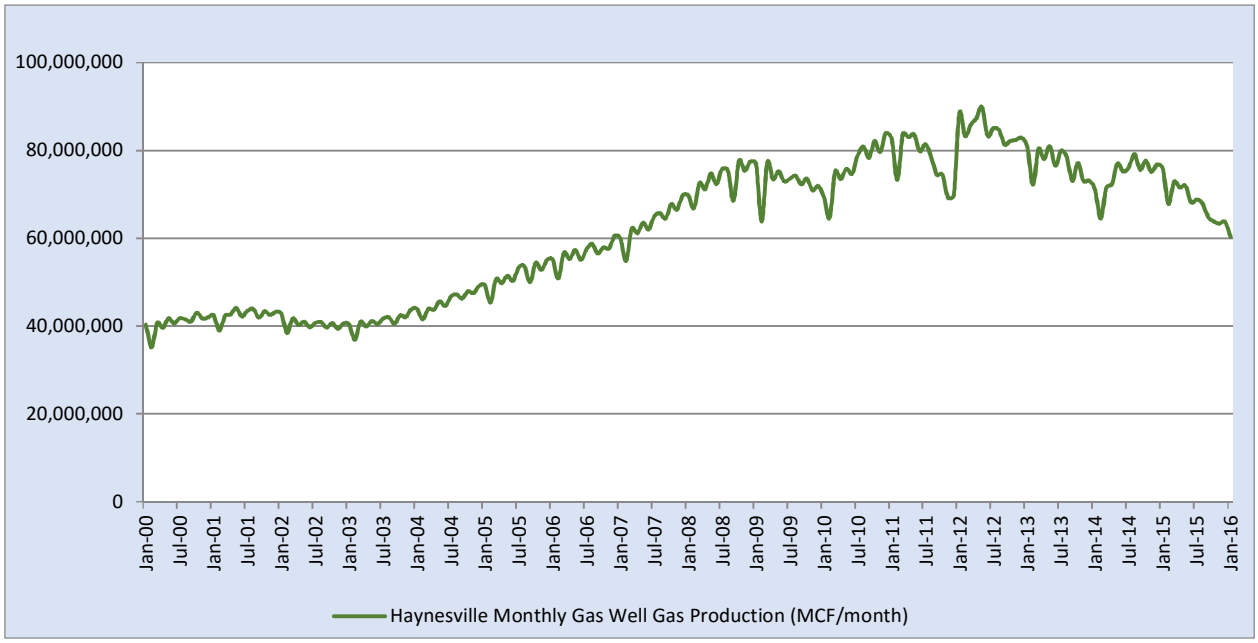
Figure A-10. Eagle Ford Shale, Gas Production From 2000 - 2016



Haynesville Shale Gas Play

There is no oil and very little condensate produced from the Haynesville Shale formation; the play is primarily a gas play. As shown in Figure A-11, production of gas appears to have peaked in 2012, and has steadily decreased since that time by over 25 percent of peak levels. The decline is most likely due to the drop in price of natural gas.

Figure A-11. Haynesville Shale Gas Play, Gas Production 2000 - 2016



Permian Basin Oil Play

While conventional oil development in the Permian Basin was steady at over 20 million barrels per month between 2000 and 2010, oil production in the Permian Basin more than doubled between 2010 and 2015 as more wells were completed using hydraulically fractured stimulation (see Figure A-12). The Permian Basin is known primarily as an oil play, but casinghead gas production in the fall of 2015 was approximately 75 percent of gas well gas production in both the Barnett Shale and Eagle Ford Shale gas plays (see Figure A-13). Production has declined since its peak in early 2015, but the decline has not been as dramatic as in the Eagle Ford Shale, possibly

due to the established baseline of conventional production. There is relatively little condensate production in the Permian Basin.

Figure A-12. Permian Basin, Oil Production 2000 - 2016

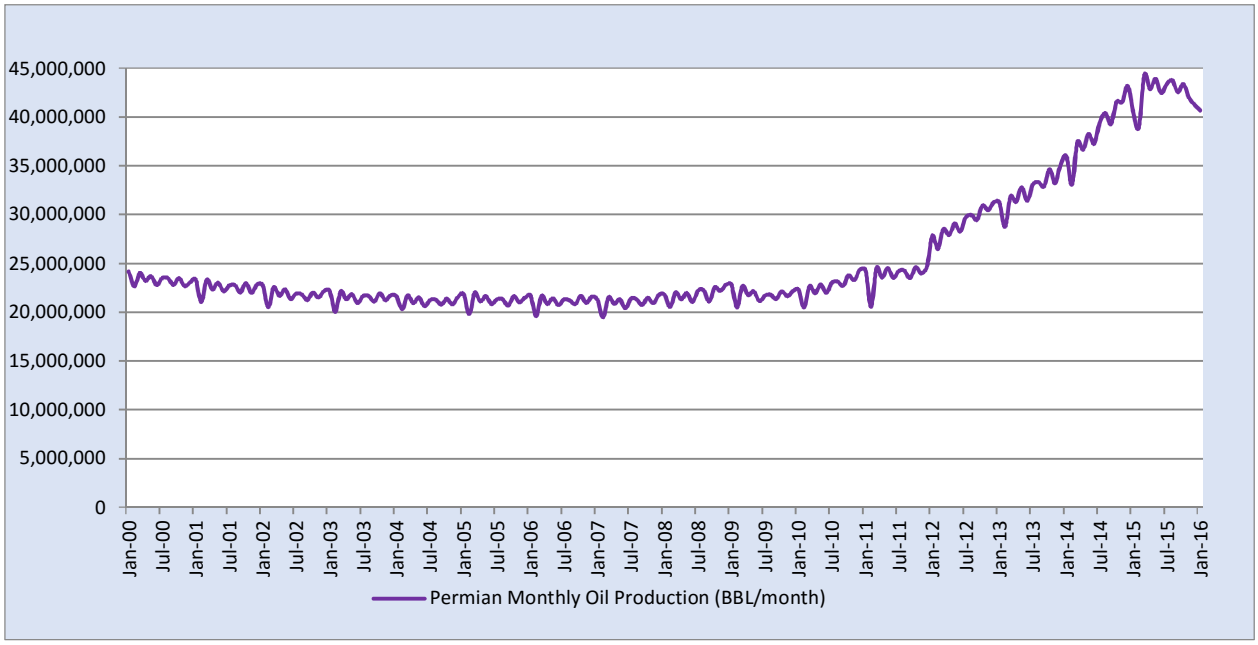
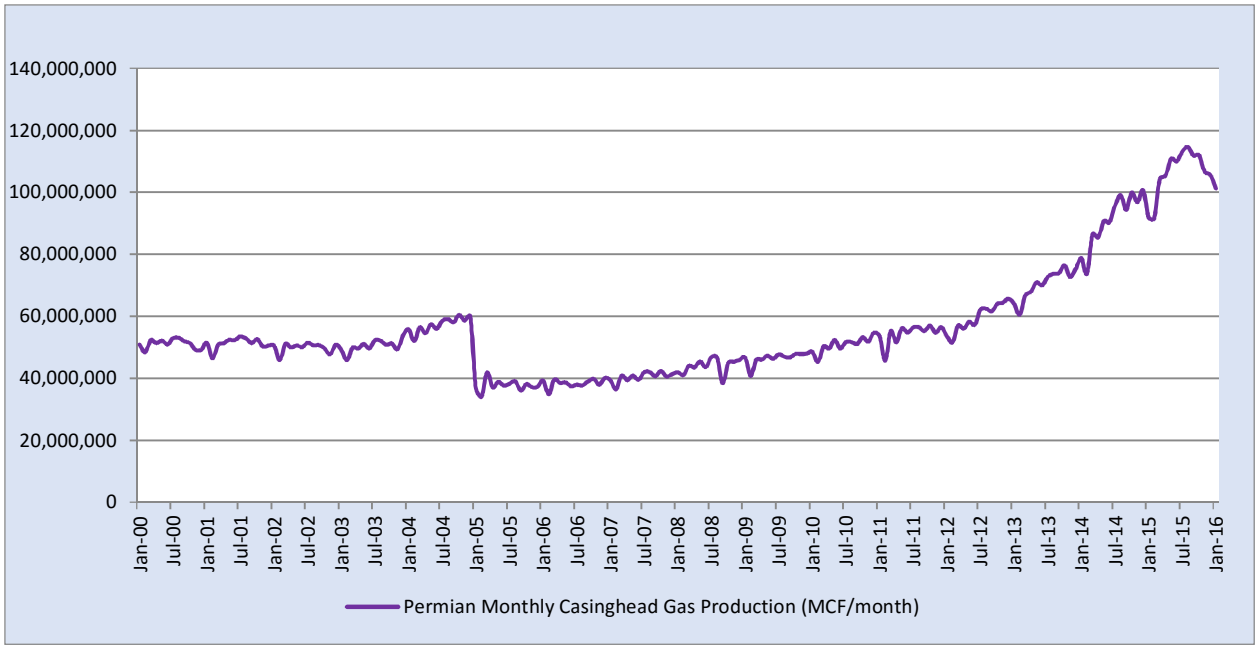


Figure A-13. Permian Basin, Gas Production 2000 - 2016



A.3 Gas and Oil Play Production and Commodity Prices

Natural Gas Prices

The price of natural gas peaked at over $12 per MCF in 2005 and again in 2008, then declined to below $5 per MCF in 2009 and is currently below $2 per MCF. Natural gas production in the Barnett Shale peaked in 2012, but has steadily declined since that time. Although drilling activity is sensitive to commodity prices, wells already in production remain in production which results in a lag between a drop in commodity prices and a drop in production. Natural gas production in the Eagle Ford Shale remained constant through about 2012, but increased rapidly between 2012 and 2015. Many new wells were brought into production during this time due to the high price of oil and the fact that the Eagle Ford Shale produces both oil and gas (see Figures A-14 and A-17). The same scenario occurred with casinghead gas production in the Permian Basin between 2012 and 2015 (see Figure A-15).

Figure A-14. Gas Well Gas Production and Commodity Prices

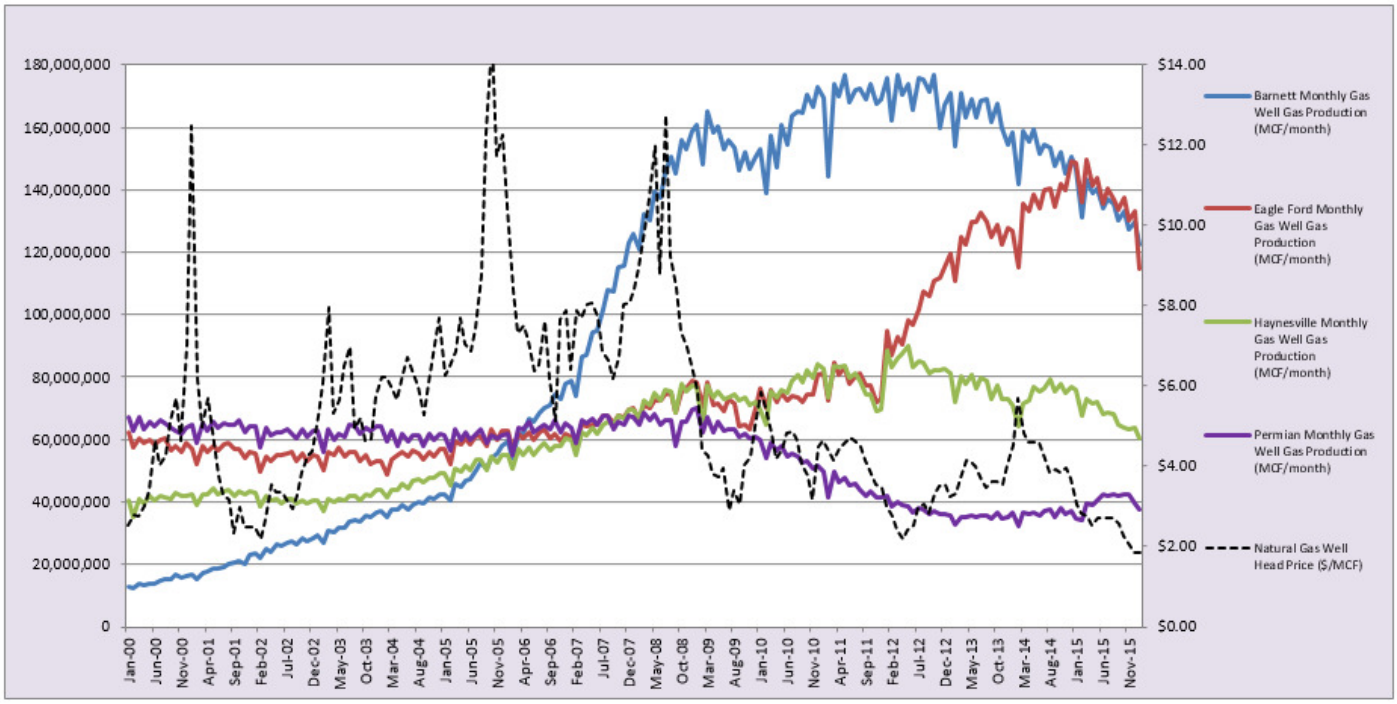
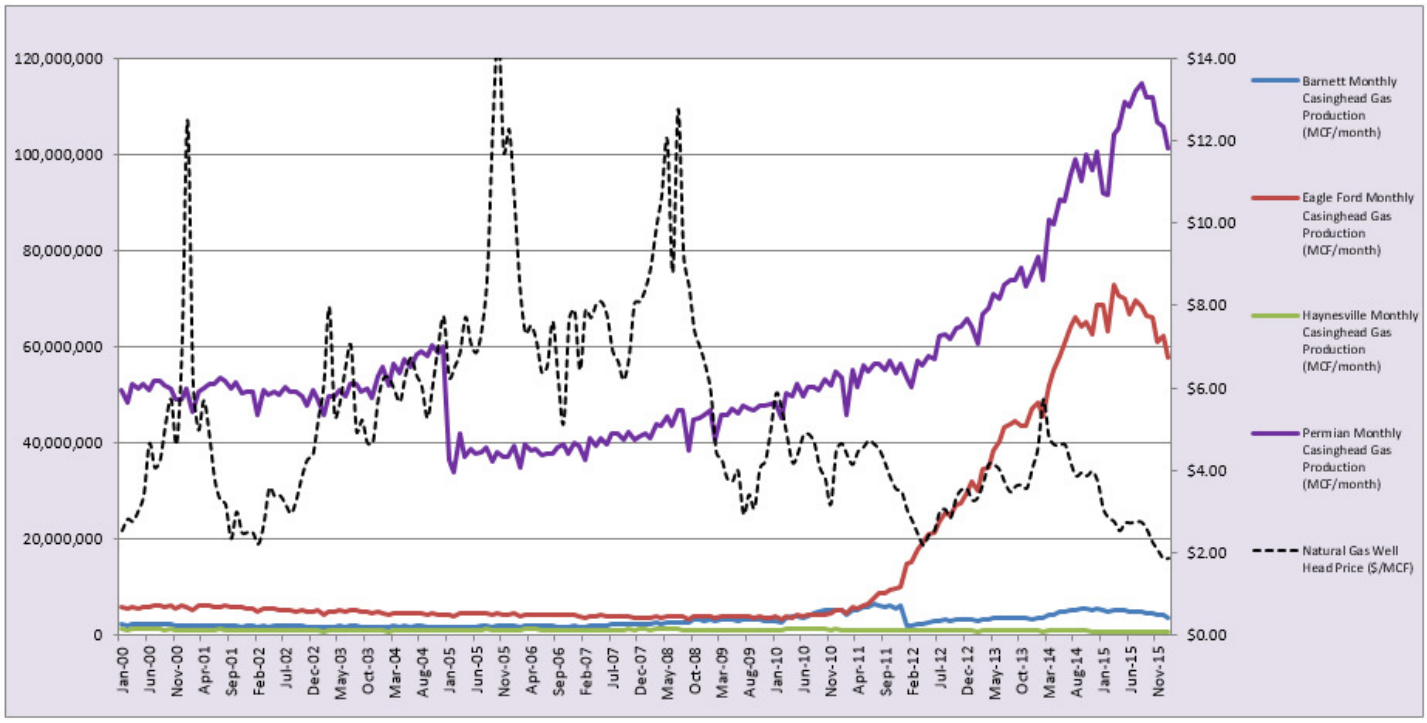


Figure A-15. Casinghead Gas Production and Commodity Prices



Oil Prices

The price of oil peaked in 2008 at over $130 per barrel before falling to approximately $40 per barrel in 2009. From there, the price trend for oil diverged from that for natural gas as prices slowly climbed back to over $100 per barrel in 2011 and remained elevated for several years before beginning to drop dramatically in late 2014 to a low of under $40 per barrel in late 2015. Prices have recently rebounded to nearly $50 per barrel. Oil and condensate production in the Eagle Ford Shale and the Permian Basin began to pick up in early 2011 following the steady price increases in oil, and the introduction of hydraulic fracturing in these areas. As with natural gas, there was a lag between the beginning of a drop in oil prices in 2014 and when peak production occurred in 2015. Liquids production has dropped in the last year, most notably in the Eagle Ford Shale where condensate production has dropped by approximately 25 percent.

See Figures A-16 and A-17 for oil and condensate production over time relative to oil prices.

Figure A-16. Oil Production and Commodity Prices

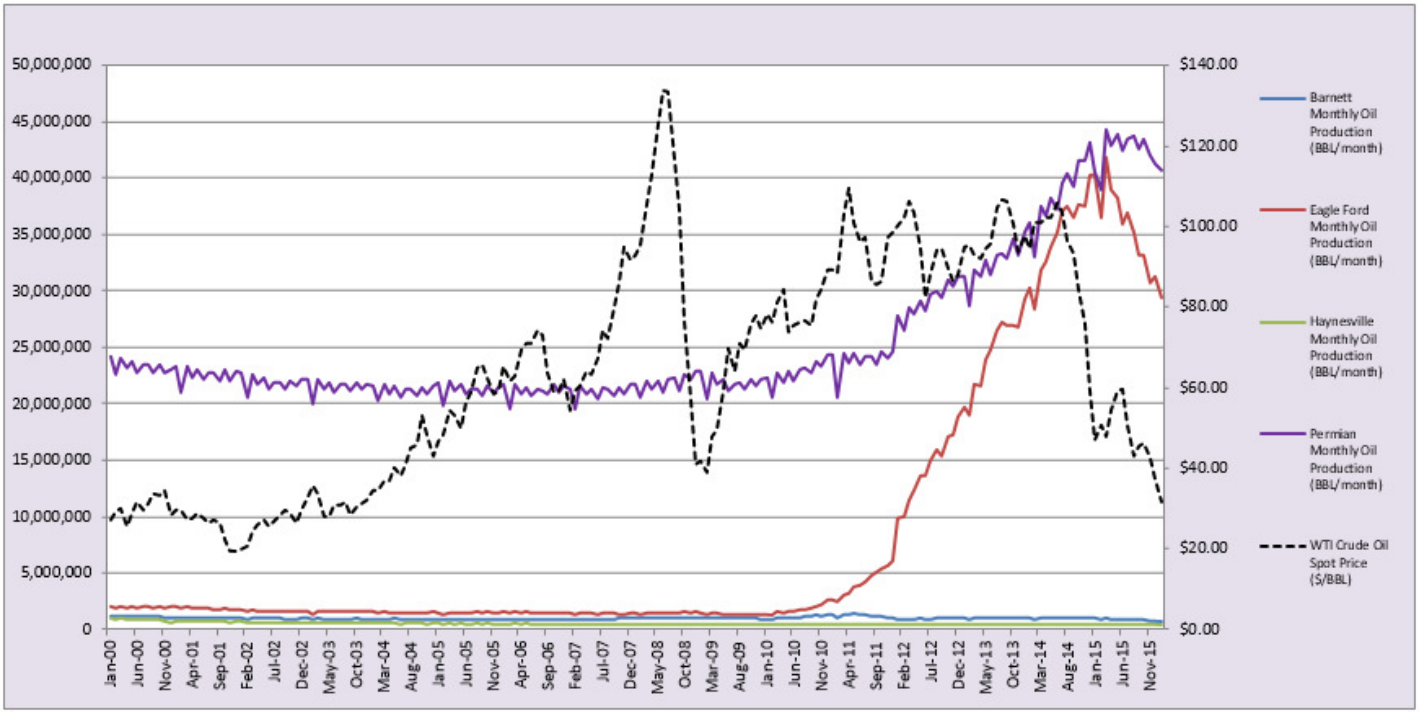
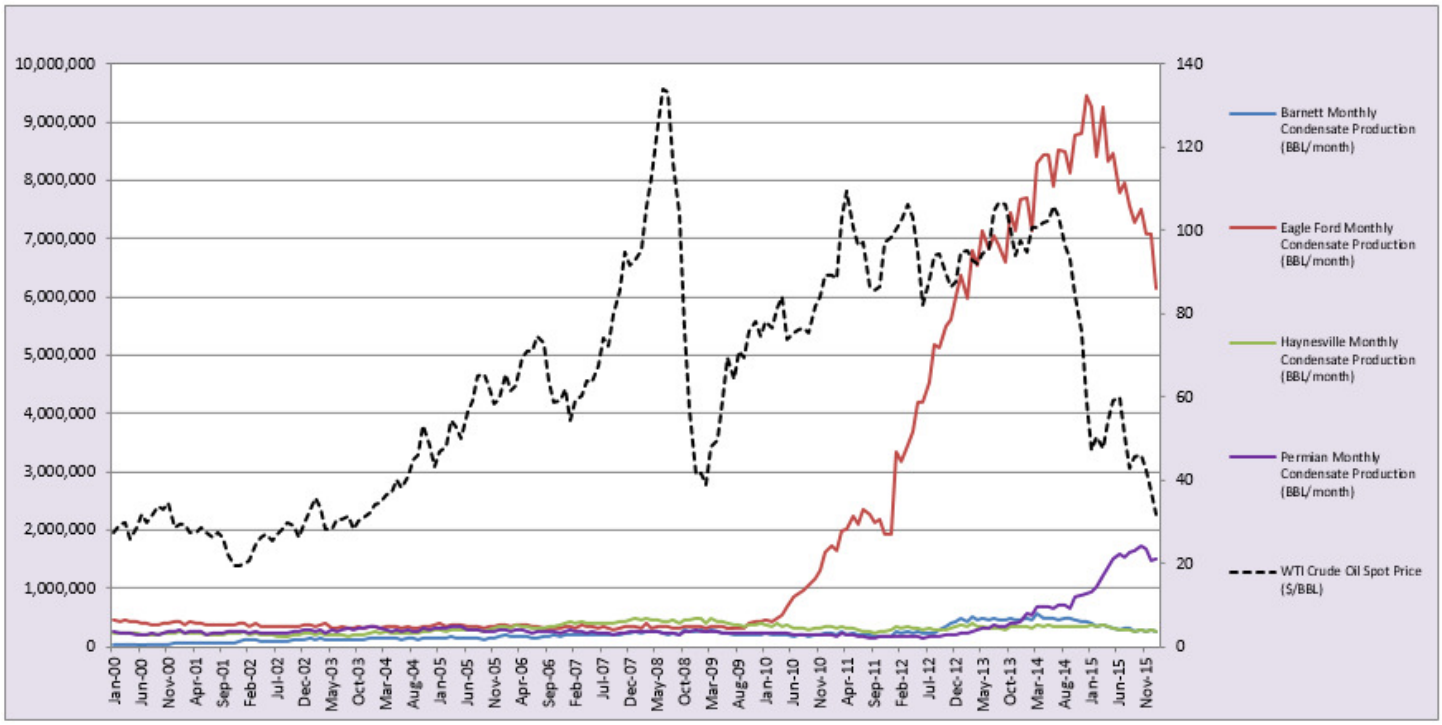


Figure A-17. Condensate Production and Commodity Prices



A.4 Future Production Scenario Methodology

ERG used Hubbert's Method to forecast future production. Cumulative production of oil, natural gas, and condensate were calculated for each play region based on the historical monthly production data from 2000 through 2014 obtained from the RRC. Hubbert's Method was then used to model historic cumulative production and to project cumulative and annual production for oil, natural gas, and condensate from the four Texas oil and gas play regions.

Attempts at calculating depletion times for oil reserves have been made since the early twentieth century (Brandt, 2010). Furthermore, these methods evolved from predicting well or field-level production using exponential or hyperbolic decline curves to predicting production at larger regional and global scales using statistical and curve-fitting methods.

One of the most well-known and simplest curve fitting models is Hubbert's logistic model. Hubbert published his model in 1956 (Hubbert, 1956) but did not provide a full derivation until 1980 (Hubbert, 1980). Brandt classifies Hubbert's model as hypothetical and physically-based and argues that, as a curve-fitting model, it is useful for first order production projections. The model is based on certain simplifying assumptions, as noted by Brandt:

- Yearly production is modeled as the first derivative of the logistic function;

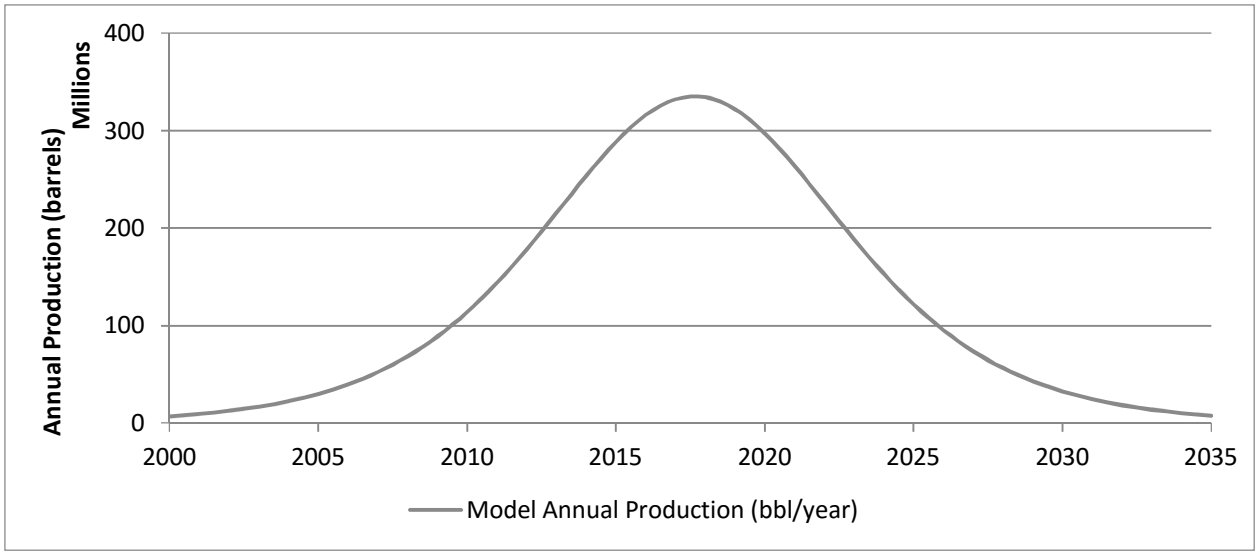
- The production profile is symmetric;
- There is a time lag where production follows discovery; and
- Production follows a single cycle; increasing and decreasing with a single peak.

Despite the assumptions and simple nature of the model, production profiles in various areas have been successfully modeled using the Hubbert logistic model (Clark, 2011). However, the model does not account for various economic, political, or other factors or conditions that may affect production but instead is based on historic cumulative production and estimates of ultimately recoverable resources. Multi-cycle Hubbert models can be used to account for various changes in conditions that affect production, as Clark has demonstrated for the Barnett Shale play by matching historical production in the Barnett Shale to a multi-cycle Hubbert model based on three cycles: one for original production in the region during the first decade, a second beginning in 2004 with the advent of horizontal drilling and an increase in natural gas prices, and a third cycle beginning in 2010 when natural gas prices again achieved another short term peak.

In using Hubbert's model to project future production levels for each of the four regions, ERG used historical production data for the region, changes in production rates due to the size of reserves and estimated ultimate recovery with a capped limit based on an estimate of the size of the reserves. There is a great amount of uncertainty in reserve estimates and published Technically Recoverable Resources (TRR) values. These values continue to change over time due to new discoveries, advances in technology, and changes in estimation methods.

The Hubbert model accounts for estimated maximum cumulative production based on the estimate of reserves. The gradual leveling of total cumulative production as resources near depletion is reflected in the production rate curve when the cumulative production curve is differentiated. The result is a clear peak in the annual production curve indicating when maximum annual production is estimated to occur. For emissions modeling and estimation purposes, this peak would also correspond to the period of peak emissions resulting from production activities. A typical Hubbert's model production rate curve is shown in Figure A-18. The height of the production peak and length of time to depletion are dependent upon the size of the reserve and the rate of extraction.

Figure A-18. Typical Hubbert's Model Production Rate Curve



As shown in Figure A-1, the production of oil and natural gas in Texas can each be imagined as two Hubbert's model production curves separated in time. The sum of the two production curves equals the total statewide production. The first set of curves, with their peaks in 1972, were produced with conventional drilling and extraction technology. The second set of curves represents the oil and gas that are being extracted with advanced drilling and extraction techniques (e.g., horizontal drilling and hydraulic fracturing). The oil and gas reserves that were tapped with conventional techniques are still being extracted, and these wells and formations continue to produce at low levels. The oil and gas reserves that have been tapped since approximately 2001 using advanced drilling and extraction techniques represent new reserves that were not previously recoverable using the older conventional techniques.

In modeling the production growth rates for each of the four regions, it is important to account for both the old and new reserves. Their size is different and their rates of production are different. Since total annual production is aggregated at the county level and production is not distinguished based on formation, drilling technique, or year of first production, the production figures used for modeling represent total production. However, the production growth rate modeling is heavily influenced by the production of new reserves. Data suggest that these reserves are being produced at a faster rate, and that the growth and decline of production will occur in a shorted time period.

The Hubbert model for cumulative production is a logistic growth function:

$$Q(t) = \frac{Q_\infty}{1 + N_o e^{-a(t-t_o)}}$$

Where:
$Q(t)$ = total cumulative production in year t;
Q_∞ = estimated ultimate recovery (EUR) or ultimately recoverable resources (URR);
N_o = $\frac{(Q_\infty - Q_o)}{Q_o}$ (where Q_o = cumulative production in base year 2014);
a = model parameter;
t = year; and
t_o = base year (2014).

Taking the derivative of the above equation results in an equation for the production rate ($P(t)$):

$$P(t) = \frac{dQ}{dt} = \frac{aQ_\infty N_O e^{-a(t-t_o)}}{(1 + N_o e^{-a(t-t_o)})^2}$$

The parameters a and Q_∞ can be determined by plotting the ratio of production rate and cumulative production against cumulative production. Assuming the plot of those data can be fit to a linear function:

$$\frac{\frac{dQ}{dt}}{Q} = \frac{P(t)}{Q(t)} = -\frac{a}{Q_\infty} Q + a$$

The parameter a can be determined from the y-intercept of the line. The slope of the line is $-\frac{a}{Q_\infty}$, where $Q_\infty = slope/-a$. After plotting the above equation and making initial estimates for a and Q_∞, the model cumulative production equation was used to determine the goodness-of-fit to the actual cumulative production data using the initial estimates of a and Q_∞. Published EIA estimates of TRRs for Barnett, Haynesville, and Permian oil and condensate were not available and thus Q_∞ was estimated as a result of using the above linearization approach. Published estimates of TRR from the EIA were available for: Eagle Ford Shale oil, condensate, and natural gas; and Barnett Shale natural gas and are presented in Table A-9 (EIA, 2015a).

Table A-9. EIA Oil and Natural Gas TRR Data for the Texas Shale Plays

	Barnett	Eagle Ford
Natural Gas TRR (TCF)	24.3	23.7

Oil TRR (BBO)	Not Available	5.17

For those regions and products where published estimates of TRR were available from the EIA, Q_∞ was calculated using the following equation:

$$Q_\infty = Q(t) + (TRR)\left(1 + \frac{GR_p}{100}\right)$$

Where:

TRR = technically recoverable resources (as of 2014); and
GR_p = overall growth rate (2014 through 2050) of TRR for product *p*, %.

TRR estimates change over time largely due to advances in technology or resource estimation methods. EIA data on end of year reserves growth rates from 2010 through 2040 for both lower 48 oil reserves and lower 48 natural gas reserves under the high TRR assumption (i.e., 1.6 percent and 0.6 percent for oil and gas, respectively) were used as surrogates for oil and gas TRR growth rates (EIA, 2015a). It was assumed that the overall TRR growth rate for 2010 through 2040 would be the same for 2014 through 2050. The calculated Q_∞ just described was used in the model cumulative production and model annual production equations for Eagle Ford oil, condensate, and natural gas; and Barnett natural gas instead of the estimated Q_∞ determined using the linearization approach.

In all cases, after Q_∞ was estimated (either by linearization or calculated using the published TRR), the *a* parameters were adjusted such that the modeled annual cumulative production in 2014 matched the actual cumulative production in 2014.

A.5 Results

The results of the growth factor development for the four oil and gas play regions using Hubbert's method are presented in this section.

Barnett Shale Play

Model development using Hubbert's method for the Barnett Shale play region resulted in the models for cumulative production and annual production as shown in Table A-10.

Table A-10. Hubbert's Method Production Models for Barnett Shale Play Region

Product	Cumulative Production	Annual Production

Oil	$Q_{Oil,B}(barrels) = \frac{276,824,257}{1+(19.25)e^{-0.2569(t-2014)}}$	$P(t)_{Oil,B}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,B} = \frac{(0.2569)(276,824,257)(19.25)e^{-0.2569(t-2014)}}{(1+(19.25)e^{-0.2569(t-2014)})^2}$
Gas	$Q_{G,B}(MCF) = \frac{41,929,072,190}{1+(239.27)e^{-0.3673(t-2014)}}$	$P(t)_{G,B-3}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,B} = \frac{(0.3673)(41,929,072,190)(239.27)e^{-0.3673(t-2014)}}{(1+(239.27)e^{-0.3673(t-2014)})^2}$
Condensate	$Q_{C,B}(barrels) = \frac{78,159,054}{1+(163.84)e^{-0.3585(t-2014)}}$	$P(t)_{C,B}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,B} = \frac{(0.3585)(78,159,054)(163.84)e^{-0.3585(t)}}{(1+(163.84)e^{-0.3585(t-2014)})^2}$

The estimated model parameters for the Barnett Shale play region are summarized in Table A-11.

Table A-11. Summary of Hubbert's Method Production Model Parameters for Barnett Shale Play Region

Product	Q_∞	A	N_0
Oil	276,824,257	0.2569	19.25
Gas	41,929,072,190	0.3673	239.27
Condensate	78,159,054	0.3585	163.84

Figures A-19 and A-20 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-21 and A-22 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-23 and A-24 present actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-19. Hubbert's Model Fit to Historic Oil Production from the Barnett Shale Play Region (2000-2014)

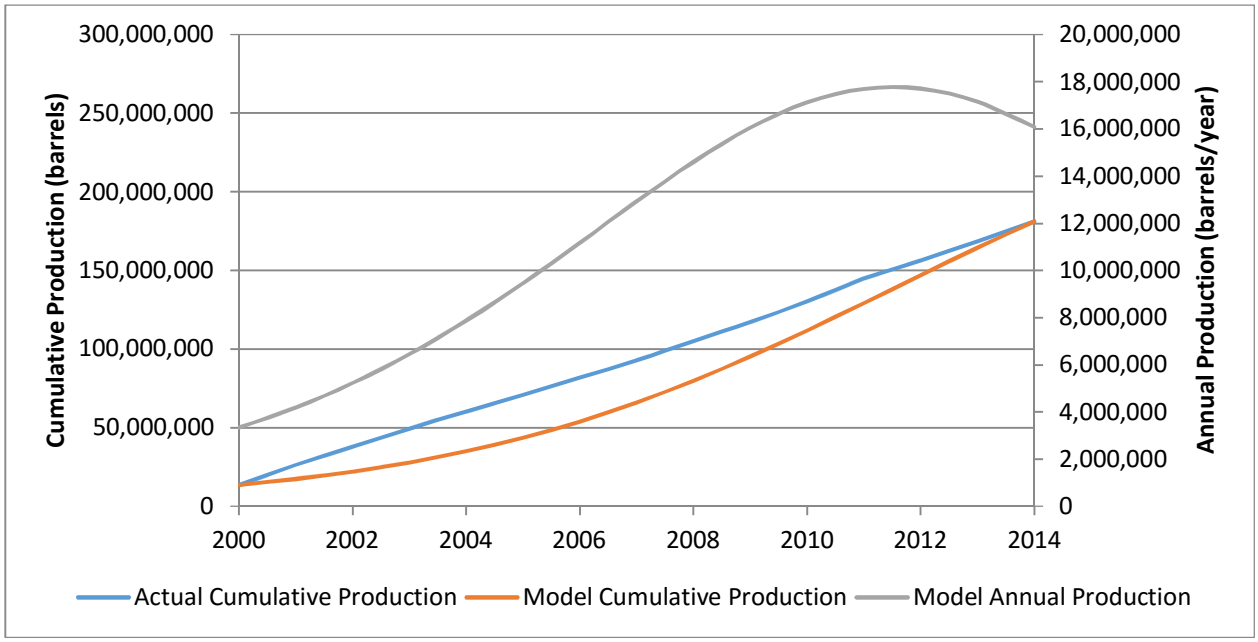


Figure A-20. Hubbert's Model Projected Cumulative and Annual Oil Production from the Barnett Shale Play Region (2015-2050)

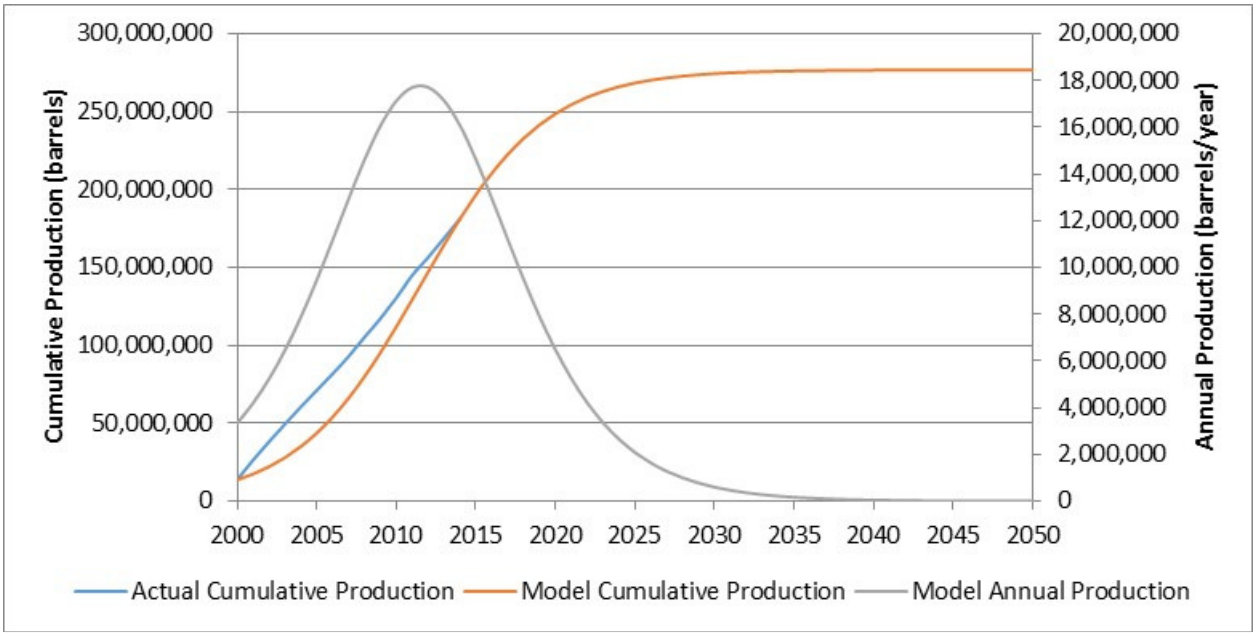


Figure A-21. Hubbert's Model Fit to Historic Natural Gas Production from the Barnett Shale Play Region (2000-2014)

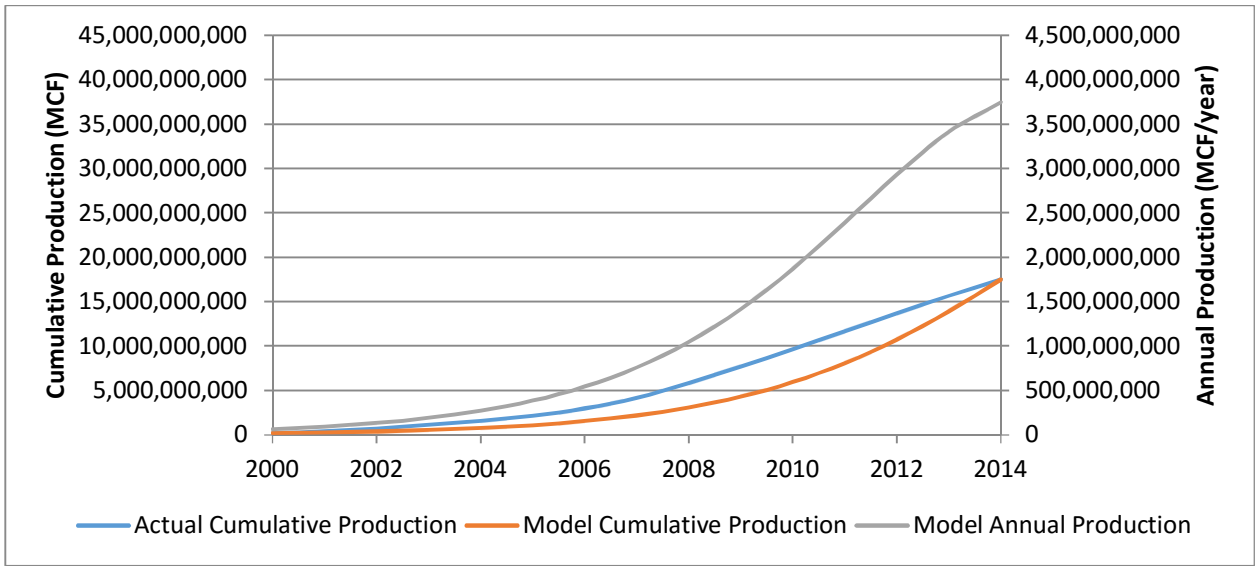


Figure A-22. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Barnett Shale Play Region (2015-2050)

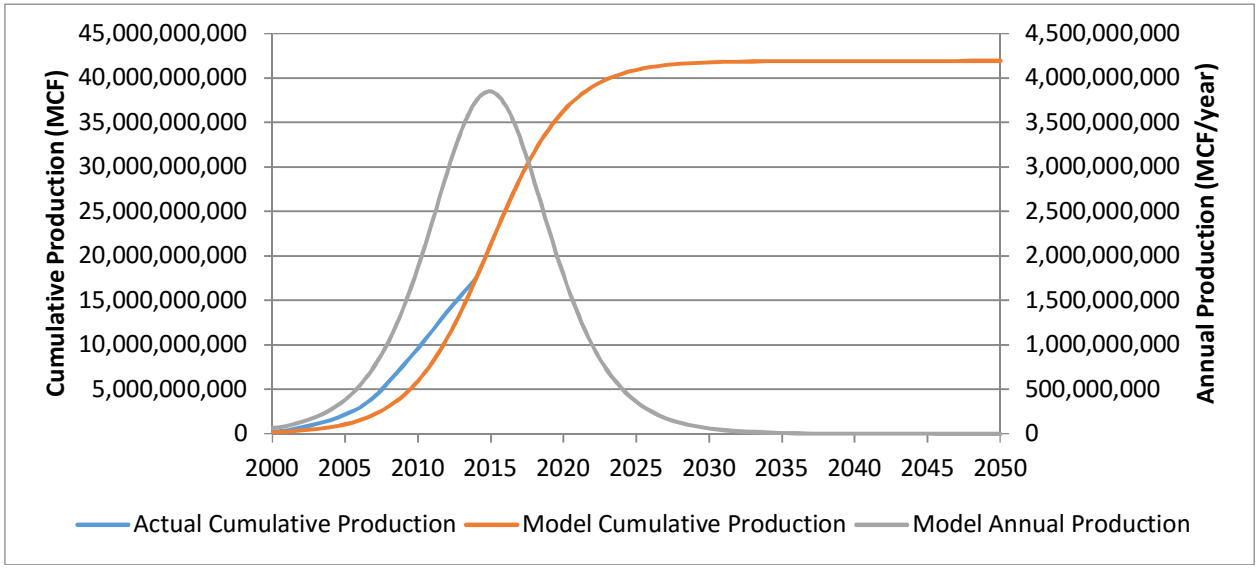


Figure A-23. Hubbert's Model Fit to Historic Condensate Production from the Barnett Shale Play Region (2000-2014)

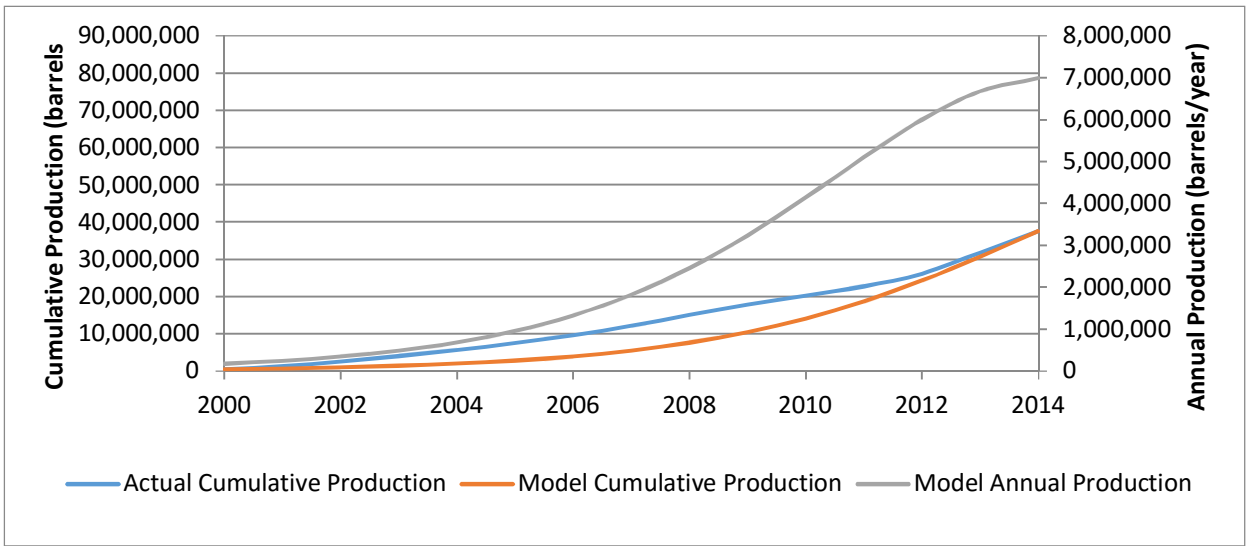
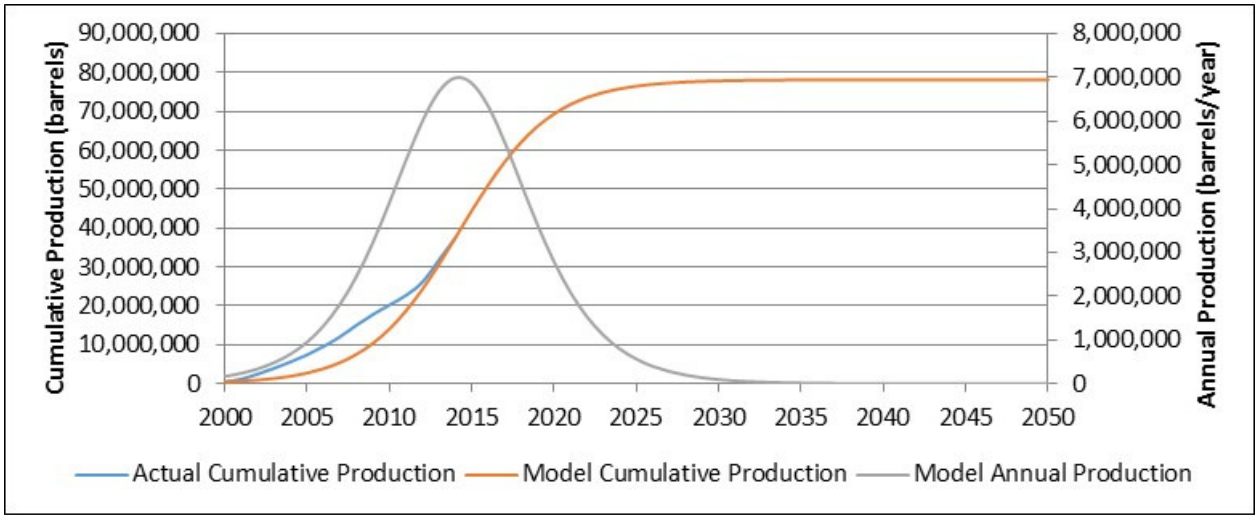


Figure A-24. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Barnett Shale Play Region (2015-2050)



A summary of the annual growth factors calculated for the Barnett Shale play region is presented in Table A-12.

Table A-12. Barnett Shale Growth Factors

Year	Oil	Gas	Condensate
2015	0.910	1.028	0.982
2016	0.806	0.988	0.906
2017	0.698	0.891	0.789
2018	0.591	0.758	0.653
2019	0.492	0.613	0.519
2020	0.403	0.476	0.398
2021	0.327	0.359	0.298
2022	0.262	0.264	0.219
2023	0.209	0.191	0.158
2024	0.165	0.136	0.113
2025	0.130	0.096	0.081
2026	0.102	0.068	0.057
2027	0.080	0.047	0.040
2028	0.062	0.033	0.028
2029	0.048	0.023	0.020
2030	0.038	0.016	0.014
2031	0.029	0.011	0.010
2032	0.023	0.008	0.007
2033	0.018	0.005	0.005
2034	0.014	0.004	0.003

Table A-12. Barnett Shale Growth Factors

Year	Oil	Gas	Condensate
2035	0.011	0.003	0.002
2036	0.008	0.002	0.002
2037	0.006	0.001	0.001
2038	0.005	0.001	0.001
2039	0.004	0.001	0.001
2040	0.00293	0.00041	0.00039
2041	0.00226	0.00028	0.00027
2042	0.00175	0.00020	0.00019
2043	0.00135	0.00014	0.00013
2044	0.00105	0.00009	0.00009
2045	0.00081	0.00007	0.00006
2046	0.00063	0.00005	0.00005
2047	0.00048	0.00003	0.00003
2048	0.00038	0.00002	0.00002
2049	0.00029	0.00002	0.00002
2050	0.00022	0.00001	0.00001

Eagle Ford Shale Play

Model development using Hubbert's Method for the Eagle Ford Shale play region resulted in the models for cumulative production and annual production as shown in Table A-13.

Table A-13. Hubbert's Method Production Models for Eagle Ford Shale Play Region

Product	Cumulative Production	Annual Production
Oil	$Q_{Oil,EF}(barrels) = \frac{4{,}517{,}942{,}672}{1+(188.27)e^{-0.2969(t-2014)}}$	$P(t)_{Oil,EF}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,EF} = \frac{(0.2969)(4{,}517{,}942{,}672)(188.27)e^{-0.2969(t-2014)}}{(1+(188.27)e^{-0.2969(t-2014)})^2}$
Gas	$Q_{G,EF}(MCF) = \frac{37{,}300{,}431{,}977}{1+(51.76)e^{-0.2411(t-2014)}}$	$P(t)_{G,EF}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,EF} = \frac{(0.2411)(37{,}300{,}431{,}977)(51.76)e^{-0.2411(t-2014)}}{(1+(51.76)e^{-0.2411(t-2014)})^2}$
Condensate	$Q_{C,EF}(barrels) = \frac{1{,}310{,}172{,}866}{1+(262.55)e^{-0.3156(t-2014)}}$	$P(t)_{C,EF}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,EF} = \frac{(0.3156)(1{,}310{,}172{,}866)(262.55)e^{-0.3156(t-2014)}}{(1+(262.55)e^{-0.3156(t-2014)})^2}$

The estimated model parameters for the Eagle Ford Shale play region are summarized in Table A-14.

Table A-14. Summary of Hubbert's Method Production Model Parameters for Eagle Ford Shale Play Region

Product	Q_∞	A	N_o
Oil	4,517,942,672	0.2969	188.27
Gas	37,300,431,977	0.2411	51.76
Condensate	1,310,172,866	0.3156	262.55

Figures A-25 and A-26 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-27 and A-28 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-29 and A-30 present actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-25. Hubbert's Model Fit to Historic Oil Production from the Eagle Ford Shale Play Region (2000-2014)

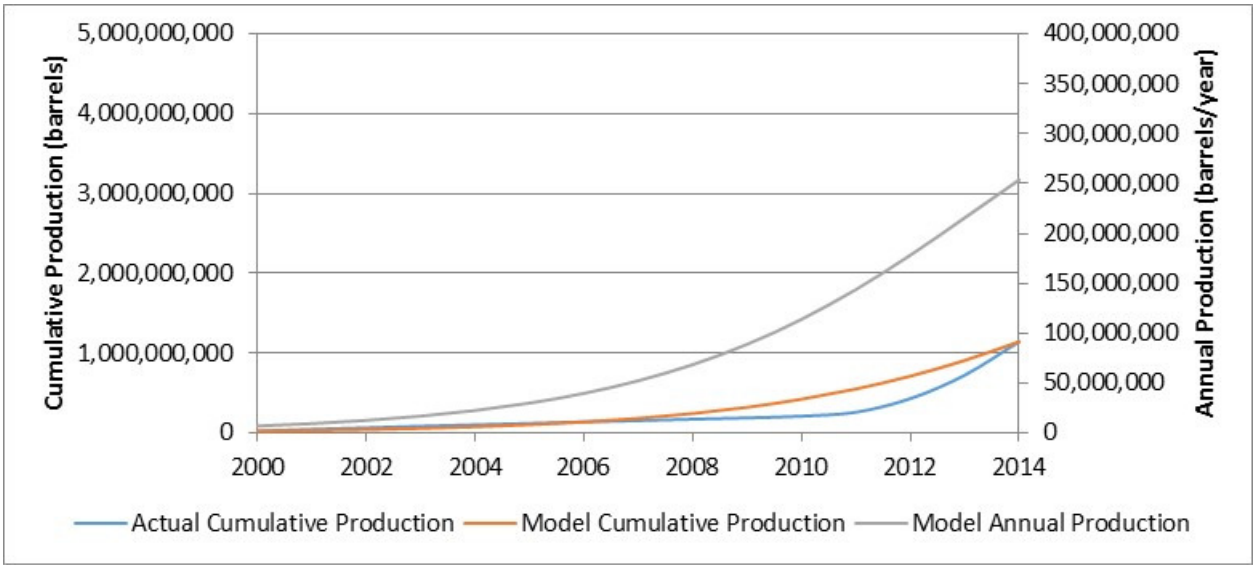


Figure A-26. Hubbert's Model Projected Cumulative and Annual Oil Production from the Eagle Ford Shale Play Region (2015-2050)

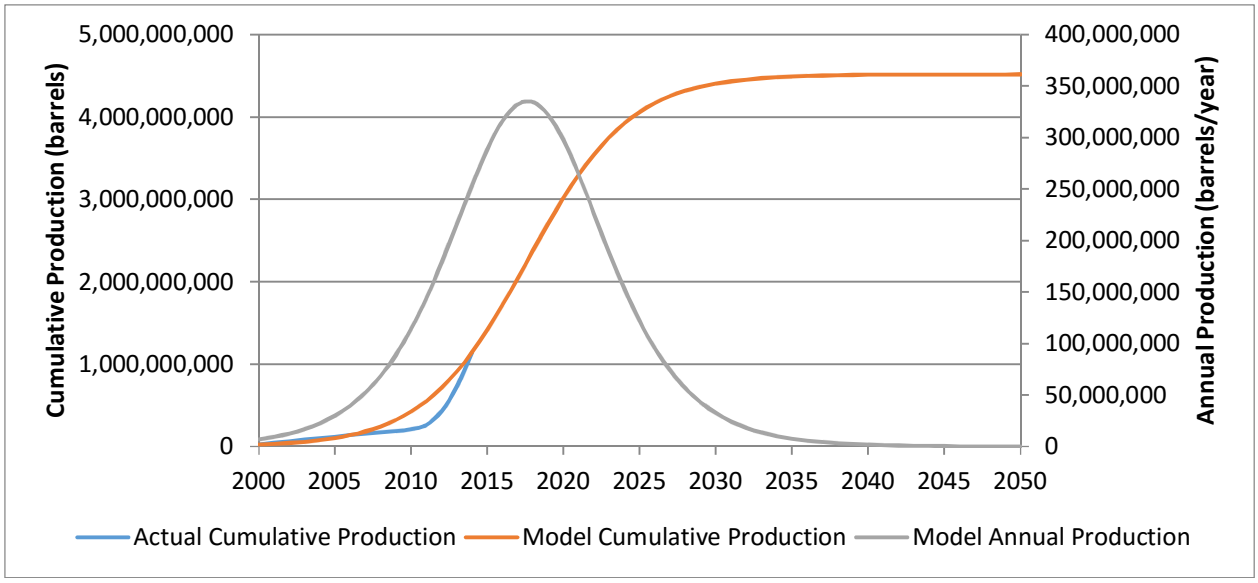


Figure A-27. Hubbert's Model Fit to Historic Natural Gas Production from the Eagle Ford Shale Play Region (2000-2014)

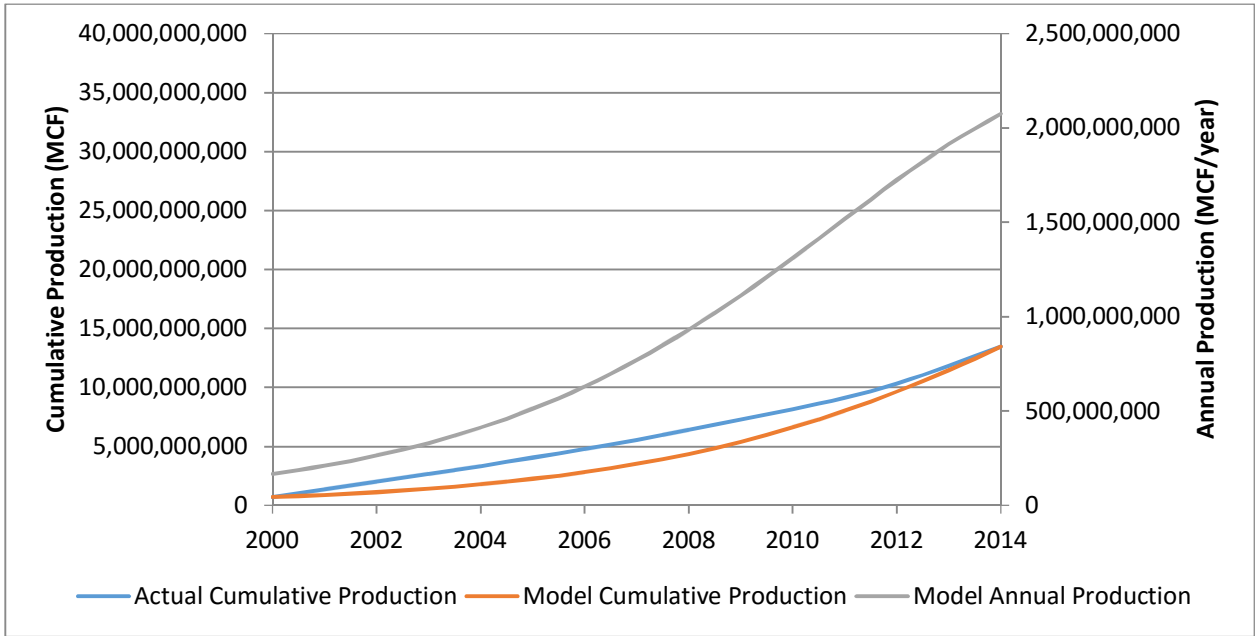


Figure A-28. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Eagle Ford Shale Play Region (2015-2050)

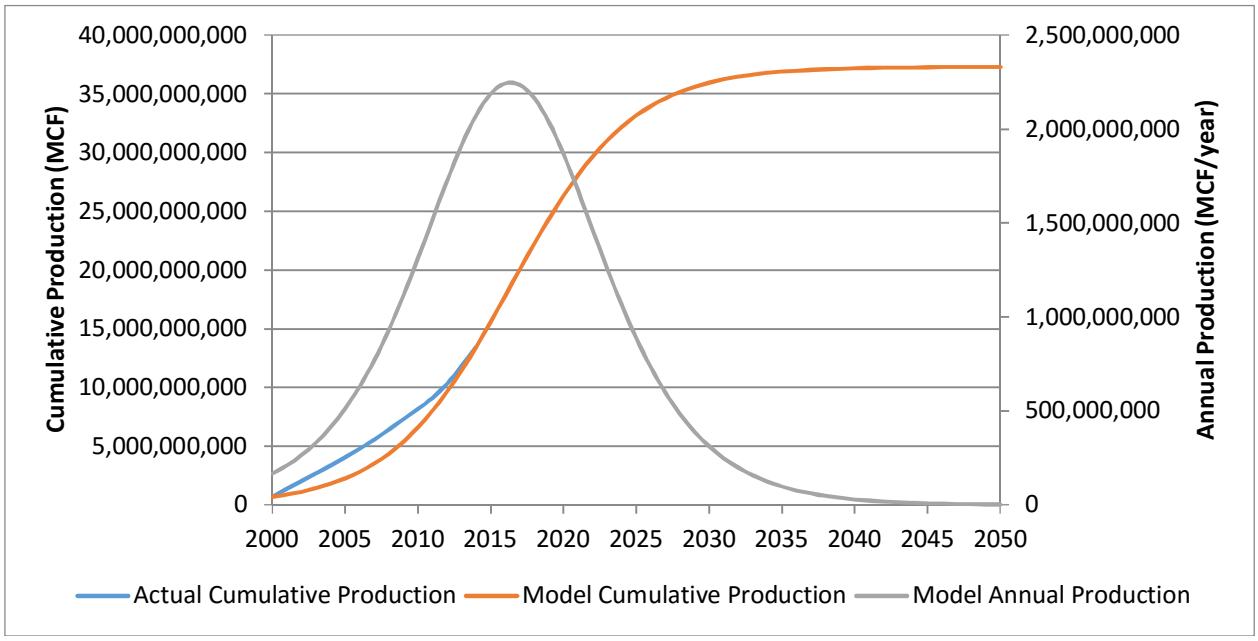


Figure A-29. Hubbert's Model Fit to Historic Condensate Production from the Eagle Ford Shale Play Region (2000-2014)

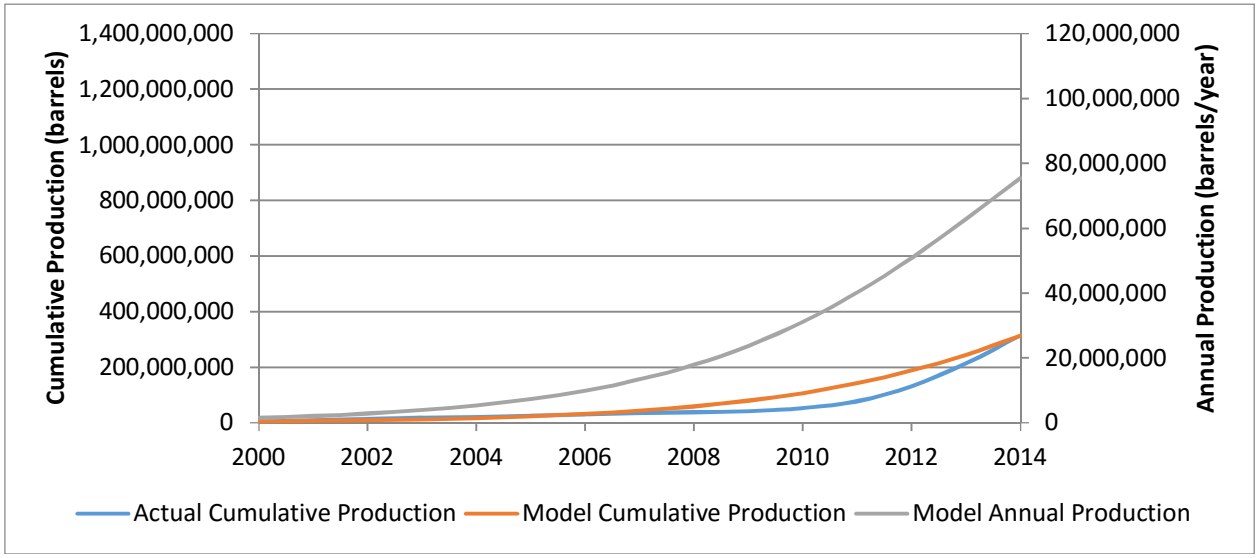
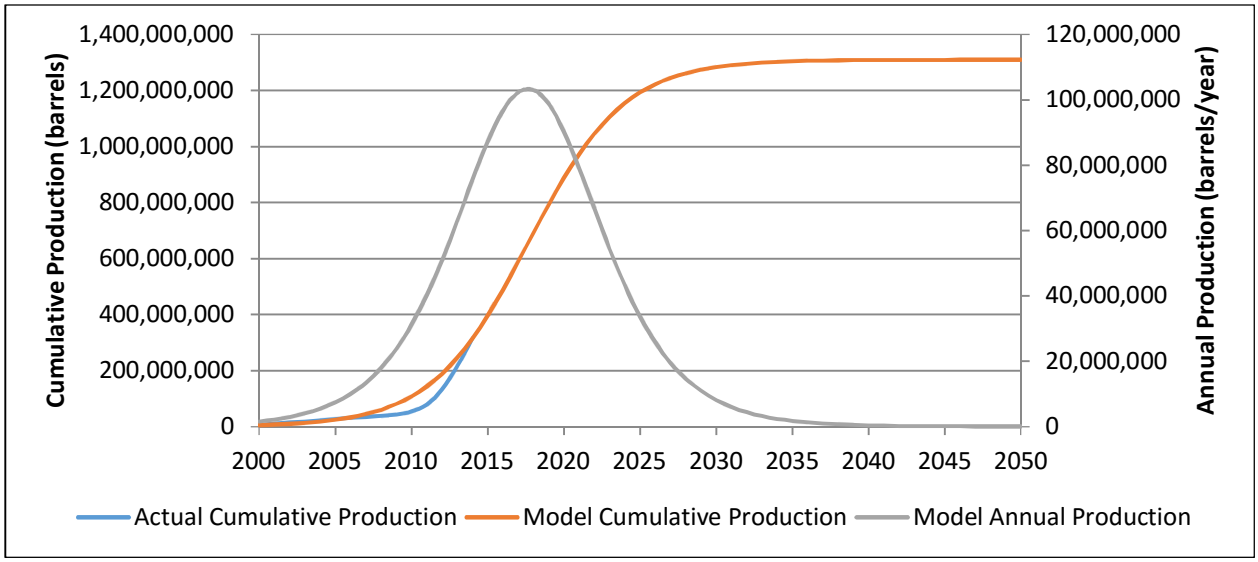


Figure A-30. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Eagle Ford Shale Play Region (2015-2050)



A summary of the annual growth factors calculated for the Eagle Ford Shale play region is presented in Table A-15.

Table A-15. Eagle Ford Shale Growth Factors

Year	Oil	Gas	Condensate
2015	1.138	1.055	1.156
2016	1.246	1.082	1.281
2017	1.310	1.078	1.356
2018	1.318	1.043	1.366
2019	1.269	0.982	1.310
2020	1.172	0.901	1.198
2021	1.041	0.806	1.049
2022	0.893	0.706	0.885
2023	0.743	0.607	0.722
2024	0.604	0.513	0.574
2025	0.481	0.428	0.447
2026	0.376	0.353	0.342
2027	0.291	0.288	0.259
2028	0.223	0.234	0.194
2029	0.170	0.188	0.144
2030	0.128	0.151	0.107
2031	0.096	0.120	0.079
2032	0.072	0.096	0.058
2033	0.054	0.076	0.043
2034	0.040	0.060	0.031
2035	0.030	0.048	0.023
2036	0.022	0.038	0.017
2037	0.017	0.030	0.012
2038	0.012	0.023	0.009
2039	0.009	0.018	0.006
2040	0.007	0.014	0.005
2041	0.005	0.011	0.003
2042	0.004	0.009	0.003
2043	0.003	0.007	0.002
2044	0.002	0.006	0.001
2045	0.002	0.004	0.001
2046	0.001	0.003	0.001
2047	0.001	0.003	0.001
2048	0.0006	0.0021	0.0004
2049	0.0005	0.0017	0.0003
2050	0.0004	0.0013	0.0002

Haynesville Shale Play

Model development under Hubbert's model for the Haynesville Shale play region resulted in the models for cumulative production and annual production as shown in Table A-16.

Table A-16. Hubbert's Method Production Models for Haynesville Shale Play Region

Product	Cumulative Production	Annual Production
Oil	$Q_{Oil,H}(barrels) = \frac{130{,}442{,}214}{1+(11.206)e^{-0.2438(t-2014)}}$	$P(t)_{Oil,H}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,H} = \frac{(0.2438)(130{,}442{,}214)(11.206)e^{-0.2438(t-2014)}}{(1+(11.206)e^{-0.2438(t-2014)})^2}$
Gas	$Q_{G,H}(MCF) = \frac{16{,}625{,}976{,}871}{1+(32.99)e^{-0.2980(t-2014)}}$	$P(t)_{G,H}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,H} = \frac{(0.2980)(16{,}625{,}976{,}871)(32.99)e^{-0.2980(t-2014)}}{(1+(32.99)e^{-0.2980(t-2014)})^2}$
Condensate	$Q_{C,H}(barrels) = \frac{69{,}988{,}261}{1+(25.19)e^{-0.3291(t-2014)}}$	$P(t)_{C,H}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,H} = \frac{(0.3291)(69{,}988{,}261)(25.19)e^{-0.3291(t-2014)}}{(1+(25.19)e^{-0.3291(t-2014)})^2}$

The estimated model parameters for the Haynesville Shale play region are summarized in Table A-17.

Table A-17. Summary of Hubbert's Method Production Model Parameters for Haynesville Shale Play Region

Product	Q_∞	A	N_o
Oil	130,442,214	0.2438	11.206
Gas	16,625,976,871	0.2980	32.99
Condensate	69,988,261	0.3291	25.19

Figures A-31 and A-32 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-33 and A-34 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-35 and A-36 present

actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-31. Hubbert's Model Fit to Historic Oil Production from the Haynesville Shale Play Region (2000-2014)

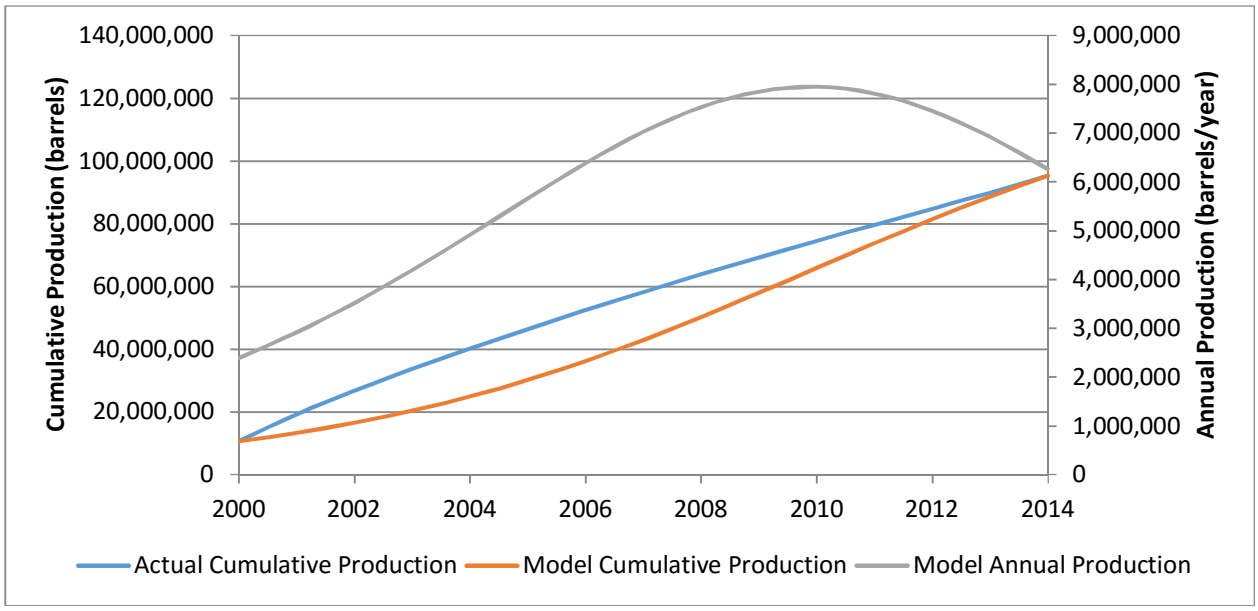


Figure A-32. Hubbert's Model Projected Cumulative and Annual Oil Production from the Haynesville Shale Play Region (2015-2050)

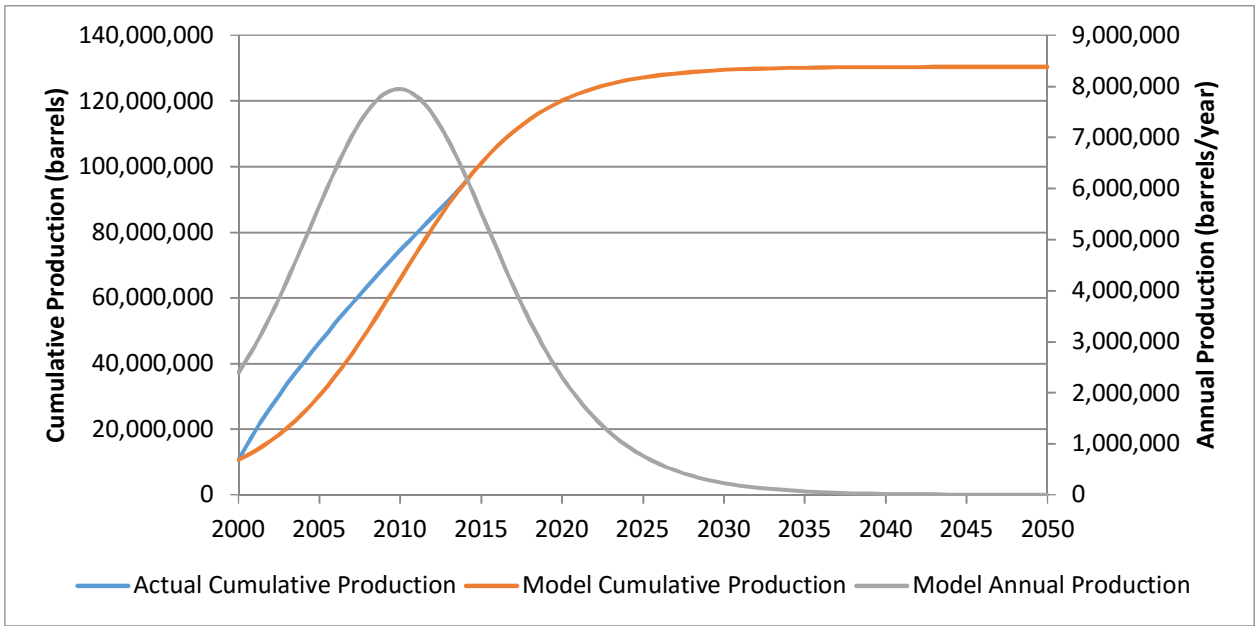


Figure A-33. Hubbert's Model Fit to Historic Natural Gas Production from the Haynesville Shale Play Region (2000-2014)

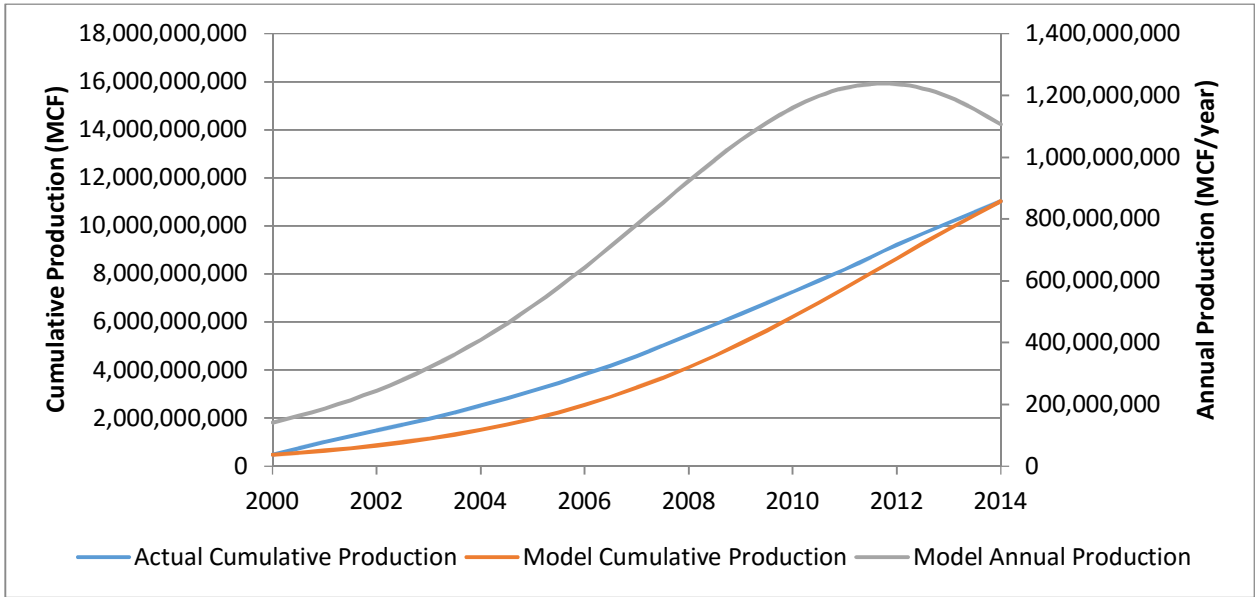


Figure A-34. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Haynesville Shale Play Region (2015-2050)

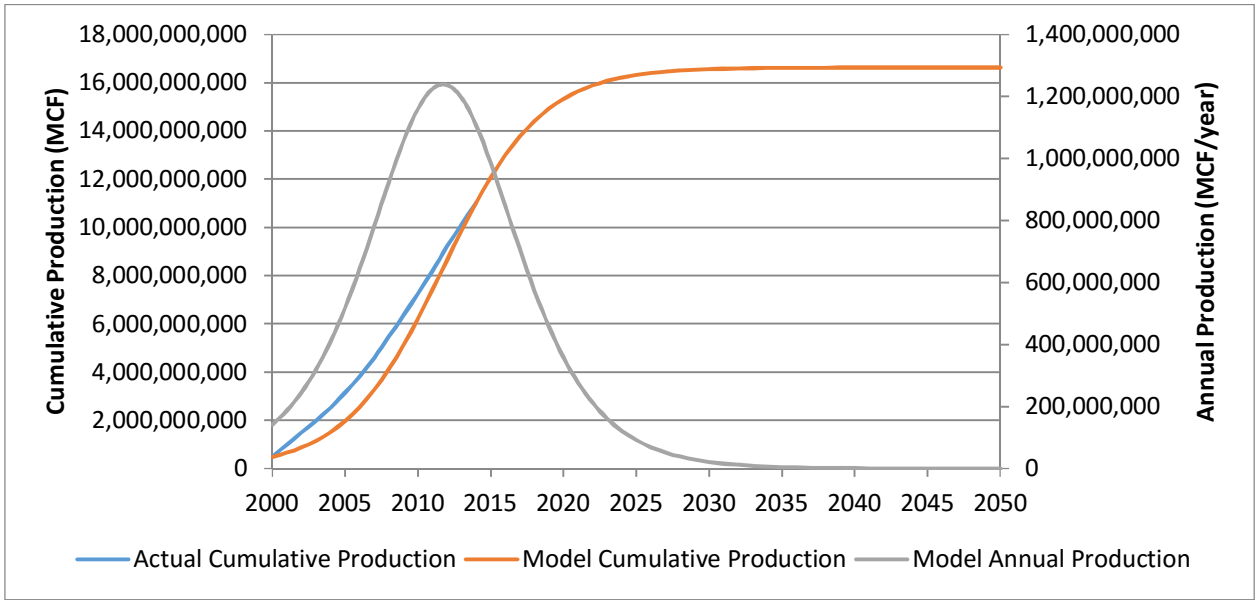


Figure A-35. Hubbert's Model Fit to Historic Condensate Production from the Haynesville Shale Play Region (2000-2014)

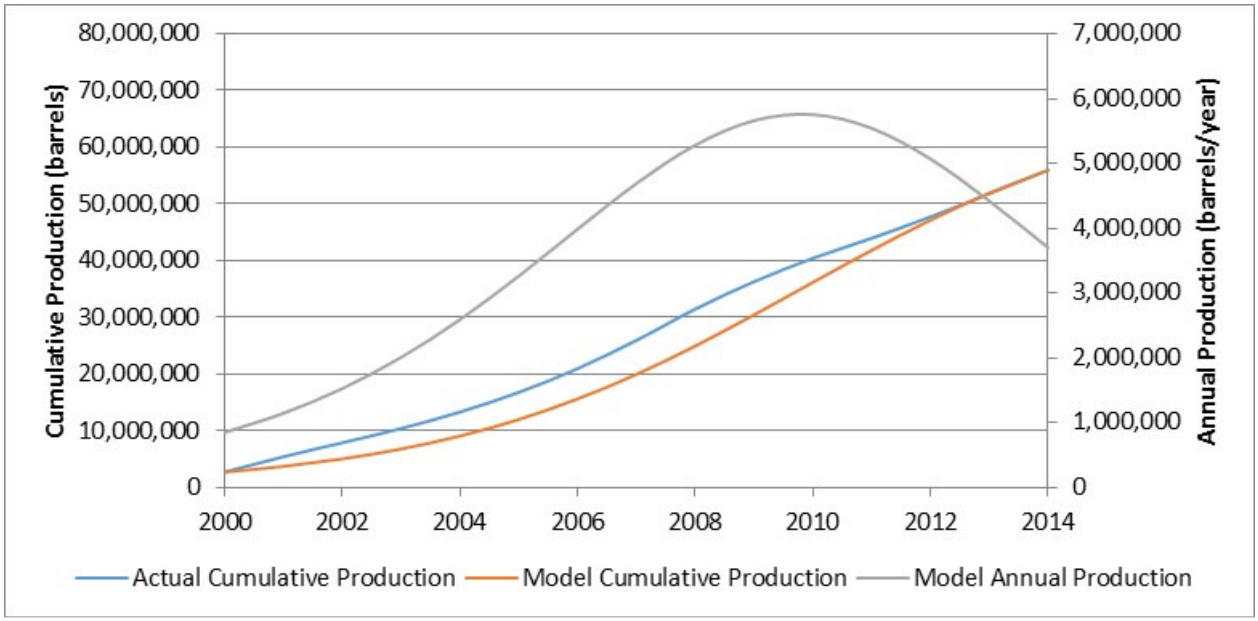
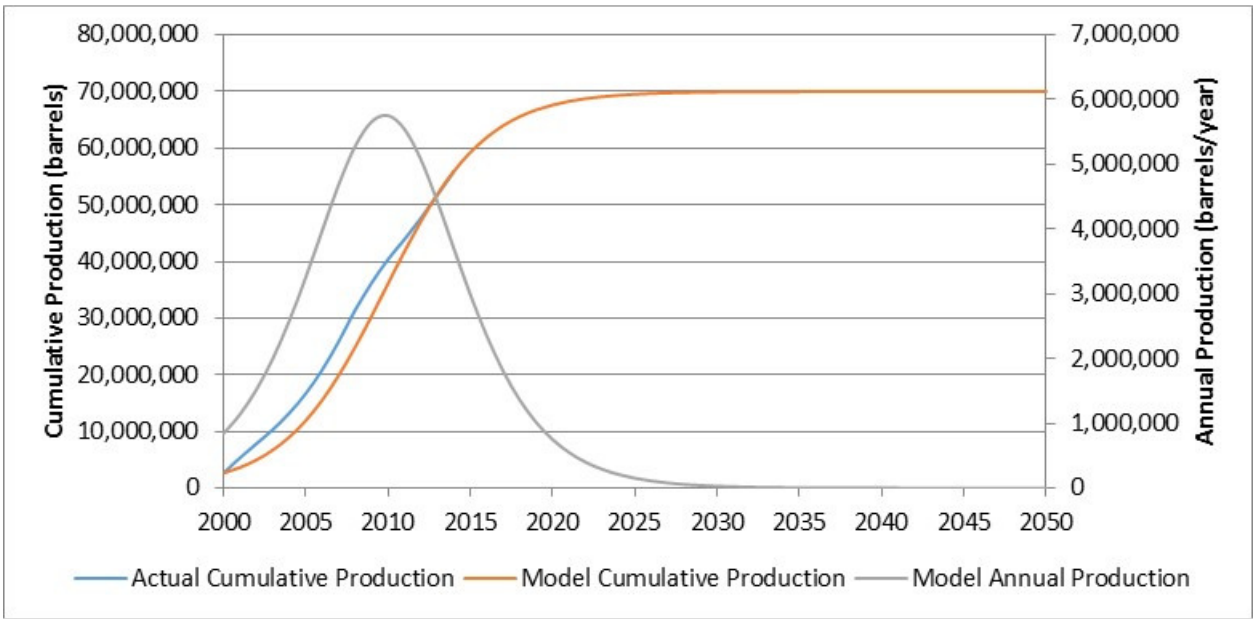


Figure A-36. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Haynesville Shale Play Region (2015-2050)



A summary of the annual growth factors calculated for the Haynesville Shale play region is presented in Table A-18.

Table A-18. Haynesville Shale Growth Factors

Year	Oil	Gas	Condensate
2015	0.884	0.890	0.808
2016	0.765	0.765	0.635
2017	0.651	0.638	0.488
2018	0.545	0.518	0.368
2019	0.450	0.413	0.275
2020	0.368	0.323	0.203
2021	0.299	0.250	0.149
2022	0.241	0.191	0.109
2023	0.193	0.145	0.079
2024	0.154	0.110	0.057
2025	0.122	0.083	0.041
2026	0.097	0.062	0.030
2027	0.076	0.046	0.022
2028	0.060	0.035	0.016
2029	0.047	0.026	0.011
2030	0.037	0.019	0.008
2031	0.029	0.014	0.006
2032	0.023	0.011	0.004
2033	0.018	0.008	0.003
2034	0.014	0.006	0.002
2035	0.011	0.004	0.002
2036	0.009	0.003	0.001
2037	0.007	0.002	0.001
2038	0.005	0.002	0.001
2039	0.0042	0.0013	0.0004
2040	0.0033	0.0010	0.0003
2041	0.0026	0.0007	0.0002
2042	0.0020	0.0005	0.0002
2043	0.0016	0.0004	0.0001
2044	0.0012	0.0003	0.0001
2045	0.0010	0.0002	0.0001
2046	0.00077	0.00016	0.00004
2047	0.00060	0.00012	0.00003
2048	0.00047	0.00009	0.00002
2049	0.00037	0.00007	0.00002
2050	0.00029	0.00005	0.00001

Permian Basin Play

Model development under Hubbert's Method for the Permian Basin oil play region resulted in the models for cumulative production and annual production as shown in Table A-19.

Table A-19. Hubbert's Method Production Models for Permian Basin Oil Play Region

Product	Cumulative Production	Annual Production
Oil	$Q_{Oil,P}(barrels) = \frac{12{,}798{,}311{,}130}{1+(44.778)e^{-0.2247(t-2014)}}$	$P(t)_{Oil,P}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,P} = \frac{(0.2247)(12{,}798{,}311{,}130)(44.778)e^{-0.2247(t-2014)}}{(1+(44.778)e^{-0.2247(t-2014)})^2}$
Gas	$Q_{G,P}(MCF) = \frac{11{,}564{,}077{,}230}{1+(13.94)e^{-0.3254(t-2014)}}$	$P(t)_{G,P}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,P} = \frac{(0.3254)(11{,}564{,}077{,}230)(13.94)e^{-0.3254(t-2014)}}{(1+(13.94)e^{-0.3254(t-2014)})^2}$
Condensate	$Q_{C,P}(barrels) = \frac{123{,}940}{1+(25.11)e^{-0.4746(t-2014)}}$	$P(t)_{C,P}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,P} = \frac{(0.4746)(123{,}940)(25.11)e^{-0.4746(t-2014)}}{(1+(25.11)e^{-0.4746(t-2014)})^2}$

The estimated model parameters for the Permian Basin oil play region are summarized in Table A-20.

Table A-20. Summary of Hubbert's Method Production Model Parameters for Permian Basin Oil Play Region

Product	Q_∞	a	N_o
Oil	12,798,311,130	0.2247	44.778
Gas	11,564,077,230	0.3254	13.94
Condensate	123,940	0.4746	25.11

Figures A-37 and A-38 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-39 and A-40 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-41 and A-42 present

actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-37. Hubbert's Model Fit to Historic Oil Production from the Permian Basin Oil Play Region (2000-2014)

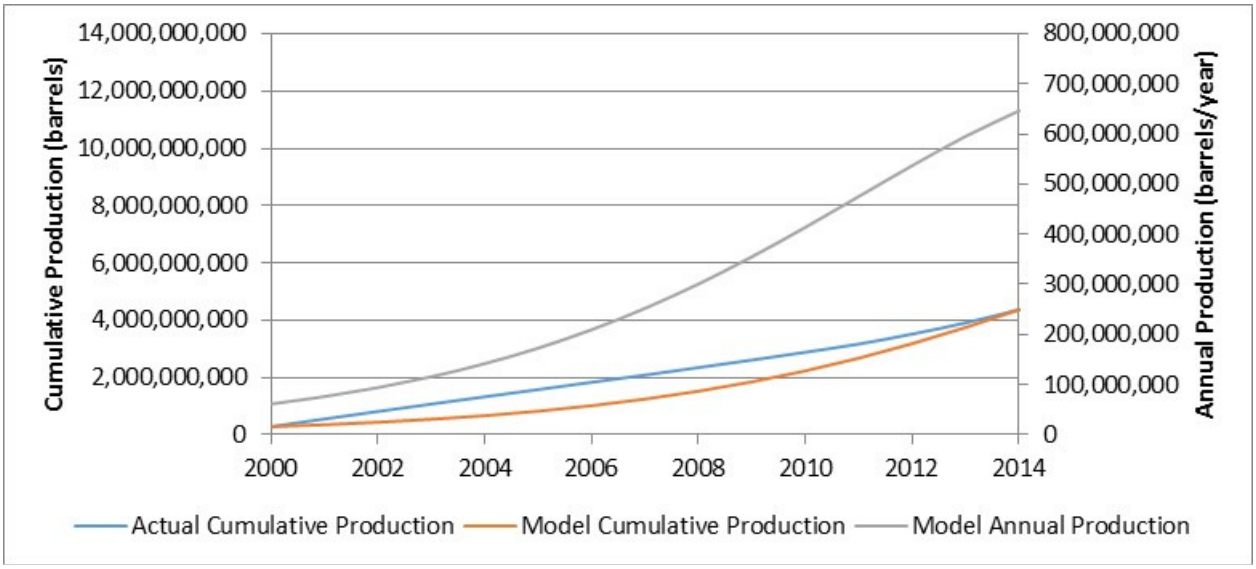


Figure A-38. Hubbert's Model Projected Cumulative and Annual Oil Production from the Permian Basin Oil Play Region (2015-2050)

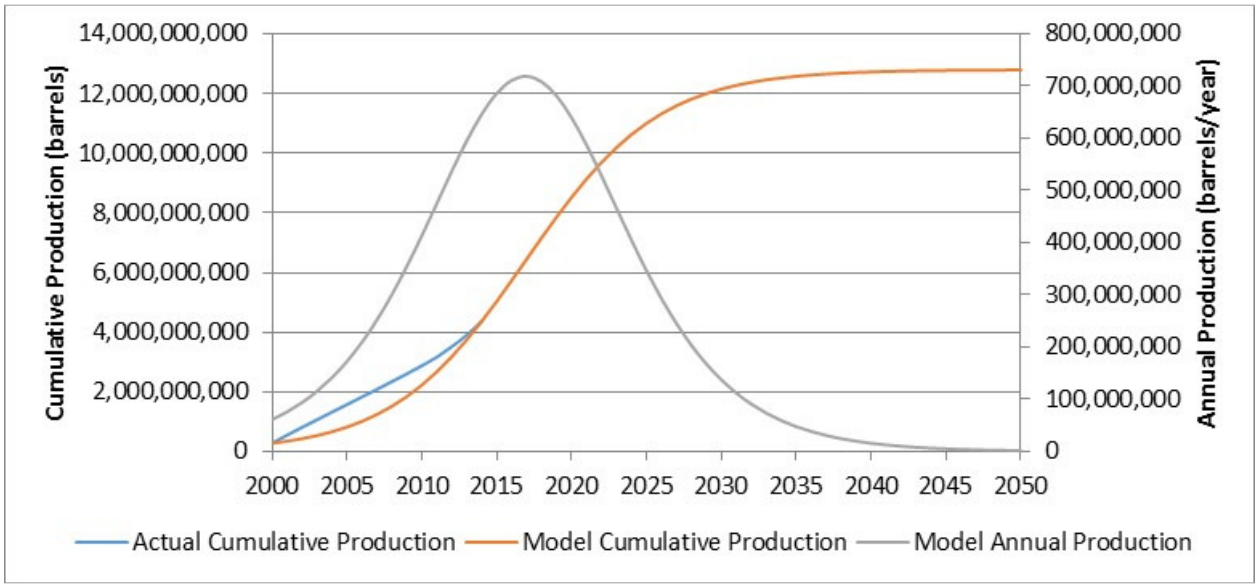


Figure A-39. Hubbert's Model Fit to Historic Natural Gas Production from the Permian Basin Oil Play Region (2000-2014)

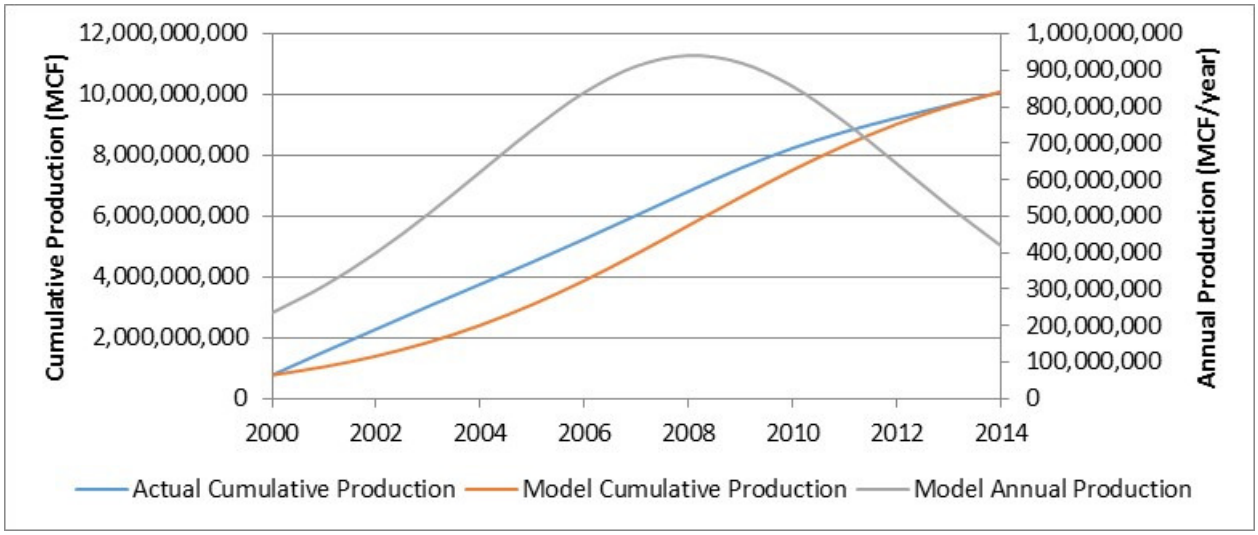


Figure A-40. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Permian Basin Oil Play Region (2015-2050)

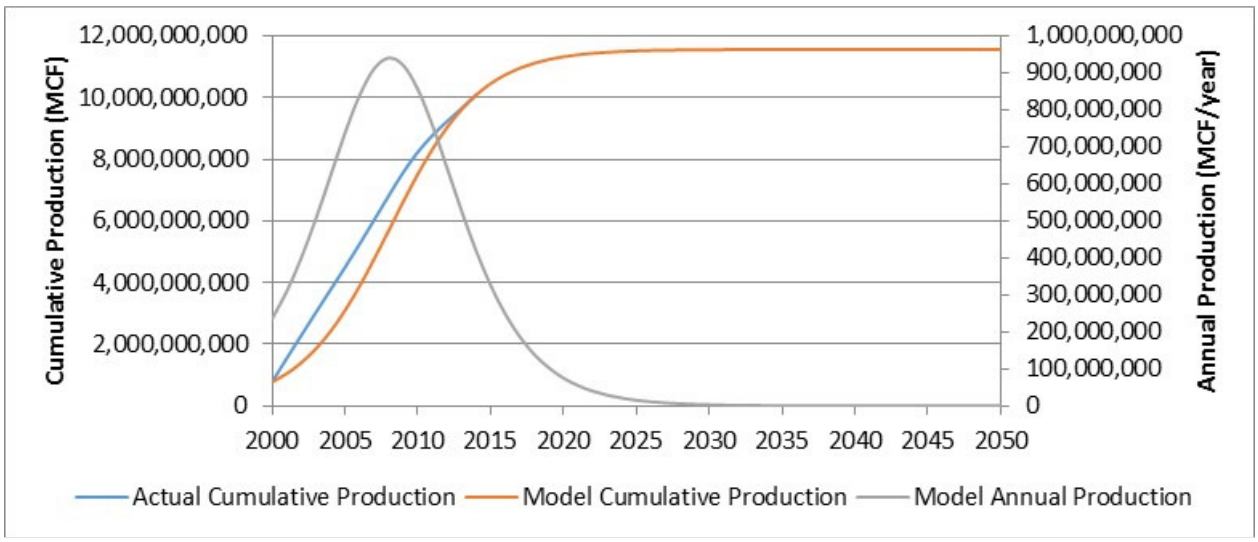


Figure A-41. Hubbert's Model Fit to Historic Condensate Production from the Permian Basin Oil Play Region (2000-2014)

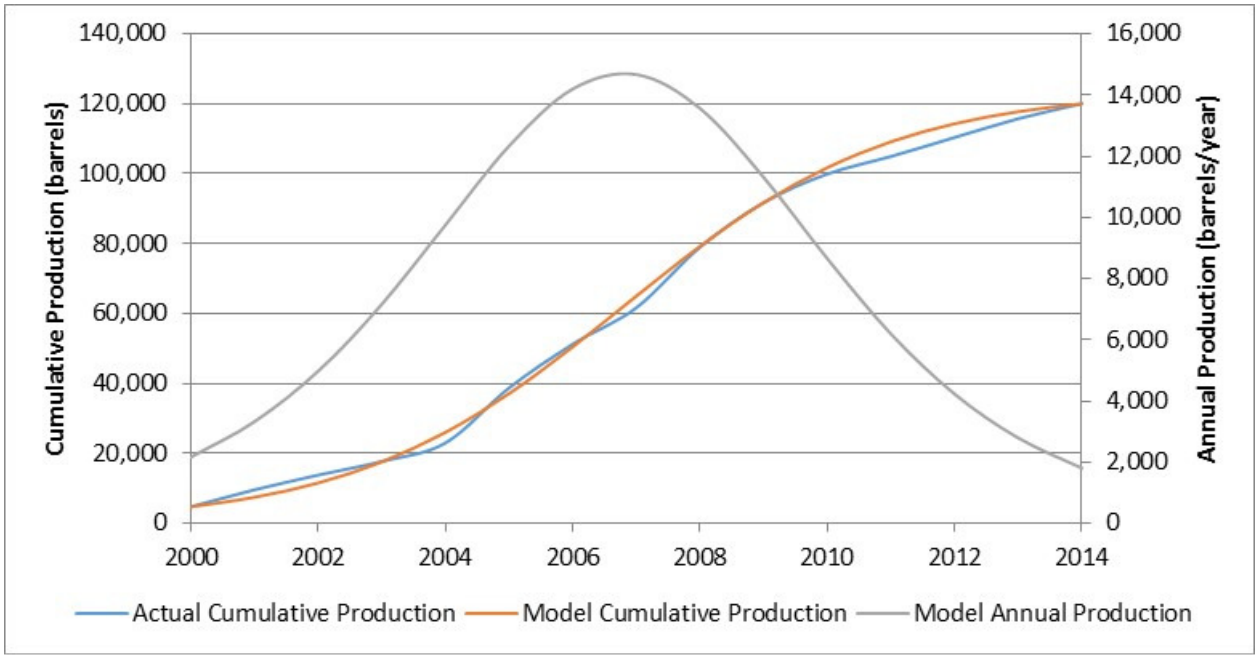
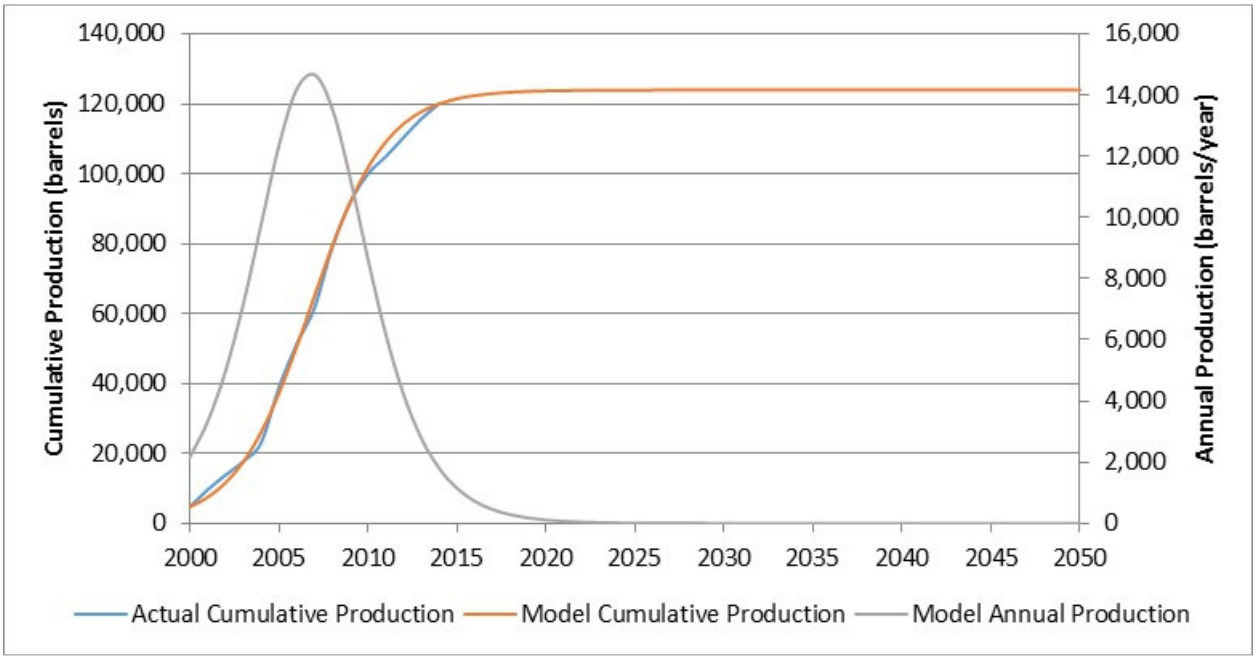


Figure A-42. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Permian Basin Oil Play Region (2015-2050)



A summary of the annual growth factors calculated for the Permian Basin is presented in Table A-21.

Table A-21. Permian Basin Growth Factors

Year	Oil	Gas	Condensate
2015	1.061	0.776	0.637
2016	1.100	0.592	0.403
2017	1.112	0.445	0.253
2018	1.096	0.331	0.158
2019	1.053	0.244	0.099
2020	0.989	0.179	0.062
2021	0.908	0.131	0.038
2022	0.816	0.095	0.024
2023	0.720	0.069	0.015
2024	0.626	0.050	0.009
2025	0.536	0.036	0.006
2026	0.453	0.026	0.004
2027	0.379	0.019	0.002
2028	0.315	0.014	0.001
2029	0.259	0.010	0.001
2030	0.212	0.007	0.001
2031	1.73E-01	5.20E-03	3.34E-04
2032	1.41E-01	3.76E-03	2.08E-04
2033	1.14E-01	2.71E-03	1.29E-04
2034	9.19E-02	1.96E-03	8.05E-05
2035	7.40E-02	1.42E-03	5.01E-05
2036	5.95E-02	1.02E-03	3.12E-05
2037	4.78E-02	7.39E-04	1.94E-05
2038	3.84E-02	5.33E-04	1.21E-05
2039	3.08E-02	3.85E-04	7.50E-06
2040	2.46E-02	2.78E-04	4.67E-06
2041	1.97E-02	2.01E-04	2.90E-06
2042	1.58E-02	1.45E-04	1.81E-06
2043	1.26E-02	1.05E-04	1.12E-06
2044	1.01E-02	7.57E-05	6.99E-07
2045	8.07E-03	5.47E-05	4.35E-07
2046	6.45E-03	3.95E-05	2.71E-07
2047	5.16E-03	2.85E-05	1.68E-07
2048	4.12E-03	2.06E-05	1.05E-07
2049	3.29E-03	1.49E-05	6.52E-08
2050	2.63E-03	1.07E-05	4.05E-08

A.6 Conservative Baseline Assumptions

To provide a conservative estimate of emissions from oil and gas production activities in future years, an analysis was conducted to determine the lowest annual production of oil, gas, and condensate for the period 1993-2014 for each study area. This production level was then used as the minimum baseline of production activity in the future years.

To provide a conservative estimate of total well counts in future years, peak well counts were assumed to occur at the peak year of production, and then held constant for a four-year period before starting to decline in parallel to production decline. This assumption is based on historical gas well counts and gas production for the Barnett Shale and the Haynesville Shale, which have each already peaked in both gas production and gas well count. As shown in Figures A-43 and A-44 below, there was an approximate 4-year lag between peak gas production and peak gas well counts in the Barnett Shale; and gas well counts remained relatively constant for a period of 4 years in the Haynesville Shale after gas production peaked.

Figure A-43. Year of Peak Production and Peak Well Count: Barnett Shale

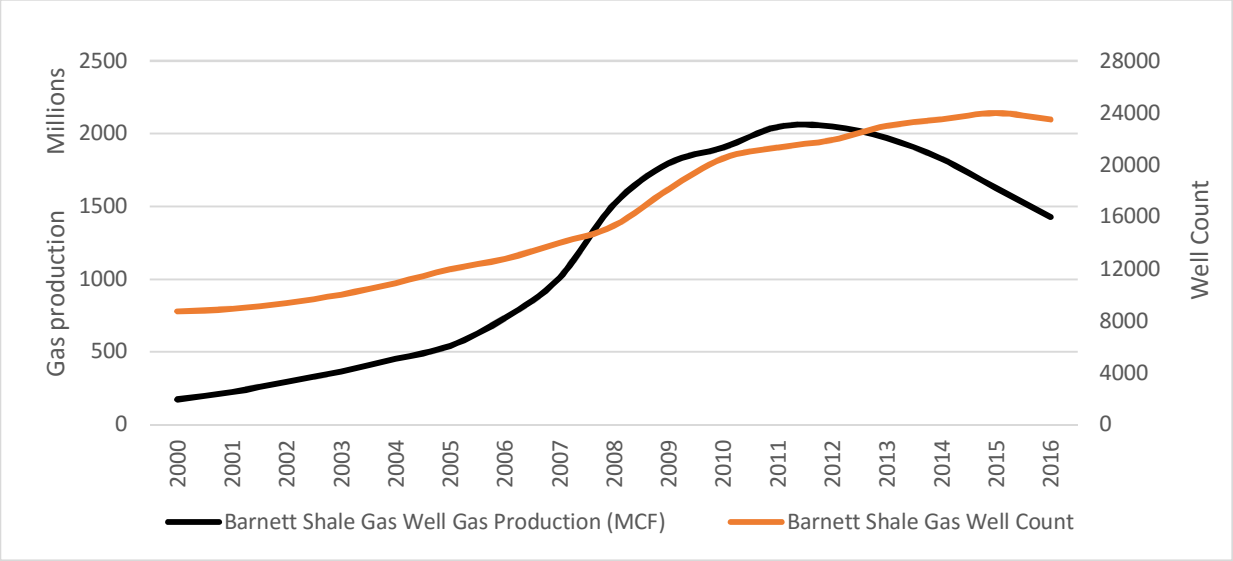
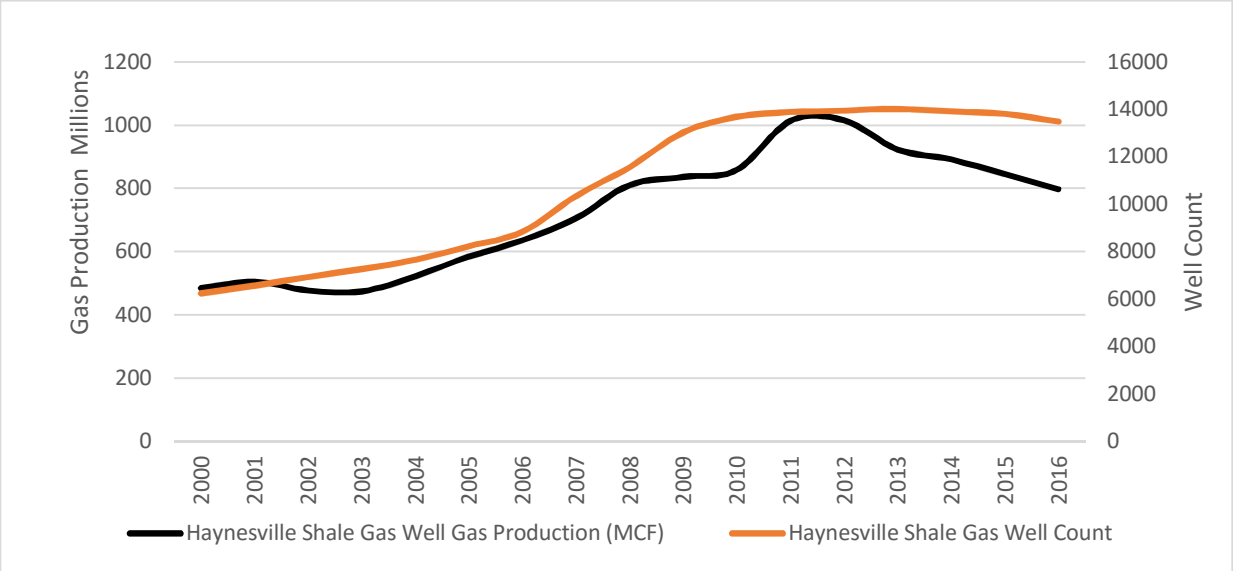


Figure A-44. Year of Peak Production and Peak Well Count: Haynesville Shale



Tables A-22 and A-23 show the final growth factors developed using the results of Hubbert's method found in Tables A-12, A-15, A-18, and A-21 above combined with these conservative baseline assumptions. As mentioned previously, growth factors for counties in Texas outside of the four study areas were estimated by averaging oil, gas, and condensate growth factors across each of the four study areas.

Table A-22. Final Production Growth Factors

	Barnett			Eagle Ford			Haynesville			Permian			Average		
Year	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.
2015	0.910	1.028	0.982	1.138	1.055	1.156	0.924*	0.890	0.808	1.061	0.776	0.637	1.008	0.937	0.896
2016	0.824*	0.988	0.906	1.246	1.082	1.281	0.924	0.765	0.635	1.100	0.731*	0.403	1.024	0.892	0.806
2017	0.824	0.891	0.789	1.310	1.078	1.356	0.924	0.638	0.578*	1.112	0.731	0.253	1.042	0.834	0.744
2018	0.824	0.758	0.653	1.318	1.043	1.366	0.924	0.539*	0.578	1.096	0.731	0.245*	1.040	0.768	0.711
2019	0.824	0.613	0.519	1.269	0.982	1.310	0.924	0.539	0.578	1.053	0.731	0.245	1.018	0.716	0.663
2020	0.824	0.476	0.398	1.172	0.901	1.198	0.924	0.539	0.578	0.989	0.731	0.245	0.977	0.662	0.605
2021	0.824	0.359	0.298	1.041	0.806	1.049	0.924	0.539	0.578	0.908	0.731	0.245	0.924	0.609	0.543
2022	0.824	0.264	0.219	0.893	0.706	0.885	0.924	0.539	0.578	0.816	0.731	0.245	0.864	0.560	0.482
2023	0.824	0.191	0.158	0.743	0.607	0.722	0.924	0.539	0.578	0.720	0.731	0.245	0.803	0.517	0.426
2024	0.824	0.136	0.113	0.604	0.513	0.574	0.924	0.539	0.578	0.626	0.731	0.245	0.744	0.480	0.378
2025	0.824	0.096	0.081	0.481	0.428	0.447	0.924	0.539	0.578	0.543*	0.731	0.245	0.693	0.449	0.338
2026	0.824	0.086*	0.071*	0.376	0.353	0.342	0.924	0.539	0.578	0.543	0.731	0.245	0.667	0.427	0.309
2027	0.824	0.086	0.071	0.291	0.291*	0.259	0.924	0.539	0.578	0.543	0.731	0.245	0.645	0.412*	0.288
2028	0.824	0.086	0.071	0.223	0.291	0.194	0.924	0.539	0.578	0.543	0.731	0.245	0.628	0.412	0.272
2029	0.824	0.086	0.071	0.170	0.291	0.144	0.924	0.539	0.578	0.543	0.731	0.245	0.615	0.412	0.260
2030	0.824	0.086	0.071	0.128	0.291	0.107	0.924	0.539	0.578	0.543	0.731	0.245	0.605	0.412	0.250
2031	0.824	0.086	0.071	0.096	0.291	0.079	0.924	0.539	0.578	0.543	0.731	0.245	0.597	0.412	0.243
2032	0.824	0.086	0.071	0.072	0.291	0.058	0.924	0.539	0.578	0.543	0.731	0.245	0.591	0.412	0.238
2033	0.824	0.086	0.071	0.054	0.291	0.043	0.924	0.539	0.578	0.543	0.731	0.245	0.586	0.412	0.234
2034	0.824	0.086	0.071	0.040	0.291	0.038*	0.924	0.539	0.578	0.543	0.731	0.245	0.583	0.412	0.233*
2035	0.824	0.086	0.071	0.038*	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582*	0.412	0.233
2036	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2037	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2038	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2039	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2040	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2041	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2042	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2043	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2044	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2045	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2046	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2047	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2048	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2049	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2050	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233

* 1st year of minimum baseline production.

Table A-23. Final Well Count Growth Factors

	Barnett			Eagle Ford			Haynesville			Permian			Average		
Year	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.	Oil	Gas	Cond.
2015	0.910	1.028	0.982	1.138	1.055	1.156	0.924*	0.890	0.808	1.061	0.776	0.637	1.008	0.937	0.896
2016	0.910	1.028	0.982	1.246	1.082	1.281	0.924	0.890	0.808	1.100	0.776	0.637	1.045	0.944	0.927
2017	0.910	1.028	0.982	1.310	1.082	1.356	0.924	0.890	0.808	1.112	0.776	0.637	1.064	0.944	0.946
2018	0.910	1.028	0.982	1.318	1.082	1.366	0.924	0.890	0.808	1.112	0.776	0.637	1.066	0.944	0.949
2019	0.824*	0.988	0.906	1.318	1.082	1.366	0.924	0.765	0.635	1.112	0.731*	0.403	1.044	0.892	0.828
2020	0.824	0.891	0.789	1.318	1.078	1.366	0.924	0.638	0.578*	1.112	0.731	0.253	1.044	0.834	0.746
2021	0.824	0.758	0.653	1.318	1.043	1.366	0.924	0.539*	0.578	1.096	0.731	0.245	1.040	0.768	0.711
2022	0.824	0.613	0.519	1.269	0.982	1.310	0.924	0.539	0.578	1.053	0.731	0.245	1.018	0.716	0.663
2023	0.824	0.476	0.398	1.172	0.901	1.198	0.924	0.539	0.578	0.989	0.731	0.245	0.977	0.662	0.605
2024	0.824	0.359	0.298	1.041	0.806	1.049	0.924	0.539	0.578	0.908	0.731	0.245	0.924	0.609	0.543
2025	0.824	0.264	0.219	0.893	0.706	0.885	0.924	0.539	0.578	0.816	0.731	0.245	0.864	0.560	0.482
2026	0.824	0.191	0.158	0.743	0.607	0.722	0.924	0.539	0.578	0.720	0.731	0.245	0.803	0.517	0.426
2027	0.824	0.136	0.113	0.604	0.513	0.574	0.924	0.539	0.578	0.626	0.731	0.245	0.744	0.480	0.378
2028	0.824	0.096	0.081	0.481	0.428	0.447	0.924	0.539	0.578	0.543*	0.731	0.245	0.693	0.449	0.338
2029	0.824	0.086*	0.071*	0.376	0.353	0.342	0.924	0.539	0.578	0.543	0.731	0.245	0.667	0.427	0.309
2030	0.824	0.086	0.071	0.291	0.291*	0.259	0.924	0.539	0.578	0.543	0.731	0.245	0.645	0.412*	0.288
2031	0.824	0.086	0.071	0.223	0.291	0.194	0.924	0.539	0.578	0.543	0.731	0.245	0.628	0.412	0.272
2032	0.824	0.086	0.071	0.170	0.291	0.144	0.924	0.539	0.578	0.543	0.731	0.245	0.615	0.412	0.260
2033	0.824	0.086	0.071	0.128	0.291	0.107	0.924	0.539	0.578	0.543	0.731	0.245	0.605	0.412	0.250
2034	0.824	0.086	0.071	0.096	0.291	0.079	0.924	0.539	0.578	0.543	0.731	0.245	0.597	0.412	0.243
2035	0.824	0.086	0.071	0.072	0.291	0.058	0.924	0.539	0.578	0.543	0.731	0.245	0.591	0.412	0.238
2036	0.824	0.086	0.071	0.054	0.291	0.043	0.924	0.539	0.578	0.543	0.731	0.245	0.586	0.412	0.234
2037	0.824	0.086	0.071	0.040	0.291	0.038*	0.924	0.539	0.578	0.543	0.731	0.245	0.583	0.412	0.233*
2038	0.824	0.086	0.071	0.038*	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582*	0.412	0.233
2039	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2040	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2041	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2042	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2043	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2044	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2045	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2046	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2047	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2048	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2049	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2050	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233

* 1st year of minimum baseline well counts.

A.7 Area Source Growth Factors and Associated Data

As described in previous sections, Hubbert's method was employed to develop growth factors for oil production, natural gas production, and condensate production for each of the four oil and gas play regions in Texas (i.e., Barnett, Eagle Ford, Haynesville, and Permian). The growth factor development and calculation spreadsheet (Oil and Gas Production Modeling and Growth Factor Calculation_05102016.xlsx) for this method was submitted to TCEQ along with this report.

The final growth factors shown in Tables A-22 and A-23, determined after applying the conservative baseline assumptions described above to the Hubbert's method results, were then applied to oil and gas-related SCCs based on the projected growth in oil, gas, or condensate production or well counts as a scaling variable. For example, projected growth in oil production was used as the scaling variable for SCC 2310011020 "On-Shore Oil Production /Storage Tanks: Crude Oil". Table A-24 below identifies the scaling variable (i.e., oil, gas, or condensate production or well counts) used to assign the growth factors to each SCC.

Seven of the area source oil and gas SCCs are generic in the sense that they are not specific to a product (i.e., oil, gas, or condensate). For example, SCC 2310000000 is for "Oil & Gas Expl & Prod /All Processes /Total: All Processes". The scaling variable for those generic SCCs is identified as "Oil and Gas Production Forecasts" in Table A-24. For those seven SCCs, the growth factor is based on a weighted average of the oil and gas well counts in each county as compared to the total well counts. Table A-25 presents the 2016 oil and gas well counts as of February 2016 for each county and shows the percentage of each type of well in each county (RRC, 2016a). These percentages were then multiplied by the oil and gas production growth factors to derive a weighted growth factor for each of the seven SCCs as follows:

$$GF_{o+g} = [GF_o \times (\%\ \text{Oil Wells}/100)] + [GF_g \times (\%\ \text{Gas Wells}/100)]$$

Where:

GF_{o+g} = oil and gas growth factor;

GF_o = oil growth factor; and

GF_g = gas growth factor

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310000000	Oil & Gas Expl & Prod /All Processes /Total: All Processes	Oil and Gas
2310000220	Oil & Gas Expl & Prod /All Processes /Drill Rigs	Oil and Gas
2310000230	Oil & Gas Expl & Prod /All Processes /Workover Rigs	Oil and Gas
2310000330	Oil & Gas Expl & Prod /All Processes /Artificial Lift	Oil Well Count

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310000440	Oil & Gas Expl & Prod /All Processes /Saltwater Disposal Engines	Oil and Gas
2310000550	Oil & Gas Expl & Prod /All Processes /Produced Water	Oil and Gas
2310000660	Oil & Gas Expl & Prod /Hydraulic Fracturing Engines (Fracking)	Oil and Gas
2310001000	Oil & Gas Expl & Prod /All Processes: On-shore /Total: All Processes	Oil and Gas
2310010000	Oil & Gas Expl & Prod /Crude Petroleum /Total: All Processes	Oil
2310010100	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Heaters	Oil Well Count
2310010200	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Tanks - Flashing & Standing/Working/Breathing	Oil
2310010300	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Pneumatic Devices	Oil Well Count
2310010700	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Fugitives	Oil Well Count
2310010800	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Truck Loading	Oil
2310011000	On-Shore Oil Production /Total: All Processes	Oil
2310011020	On-Shore Oil Production /Storage Tanks: Crude Oil	Oil
2310011100	On-Shore Oil Production /Heater Treater	Oil Well Count
2310011201	On-Shore Oil Production /Tank Truck/Railcar Loading: Crude Oil	Oil
2310011450	On-Shore Oil Production /Wellhead	Oil Well Count
2310011500	On-Shore Oil Production /Fugitives: All Processes	Oil Well Count
2310011501	On-Shore Oil Production /Fugitives: Connectors	Oil Well Count
2310011502	On-Shore Oil Production /Fugitives: Flanges	Oil Well Count
2310011503	On-Shore Oil Production /Fugitives: Open Ended Lines	Oil Well Count
2310011504	On-Shore Oil Production /Fugitives: Pumps	Oil Well Count
2310011505	On-Shore Oil Production /Fugitives: Valves	Oil Well Count
2310011506	On-Shore Oil Production /Fugitives: Other	Oil Well Count
2310011600	On-Shore Oil Production /Artificial Lift Engines	Oil Well Count
2310020000	Oil & Gas Expl & Prod /Natural Gas /Total: All Processes	Gas
2310020600	Oil & Gas Expl & Prod /Natural Gas /Compressor Engines	Gas
2310020700	Oil & Gas Expl & Prod /Natural Gas /Gas Well Fugitives	Gas Well Count
2310020800	Oil & Gas Expl & Prod /Natural Gas /Gas Well Truck Loading	Condensate
2310021000	On-Shore Gas Production /Total: All Processes	Gas
2310021010	On-Shore Gas Production /Storage Tanks: Condensate	Condensate
2310021011	On-Shore Gas Production / Condensate Tank Flaring	Condensate
2310021030	On-Shore Gas Production /Tank Truck/Railcar Loading: Condensate	Condensate
2310021100	On-Shore Gas Production /Gas Well Heaters	Gas Well Count
2310021101	On-Shore Gas Production /Natural Gas Fired 2Cycle Lean Burn Compressor Engines < 50 HP	Gas

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310021102	On-Shore Gas Production /Natural Gas Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP	Gas
2310021103	On-Shore Gas Production /Natural Gas Fired 2Cycle Lean Burn Compressor Engines 500+ HP	Gas
2310021109	On-Shore Gas Production /Total: All Natural Gas Fired 2Cycle Lean Burn Compressor Engines	Gas
2310021201	On-Shore Gas Production /Natural Gas Fired 4Cycle Lean Burn Compressor Engines <50 HP	Gas
2310021202	On-Shore Gas Production /Natural Gas Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP	Gas
2310021203	On-Shore Gas Production /Natural Gas Fired 4Cycle Lean Burn Compressor Engines 500+ HP	Gas
2310021209	On-Shore Gas Production /Total: All Natural Gas Fired 4Cycle Lean Burn Compressor Engines	Gas
2310021251	Lateral/Gathering Line Compressors (4Cycle Lean)	Gas
2310021300	On-Shore Gas Production /Gas Well Pneumatic Devices	Gas Well Count
2310021301	On-Shore Gas Production /Natural Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP	Gas
2310021302	On-Shore Gas Production /Natural Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP	Gas
2310021303	On-Shore Gas Production /Natural Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP	Gas
2310021309	On-Shore Gas Production /Total: All Natural Gas Fired 4Cycle Rich Burn Compressor Engines	Gas
2310021310	On-Shore Gas Production / Gas Well Pneumatic Pumps	Gas Well Count
2310021351	Lateral/Gathering Line Compressors (4Cycle Rich)	Gas
2310021400	On-Shore Gas Production /Gas Well Dehydrators	Gas
2310021401	On-Shore Gas Production /Nat Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP w/NSCR	Gas
2310021402	On-Shore Gas Production /Nat Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP w/NSCR	Gas
2310021403	On-Shore Gas Production /Nat Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP w/NSCR	Gas
2310021409	On-Shore Gas Production /Total: All Nat Gas Fired 4Cycle Rich Burn Compressor Engines w/NSCR	Gas
2310021410	On-Shore Gas Production /Amine Unit	Gas
2310021411	On-Shore Gas Production / Gas Well Dehydrators - Flaring	Gas
2310021450	On-Shore Gas Production /Wellhead	Gas
2310021500	On-Shore Gas Production /Gas Well Completion - Flaring	Gas
2310021501	On-Shore Gas Production /Fugitives: Connectors	Gas Well Count
2310021502	On-Shore Gas Production /Fugitives: Flanges	Gas Well Count
2310021503	On-Shore Gas Production /Fugitives: Open Ended Lines	Gas Well Count
2310021504	On-Shore Gas Production /Fugitives: Pumps	Gas Well Count
2310021505	On-Shore Gas Production /Fugitives: Valves	Gas Well Count
2310021506	On-Shore Gas Production /Fugitives: Other	Gas Well Count
2310021509	On-Shore Gas Production /Fugitives: All Processes	Gas Well Count

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310021600	On-Shore Gas Production /Gas Well Venting	Gas Well Count
2310021601	On-Shore Gas Production / Gas Well Venting - Initial Completions	Gas
2310021602	On-Shore Gas Production / Gas Well Venting– Recompletions	Gas
2310021603	On-Shore Gas Production / Gas Well Venting - Blowdowns	Gas Well Count
2310021604	On-Shore Gas Production / Gas Well Venting - Compressor Startups	Gas
2310021605	On-Shore Gas Production / Gas Well Venting - Compressor Shutdowns	Gas
2310021700	On-Shore Gas Production / Miscellaneous Engines	Gas
2310023000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Cbm Gas Well - Dewatering Pump Engines	Gas
2310030000	Oil & Gas Expl & Prod /Natural Gas Liquids /Total: All Processes	Condensate
2310030210	Oil & Gas Expl & Prod /Natural Gas Liquids /Gas Well Tanks - Flashing & Standing/Working/Breathing, Uncontrolled	Condensate
2310030220	Oil & Gas Expl & Prod /Natural Gas Liquids /Gas Well Tanks - Flashing & Standing/Working/Breathing, Controlled	Condensate
2310030230	Natural Gas Liquids / Gas Well Tanks – Flaring	Condensate
2310030300	Natural Gas Liquids / Gas Well Water Tank Losses	Condensate
2310030400	Natural Gas Liquids / Truck Loading	Condensate
2310030401	Natural Gas Liquids / Gas Plant Truck Loading	Condensate
2310031000	Oil & Gas Expl & Prod /Natural Gas Liquids: On-shore /Total: All Processes	Condensate
2310111000	On-Shore Oil Exploration /All Processes	Oil
2310111100	On-Shore Oil Exploration /Mud Degassing	Oil
2310111401	On-Shore Oil Exploration /Oil Well Pneumatic Pumps	Oil Well Count
2310111700	On-Shore Oil Exploration /Oil Well Completion: All Processes	Oil
2310111701	On-Shore Oil Exploration /Oil Well Completion: Flaring	Oil
2310111702	On-Shore Oil Exploration /Oil Well Completion: Venting	Oil
2310121000	On-Shore Gas Exploration /All Processes	Gas
2310121100	On-Shore Gas Exploration /Mud Degassing	Gas
2310121401	On-Shore Gas Exploration /Gas Well Pneumatic Pumps	Gas Well Count
2310121700	On-Shore Gas Exploration /Gas Well Completion: All Processes	Gas
2310121701	On-Shore Gas Exploration /Gas Well Completion: Flaring	Gas
2310121702	On-Shore Gas Exploration /Gas Well Completion: Venting	Gas

Table A-25. Growth Factor Weighting Percentages

County	Oil and Gas Play	Oil Well Count	Gas Well Count	Total Well Count	% Oil	% Gas
Archer	Barnett Shale	3,207	4	3,211	99.9%	0.1%
Bosque	Barnett Shale	1	2	3	33.3%	66.7%
Clay	Barnett Shale	1,134	23	1,157	98.0%	2.0%
Comanche	Barnett Shale	89	170	259	34.4%	65.6%
Cooke	Barnett Shale	2,080	318	2,398	86.7%	13.3%
Coryell	Barnett Shale	4	1	5	80.0%	20.0%
Dallas	Barnett Shale	0	30	30	0.0%	100.0%
Denton	Barnett Shale	50	2,960	3,010	1.7%	98.3%
Eastland	Barnett Shale	560	701	1,261	44.4%	55.6%
Ellis	Barnett Shale	14	51	65	21.5%	78.5%
Erath	Barnett Shale	3	296	299	1.0%	99.0%
Hamilton	Barnett Shale	2	13	15	13.3%	86.7%
Hill	Barnett Shale	7	227	234	3.0%	97.0%
Hood	Barnett Shale	1	659	660	0.2%	99.8%
Jack	Barnett Shale	1,822	1,160	2,982	61.1%	38.9%
Johnson	Barnett Shale	2	3,080	3,082	0.1%	99.9%
Montague	Barnett Shale	2,229	826	3,055	73.0%	27.0%
Palo Pinto	Barnett Shale	467	1,312	1,779	26.3%	73.7%
Parker	Barnett Shale	9	1,749	1,758	0.5%	99.5%
Shackelford	Barnett Shale	1,808	194	2,002	90.3%	9.7%
Somervell	Barnett Shale	1	57	58	1.7%	98.3%
Stephens	Barnett Shale	1,427	1,021	2,448	58.3%	41.7%
Tarrant	Barnett Shale	20	3,928	3,948	0.5%	99.5%
Wise	Barnett Shale	495	4,481	4,976	9.9%	90.1%
Young	Barnett Shale	2,467	234	2,701	91.3%	8.7%
Atascosa	Eagle Ford Shale	1,842	67	1,909	96.5%	3.5%
Bastrop	Eagle Ford Shale	247	69	316	78.2%	21.8%
Bee	Eagle Ford Shale	214	344	558	38.4%	61.6%
Brazos	Eagle Ford Shale	646	80	726	89.0%	11.0%
Burleson	Eagle Ford Shale	1,049	97	1146	91.5%	8.5%
De Witt	Eagle Ford Shale	1,421	0	1421	100.0%	0.0%
Dimmit	Eagle Ford Shale	1,606	1,346	2,952	54.4%	45.6%
Fayette	Eagle Ford Shale	620	209	829	74.8%	25.2%
Frio	Eagle Ford Shale	692	94	786	88.0%	12.0%
Gonzales	Eagle Ford Shale	1,293	12	1,305	99.1%	0.9%
Grimes	Eagle Ford Shale	78	197	275	28.4%	71.6%
Karnes	Eagle Ford Shale	1,727	572	2,299	75.1%	24.9%
La Salle	Eagle Ford Shale	196	0	196	100.0%	0.0%
Lavaca	Eagle Ford Shale	226	445	671	33.7%	66.3%
Lee	Eagle Ford Shale	788	66	854	92.3%	7.7%
Leon	Eagle Ford Shale	229	587	816	28.1%	71.9%
Live Oak	Eagle Ford Shale	530	533	1,063	49.9%	50.1%
Madison	Eagle Ford Shale	107	0	107	100.0%	0.0%
Maverick	Eagle Ford Shale	682	114	796	85.7%	14.3%

Table A-25. Growth Factor Weighting Percentages

County	Oil and Gas Play	Oil Well Count	Gas Well Count	Total Well Count	% Oil	% Gas
McMullen	Eagle Ford Shale	682	114	796	85.7%	14.3%
Milam	Eagle Ford Shale	1,797	10	1,807	99.4%	0.6%
Robertson	Eagle Ford Shale	239	920	1,159	20.6%	79.4%
Walker	Eagle Ford Shale	16	17	33	48.5%	51.5%
Webb	Eagle Ford Shale	102	5,893	5,995	1.7%	98.3%
Wilson	Eagle Ford Shale	624	2	626	99.7%	0.3%
Zavala	Eagle Ford Shale	449	58	507	88.6%	11.4%
Angelina	Haynesville Shale	2	93	95	2.1%	97.9%
Gregg	Haynesville Shale	2,954	887	3,841	76.9%	23.1%
Harrison	Haynesville Shale	269	2,519	2,788	9.6%	90.4%
Marion	Haynesville Shale	107	0	107	100.0%	0.0%
Nacogdoches	Haynesville Shale	45	1,384	1,429	3.1%	96.9%
Panola	Haynesville Shale	233	5,190	5,423	4.3%	95.7%
Rusk	Haynesville Shale	1,716	2,395	4,111	41.7%	58.3%
Sabine	Haynesville Shale	8	14	22	36.4%	63.6%
San Augustine	Haynesville Shale	11	251	262	4.2%	95.8%
Shelby	Haynesville Shale	33	666	699	4.7%	95.3%
Andrews	Permian Basin	11,136	128	11,264	98.9%	1.1%
Borden	Permian Basin	671	0	671	100.0%	0.0%
Brewster	Permian Basin	0	0	0	0	0
Cochran	Permian Basin	1,858	28	1,886	98.5%	1.5%
Coke	Permian Basin	333	25	358	93.0%	7.0%
Crane	Permian Basin	4,688	459	5,147	91.1%	8.9%
Crockett	Permian Basin	2,645	5726	8,371	31.6%	68.4%
Crosby	Permian Basin	784	0	784	100.0%	0.0%
Culberson	Permian Basin	136	221	357	38.1%	61.9%
Dawson	Permian Basin	1,421	0	1,421	100.0%	0.0%
Dickens	Permian Basin	227	0	227	100.0%	0.0%
Ector	Permian Basin	7,751	75	7,826	99.0%	1.0%
Edwards	Permian Basin	99	515	614	16.1%	83.9%
Fisher	Permian Basin	569	18	587	96.9%	3.1%
Gaines	Permian Basin	3,932	139	4,071	96.6%	3.4%
Garza	Permian Basin	2,223	0	2,223	100.0%	0.0%
Glasscock	Permian Basin	4,574	84	4,658	98.2%	1.8%
Hale	Permian Basin	212	0	212	100.0%	0.0%
Hockley	Permian Basin	4,108	13	4,121	99.7%	0.3%
Howard	Permian Basin	4,808	26	4,834	99.5%	0.5%
Hudspeth	Permian Basin	0	0	0	0	0
Irion	Permian Basin	2,446	257	2,703	90.5%	9.5%
Jeff Davis	Permian Basin	1	1	2	50.0%	50.0%
Kent	Permian Basin	622	0	622	100.0%	0.0%
Kimble	Permian Basin	1	14	15	6.7%	93.3%
King	Permian Basin	471	30	501	94.0%	6.0%
Lamb	Permian Basin	68	0	68	100.0%	0.0%

Table A-25. Growth Factor Weighting Percentages

County	Oil and Gas Play	Oil Well Count	Gas Well Count	Total Well Count	% Oil	% Gas
Loving	Permian Basin	1,028	304	1,332	77.2%	22.8%
Lubbock	Permian Basin	448	0	448	100.0%	0.0%
Lynn	Permian Basin	107	0	107	100.0%	0.0%
Martin	Permian Basin	5,719	2	5,721	100.0%	0.0%
Midland	Permian Basin	6,526	133	6,659	98.0%	2.0%
Mitchell	Permian Basin	2,730	4	2,734	99.9%	0.1%
Nolan	Permian Basin	639	38	677	94.4%	5.6%
Pecos	Permian Basin	3,226	1,340	4,566	70.7%	29.3%
Presidio	Permian Basin	0	0	0	0	0
Reagan	Permian Basin	5,453	45	5,498	99.2%	0.8%
Reeves	Permian Basin	1,918	338	2,256	85.0%	15.0%
Schleicher	Permian Basin	396	806	1,202	32.9%	67.1%
Scurry	Permian Basin	2,665	1	2,666	100.0%	0.0%
Sterling	Permian Basin	1391	578	1,969	70.6%	29.4%
Stonewall	Permian Basin	632	1	633	99.8%	0.2%
Sutton	Permian Basin	59	5,816	5,875	1.0%	99.0%
Terrell	Permian Basin	21	669	690	3.0%	97.0%
Terry	Permian Basin	899	7	906	99.2%	0.8%
Tom Green	Permian Basin	653	73	726	89.9%	10.1%
Upton	Permian Basin	5,813	345	6,158	94.4%	5.6%
Val Verde	Permian Basin	6	242	248	2.4%	97.6%
Ward	Permian Basin	3,676	248	3,924	93.7%	6.3%
Winkler	Permian Basin	1,810	312	2,122	85.3%	14.7%
Yoakum	Permian Basin	3,797	22	3,819	99.4%	0.6%

A.8 References

Brandt, A, 2010. "Review of mathematical models of future oil supply: Historical overview and synthesizing critique." *Energy* 35 (2010) 3958-3974.

Clark, A.J., 2011. "Decline Curve Analysis in Unconventional Resource Plays Using Logistic Growth Models". Master's Degree Thesis. The University of Texas at Austin. August.

EIA, 2011. *Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays*. U.S. Energy Information Administration. July.

EIA, 2014a. "Six formations are responsible for surge in Permian Basin crude oil production", July 9. Internet address: http://www.eia.gov/todayinenergy/ detail.cfm?id=17031

EIA, 2014b. *Crude Oil Proved Reserves, Reserves Changes, and Production, as of 12/31/2014*. U.S. Energy Information Administration. This estimate is based on proved reserves information for Texas Districts 7C, 8, and 8A. Internet address: http://www.eia.gov/dnav/pet/ pet_crd_pres_a_EPC0_R01_mmbbl_a.htm

EIA, 2015a. *U.S. Crude Oil and Natural Gas Proved Reserves*. U.S. Energy Information Administration. November.

ERG, 2012. *Forecasting Oil and Gas Activities*. Final Report. Prepared for the Texas Commission on Environmental Quality (TCEQ) by Eastern Research Group, Inc. (ERG), Morrisville, North Carolina. August 31.

Hubbert, M., 1956. "Nuclear energy and fossil fuels." In: Meeting of the Southern District, Division of Production, American Petroleum Institute. San Antonio, Texas: Shell Development Company.

Hubbert, M., 1980. "Techniques of prediction as applied to the production of oil and gas." In: Symposium on oil and gas supply modeling. Washington, D.C.: Department of Commerce, National Bureau of Standards.

RRC, 2016a. Historical production data. Railroad Commission of Texas, Oil and Gas Research and Statistics. Internet address: http://www.rrc.state.tx.us/oil-gas/research-and-statistics/production-data/historical-production-data/natural-gas-production-and-well-counts-since-1935/

RRC, 2016b. *Permian Basin Information*. Railroad Commission of Texas. This estimate based on historical production of 29 billion barrels, an equivalent amount in ultimately recoverable reserves, and the EIA estimate of 7 billion bbl in proved reserves for Districts 7C, 8, and 8A. Internet address: http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/permian-basin/

APPENDIX B
POINT SOURCE SIC-TO-NAICS CROSSWALK AND GROWTH FACTOR SURROGATE ASSIGNMENTS

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
119	Cash Grains, NEC	3112XX[a]	Grain and Oilseed Milling	3112	Grain and oilseed milling
723	Crop Prep Services For Market	3112XX[b]	Grain and Oilseed Milling	3112	Grain and oilseed milling
1221	Bituminous Coal/Lignite Surface Mining	212111	Bituminous Coal and Lignite Surface Mining	2121	Coal mining
1241	Coal Mining Services	213113	Support Activities for Coal Mining	2131	Support activities for mining
1311	Crude Petroleum & Natural Gas	211111[c]	Crude Petroleum and Natural Gas Extraction	SCC 2310000000	Oil and gas exploration and production, Total, All processes
1321	Natural Gas Liquids	211112[d]	Natural Gas Liquid Extraction	SCC 2310000000	Oil and gas exploration and production, Total, All processes
1382	Oil and Gas Field Exploration Services	541360	Geophysical Surveying and Mapping Services	5413	Architectural, engineering, and related services
1389	Oil and Gas Field Services, NEC	237120	Oil and Gas Pipeline and Related Structures Construction	2371	Utility system construction
1422	Crushed and Broken Limestone	212312	Crushed and Broken Limestone Mining and Quarrying	2123	Nonmetallic mineral mining and quarrying
1541	Industrial Building/Warehouses	236220	Commercial and Institutional Building Construction	2362	Nonresidential building construction
1629	Heavy Construction, NEC	237990	Other Heavy and Civil Engineering Construction	2379	Other heavy and civil engineering construction
1721	Painting Paper Hanging Decorating	238320	Painting and Wall Covering Contractors	2383	Building finishing contractors
2011	Meat Packing Plants	311611	Animal (except Poultry) Slaughtering	3116	Animal slaughtering and processing
2013	Sausages & Other Prepared Meat	311612	Meat Processed from Carcasses	3116	Animal slaughtering and processing
2023	Dry Condensed/Evaporated Dairy Products	311514[e]	Dry, Condensed, and Evaporated Dairy Product Manufacturing	3115	Dairy product manufacturing
2026	Fluid Milk	311511[f]	Fluid Milk Manufacturing	3115	Dairy product manufacturing
2032	Canned Specialties	311999	All Other Miscellaneous Food Manufacturing	3119	Other food manufacturing

[a] Original NAICS 111130 (Dry Pea and Bean Farming) was matched to SIC 119; changed to NAICS 3112XX (Grain and Oilseed Milling) based on discussion with TCEQ.
[b] Original NAICS 115114 (Postharvest Crop Activities [except Cotton Ginning]) was matched to SIC 723; changed to NAICS 3112XX (Grain and Oilseed Milling) based on discussion with TCEQ.
[c] For SIC 1311, the original growth factor data assignment was Economy.com output data for NAICS 2111 (Oil and Gas Extraction). This was changed to the area source SCC 2310000000 based on discussion with TCEQ.
[d] For SIC 1321, the original growth factor data assignment was Economy.com output data for NAICS 2111 (Oil and Gas Extraction). This was changed to the area source SCC 2310000000 based on discussion with TCEQ.
[e] Original NAICS 311511 (Fluid Milk) incorrectly matched to SIC 2023; changed to NAICS 311514 (Dry/Condensed/Evaporated Dairy Products).
[f] Original NAICS 311514 (Dry/Condensed/Evaporated Dairy Products) incorrectly matched to SIC 2026; changed to NAICS 311511 (Fluid Milk).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
2035	Pickles Sauces and Salad Dress	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing	3119	Other food manufacturing
2041	Flour & Other Grain Mill Products	311211	Flour Milling	3112	Grain and oilseed milling
2046	Wet Corn Milling	311221	Wet Corn Milling	3112	Grain and oilseed milling
2048	Prepared Feeds, NEC	311119	Other Animal Food Manufacturing	3111	Animal food manufacturing
2051	Bread, Cake and Related Products	311812	Commercial Bakeries	3118	Bakeries and tortilla manufacturing
2061	Raw Cane Sugar Except Refining	311314	Cane Sugar Manufacturing	3113	Sugar and confectionery product manufacturing
2074	Cottonseed Oil Mills	311224	Soybean and Other Oilseed Processing	3112	Grain and oilseed milling
2077	Animal and Marine Fats and Oil	311613	Rendering and Meat Byproduct Processing	3116	Animal slaughtering and processing
2082	Malt Beverages	312120	Breweries	3121	Beverage manufacturing
2095	Roasted Coffee	311920	Coffee and Tea Manufacturing	3119	Other food manufacturing
2096	Potato, Corn Chips, Similar Snack	311919	Other Snack Food Manufacturing	3119	Other food manufacturing
2099	Food Preparations, NEC	311991	Perishable Prepared Food Manufacturing	3119	Other food manufacturing
2221	Broad woven Fabric Mills/Man-Made Fiber and Silk	313210	Broad woven Fabric Mills	3132	Fabric mills
2295	Coated Fabrics, Not Rubberized	313320	Fabric Coating Mills	3133	Textile and fabric finishing and fabric coating mills
2353	Hats, Caps and Millinery	315990	Apparel Accessories and Other Apparel Manufacturing	3159	Apparel accessories and other apparel manufacturing
2421	Sawmills & Planning Mills General	321113	Sawmills	3211	Sawmills and wood preservation
2431	Millwork	321911	Wood Window and Door Manufacturing	3219	Other wood product manufacturing
2434	Wood Kitchen Cabinets	337110	Wood Kitchen Cabinet and Countertop Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing
2436	Softwood Veneer and Plywood	321212	Softwood Veneer and Plywood Manufacturing	3212	Veneer, plywood, and engineered wood product manufacturing
2449	Wood Containers, NEC	321999	All Other Miscellaneous Wood Product Manufacturing	3219	Other wood product manufacturing
2493	Reconstituted Wood Products	321219	Reconstituted Wood Product Manufacturing	3212	Veneer, plywood, and engineered wood product manufacturing
2499	Wood Products, NEC	321999	All Other Miscellaneous Wood Product Manufacturing	3219	Other wood product manufacturing
2519	Household Furniture, NEC	337125	Household Furniture (except Wood and Metal) Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
2521	Wood Office Furniture	337211	Wood Office Furniture Manufacturing	3372	Office furniture (including fixtures) manufacturing
2541	Wood Partitions and Fixtures	337110	Wood Kitchen Cabinet and Countertop Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing
2542	Partition and Fixtures Except Wood	337127	Institutional Furniture Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing
2621	Paper Mills	322121	Paper (except Newsprint) Mills	3221	Pulp, paper, and paperboard mills
2631	Paperboard Mills	322130	Paperboard Mills	3221	Pulp, paper, and paperboard mills
2653	Corrugated and Solid Fiber Box	322211	Corrugated and Solid Fiber Box Manufacturing	3222	Converted paper product manufacturing
2656	Sanitary Food Containers	322219	Other Paperboard Container Manufacturing	3222	Converted paper product manufacturing
2671	Paper Coated & Laminated Pkg.	322220[g]	Paper Bag and Coated and Treated Paper Manufacturing	3222	Converted paper product manufacturing
2672	Paper Coated & Laminated, NEC	322220[h]	Paper Bag and Coated and Treated Paper Manufacturing	3222	Converted paper product manufacturing
2673	Bags, Plastics, Laminated Coat	326111	Plastics Bag and Pouch Manufacturing	3261	Plastics product manufacturing
2679	Converted Paper Products, NEC	322299	All Other Converted Paper Product Manufacturing	3222	Converted paper product manufacturing
2711	Newspapers	511110	Newspaper Publishers	5111	Newspaper, periodical, book, and directory publishers
2752	Commercial Printing Lithograph	323111	Commercial Printing (except Screen and Books)	3231	Printing and related support activities
2754	Commercial Printing, Gravure	323111	Commercial Printing (except Screen and Books)	3231	Printing and related support activities
2759	Commercial Printing, NEC	323111	Commercial Printing (except Screen and Books)	3231	Printing and related support activities
2812	Alkalies and Chlorine	325180	Other Basic Inorganic Chemical Manufacturing	3251	Basic chemical manufacturing
2813	Industrial Gases	325120	Industrial Gas Manufacturing	3251	Basic chemical manufacturing
2819	Industrial Inorganic Chemicals	325180	Other Basic Inorganic Chemical Manufacturing	3251	Basic chemical manufacturing

[g] Original NAICS 326112 (Plastics Packaging, Film and Sheet Manufacturing) incorrectly matched to SIC 2671; changed to NAICS 322220 (Paper Bag and Coated and Treated Paper Manufacturing).
[h] Original NAICS 326111 (Plastics Bag and Pouch Manufacturing) incorrectly matched to SIC 2672; changed to NAICS 322220 (Paper Bag and Coated and Treated Paper Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
2821	Plastics Materials and Synthetic Resins	325211	Plastics Material and Resin Manufacturing	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
2822	Synthetic Rubber	325212	Synthetic Rubber Manufacturing	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
2833	Medicinals and Botanicals	325411	Medicinal and Botanical Manufacturing	3254	Pharmaceutical and medicine manufacturing
2834	Pharmaceutical Preparations	325412	Pharmaceutical Preparation Manufacturing	3254	Pharmaceutical and medicine manufacturing
2842	Specialty Cleaning, Polishes and Sanitation Goods	325612	Polish and Other Sanitation Good Manufacturing	3256	Soap, cleaning compound, and toilet preparation manufacturing
2843	Surface Active Agents	325613	Surface Active Agent Manufacturing	3256	Soap, cleaning compound, and toilet preparation manufacturing
2844	Toilet Preparations	325620	Toilet Preparation Manufacturing	3256	Soap, cleaning compound, and toilet preparation manufacturing
2851	Paints and Allied Products	325510	Paint and Coating Manufacturing	3255	Paint, coating, and adhesive manufacturing
2865	Cyclic Crudes and Intermediates, and Organic Dyes	325110	Petrochemical Manufacturing	3251	Basic chemical manufacturing
2869	Industrial Organic Chemicals, NEC	325110	Petrochemical Manufacturing	3251	Basic chemical manufacturing
2873	Nitrogenous Fertilizers	325311	Nitrogenous Fertilizer Manufacturing	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
2874	Phosphatic Fertilizers	325312	Phosphatic Fertilizer Manufacturing	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
2879	Agricultural Chemicals, NEC	325320	Pesticide and Other Agricultural Chemical Manufacturing	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
2891	Adhesives and Sealants	325520	Adhesive Manufacturing	3255	Paint, coating, and adhesive manufacturing
2895	Carbon Black	325180	Other Basic Inorganic Chemical Manufacturing	3251	Basic chemical manufacturing
2899	Chemical Preparations, NEC	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing	3259	Other chemical product and preparation manufacturing
2911	Petroleum Refining	324110	Petroleum Refineries	3241	Petroleum and coal products manufacturing
2951	Paving Mixtures and Blocks	324121	Asphalt Paving Mixture and Block Manufacturing	3241	Petroleum and coal products manufacturing
2952	Asphalt Felts and Coatings	324122	Asphalt Shingle and Coating Materials Manufacturing	3241	Petroleum and coal products manufacturing
2992	Lubricating Oils and Greases	324191	Petroleum Lubricating Oil and Grease Manufacturing	3241	Petroleum and coal products manufacturing
2999	Petroleum and Coal Products, NEC	324199	All Other Petroleum and Coal Products Manufacturing	3241	Petroleum and coal products manufacturing

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3011	Tires and Inner Tubes	326211	Tire Manufacturing (except Retreading)	3262	Rubber product manufacturing
3052	Rubber & Plastics Hose and Belting	326220	Rubber and Plastics Hoses and Belting Manufacturing	3262	Rubber product manufacturing
3053	Gaskets, Packing and Sealing Devices	339991	Gasket, Packing, and Sealing Device Manufacturing	3399	Other miscellaneous manufacturing
3061	Mechanical Rubber Goods	326291	Rubber Product Manufacturing for Mechanical Use	3262	Rubber product manufacturing
3081	Unsupported Plastics, Film & Sheet	326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing	3261	Plastics product manufacturing
3082	Unsupported Plastics Profile Shape	326121	Unlaminated Plastics Profile Shape Manufacturing	3261	Plastics product manufacturing
3084	Plastics, Pipe	326122	Plastics Pipe and Pipe Fitting Manufacturing	3261	Plastics product manufacturing
3086	Plastics, Foam Products	326140	Polystyrene Foam Product Manufacturing	3261	Plastics product manufacturing
3087	Custom Compound Purchased Resin	325991	Custom Compounding of Purchased Resins	3259	Other chemical product and preparation manufacturing
3088	Plastics, Plumbing Fixtures	326191	Plastics Plumbing Fixture Manufacturing	3261	Plastics product manufacturing
3089	Plastics Products, NEC	326121	Unlaminated Plastics Profile Shape Manufacturing	3261	Plastics product manufacturing
3143	Men's Footwear, Except Athletic	316210	Footwear Manufacturing	3162	Footwear manufacturing
3149	Footwear, Except Rubber, NEC	316210	Footwear Manufacturing	3162	Footwear manufacturing
3211	Flat Glass	327211	Flat Glass Manufacturing	3272	Glass and glass product manufacturing
3221	Glass Containers	327213	Glass Container Manufacturing	3272	Glass and glass product manufacturing
3229	Pressed and Blown Glass, NEC	327212	Other Pressed and Blown Glass and Glassware Manufacturing	3272	Glass and glass product manufacturing
3231	Products Of Purchased Glass	327215	Glass Product Manufacturing Made of Purchased Glass	3272	Glass and glass product manufacturing
3241	Cement, Hydraulic	327310	Cement Manufacturing	3273	Cement and concrete product manufacturing
3251	Brick and Structural Clay Tile	327120	Clay Building Material and Refractories Manufacturing	3271	Clay product and refractory manufacturing
3253	Ceramic Wall and Floor Tile	327120	Clay Building Material and Refractories Manufacturing	3271	Clay product and refractory manufacturing
3261	Vitreous Plumbing Fixtures	327110	Pottery, Ceramics, and Plumbing Fixture Manufacturing	3271	Clay product and refractory manufacturing

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3269	Pottery Products, NEC	327110	Pottery, Ceramics, and Plumbing Fixture Manufacturing	3271	Clay product and refractory manufacturing
3272	Concrete Products, NEC	327390	Other Concrete Product Manufacturing	3273	Cement and concrete product manufacturing
3274	Lime	327410	Lime Manufacturing	3274	Lime and gypsum product manufacturing
3275	Gypsum Products	327420	Gypsum Product Manufacturing	3274	Lime and gypsum product manufacturing
3291	Abrasive Products	327910	Abrasive Product Manufacturing	3279	Other nonmetallic mineral product manufacturing
3295	Minerals, Ground Or Treated	327992	Ground or Treated Mineral and Earth Manufacturing	3279	Other nonmetallic mineral product manufacturing
3296	Mineral Wool	327993	Mineral Wool Manufacturing	3279	Other nonmetallic mineral product manufacturing
3299	Nonmetallic Mineral Products	327999[i]	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	3279	Other nonmetallic mineral product manufacturing
3312	Blast Furnaces and Steel Mills	331110[j]	Iron and Steel Mills and Ferroalloy Manufacturing	3311	Iron and steel mills and ferroalloy manufacturing
3317	Steel Pipe and Tubes	331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	3312	Steel product manufacturing from purchased steel
3321	Gray & Ductile Iron Foundries	331511	Iron Foundries	3315	Foundries
3322	Malleable Iron Foundries	331511	Iron Foundries	3315	Foundries
3325	Steel Foundries, NEC	331513	Steel Foundries (except Investment)	3315	Foundries
3331	Primary Copper	331410	Nonferrous Metal (except Aluminum) Smelting and Refining	3314	Nonferrous metal (except aluminum) production and processing
3334	Primary Aluminum	331313	Alumina Refining and Primary Aluminum Production	3313	Alumina and aluminum production and processing
3341	Secondary Nonferrous Metals	331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)	3314	Nonferrous metal (except aluminum) production and processing
3351	Copper Rolling and Drawing	331420	Copper Rolling, Drawing, Extruding, and Alloying	3314	Nonferrous metal (except aluminum) production and processing
3353	Aluminum Sheet Plate & Foil	331315	Aluminum Sheet, Plate, and Foil Manufacturing	3313	Alumina and aluminum production and processing

[i] Original NAICS 327110 (Pottery, Ceramics, and Plumbing Fixture Manufacturing) incorrectly matched to SIC 3299; changed to NAICS 327999 (All Other Miscellaneous Nonmetallic Mineral Product Manufacturing).
[j] Original NAICS 331221 (Rolled Steel Shape Manufacturing) incorrectly matched to SIC 3312; changed to NAICS 331110 (Iron and Steel Mills and Ferroalloy Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3354	Aluminum Extruded Products	331318	Other Aluminum Rolling, Drawing, and Extruding	3313	Alumina and aluminum production and processing
3357	Nonferrous Wire Drawing & Insulating	331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	3314	Nonferrous metal (except aluminum) production and processing
3364	Nonferrous Die-Casting, Except Aluminum	331523	Nonferrous Metal Die-Casting Foundries	3315	Foundries
3366	Copper Foundries	331529	Other Nonferrous Metal Foundries (except Die-Casting)	3315	Foundries
3411	Metal Cans	332431	Metal Can Manufacturing	3324	Boiler, tank, and shipping container manufacturing
3412	Metal Barrels, Drums & Pails	332439	Other Metal Container Manufacturing	3324	Boiler, tank, and shipping container manufacturing
3441	Fabricated Structural Metal	332312	Fabricated Structural Metal Manufacturing	3323	Architectural and structural metals manufacturing
3442	Metal Doors, Sash, and Trim	332321	Metal Window and Door Manufacturing	3323	Architectural and structural metals manufacturing
3443	Fabricated Plate Work (Boiler Shops)	332313	Plate Work Manufacturing	3323	Architectural and structural metals manufacturing
3444	Sheet Metal Work	332322	Sheet Metal Work Manufacturing	3323	Architectural and structural metals manufacturing
3448	Prefabricated Metal Buildings	332311	Prefabricated Metal Building and Component Manufacturing	3323	Architectural and structural metals manufacturing
3452	Bolts Nuts Rivets & Washers	332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing	3327	Machine shops, turned product, and screw, nut, and bolt manufacturing
3462	Iron and Steel Forgings	332111	Iron and Steel Forging	3321	Forging and stamping
3463	Nonferrous Forgings	332112	Nonferrous Forging	3321	Forging and stamping
3471	Plating and Polishing	332813	Electroplating, Plating, Polishing, Anodizing, and Coloring	3328	Coating, engraving, heat treating, and allied activities
3479	Metal Coating and Allied Services	332812[k]	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	3328	Coating, engraving, heat treating, and allied activities
3483	Ammunition, Except For Small Arm	332993	Ammunition (except Small Arms) Manufacturing	3329	Other fabricated metal product manufacturing
3492	Fluid Power Valves & Hose Fittings	332912	Fluid Power Valve and Hose Fitting Manufacturing	3329	Other fabricated metal product manufacturing

[k] Original NAICS 332999 (All Other Miscellaneous Fabricated Metal Product Manufacturing) incorrectly matched to SIC 3479; changed to NAICS 332812 (Metal Coating, Engraving [except Jewelry and Silverware], and Allied Services to Manufacturers).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3498	Fabricated Pipe and Pipe Fittings	332996	Fabricated Pipe and Pipe Fitting Manufacturing	3329	Other fabricated metal product manufacturing
3499	Fabricated Metal Products, NEC	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	3329	Other fabricated metal product manufacturing
3511	Turbines and Turbine Generator	333611	Turbine and Turbine Generator Set Units Manufacturing	3336	Engine, turbine, and power transmission equipment manufacturing
3519	Internal Combustion Engines	333618[l]	Other Engine Equipment Manufacturing	3336	Engine, turbine, and power transmission equipment manufacturing
3523	Farm Machinery and Equipment	333111[m]	Farm Machinery and Equipment Manufacturing	3331	Agriculture, construction, and mining machinery manufacturing
3531	Construction Machinery	333120[n]	Construction Machinery Manufacturing	3331	Agriculture, construction, and mining machinery manufacturing
3533	Oil and Gas Field Machinery	333132	Oil and Gas Field Machinery and Equipment Manufacturing	3331	Agriculture, construction, and mining machinery manufacturing
3535	Conveyors and Conveying Equipment	333922	Conveyor and Conveying Equipment Manufacturing	3339	Other general purpose machinery manufacturing
3537	Industrial Trucks and Tractors	333924[o]	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing	3339	Other general purpose machinery manufacturing
3553	Woodworking Machinery	333243	Sawmill, Woodworking, and Paper Machinery Manufacturing	3332	Industrial machinery manufacturing
3555	Printing Trades Machinery	333244	Printing Machinery and Equipment Manufacturing	3332	Industrial machinery manufacturing
3563	Air and Gas Compressors	333912	Air and Gas Compressor Manufacturing	3339	Other general purpose machinery manufacturing
3569	General Industrial Machinery, NEC	333999[p]	All Other Miscellaneous General Purpose Machinery Manufacturing	3339	Other general purpose machinery manufacturing

[l] Original NAICS 336390 (Other Motor Vehicle Parts Manufacturing) incorrectly matched to SIC 3519; changed to NAICS 333618 (Other Engine Equipment Manufacturing).
[m] Original NAICS 333922 (Conveyor and Conveying Equipment Manufacturing) incorrectly matched to SIC 3523; changed to NAICS 333111 (Farm Machinery and Equipment Manufacturing).
[n] Original NAICS 336510 (Railyard Rolling Stock Manufacturing) incorrectly matched to SIC 3531; changed to NAICS 333120 (Construction Machinery Manufacturing).
[o] Original NAICS 332999 (All Other Miscellaneous Fabricated Metal Product Manufacturing) incorrectly matched to SIC 3537; changed to NAICS 333924 (Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing).
[p] Original NAICS 314999 (All Other Miscellaneous Textile Product Mills) incorrectly matched to SIC 3569; changed to NAICS 333999 (All Other Miscellaneous General Purpose Machinery Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3585	Refrigeration & Heating Equipment	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	3334	Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing
3599	Machinery Except Electrical, NEC	333999	All Other Miscellaneous General Purpose Machinery Manufacturing	3339	Other general purpose machinery manufacturing
3613	Switchgear & Switchboard Apparatus	335313	Switchgear and Switchboard Apparatus Manufacturing	3353	Electrical equipment manufacturing
3621	Motors and Generators	335312	Motor and Generator Manufacturing	3353	Electrical equipment manufacturing
3669	Communications Equipment, NEC	334290	Other Communications Equipment Manufacturing	3342	Communications equipment manufacturing
3672	Printed Circuit Boards	334412	Bare Printed Circuit Board Manufacturing	3344	Semiconductor and other electronic component manufacturing
3674	Semiconductors and Related Devices	334413	Semiconductor and Related Device Manufacturing	3344	Semiconductor and other electronic component manufacturing
3679	Electronic Components, NEC	334419	Other Electronic Component Manufacturing	3344	Semiconductor and other electronic component manufacturing
3699	Electrical Equipment & Supply	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	3359	Other electrical equipment and component manufacturing
3711	Motor Vehicles and Car Bodies	336112, 336111, 336211[q]	Light Truck and Utility Vehicle Manufacturing; Automobile Manufacturing; Motor Vehicle Body Manufacturing	3361 & 3362	(Motor vehicle manufacturing & Motor vehicle body and trailer manufacturing)
3713	Truck and Bus Bodies	336120[r]	Heavy Duty Truck Manufacturing	3361	Motor vehicle manufacturing
3714	Motor Vehicle Parts & Accessories	336390	Other Motor Vehicle Parts Manufacturing	3363	Motor vehicle parts manufacturing
3715	Truck Trailers	336212	Truck Trailer Manufacturing	3362	Motor vehicle body and trailer manufacturing
3716	Motor Homes	336213	Motor Home Manufacturing	3362	Motor vehicle body and trailer manufacturing
3721	Aircraft	336411	Aircraft Manufacturing	3364	Aerospace product and parts manufacturing
3724	Aircraft Engines & Engine Parts	336412	Aircraft Engine and Engine Parts Manufacturing	3364	Aerospace product and parts manufacturing

[q] Original NAICS 336112 (Light Truck and Utility Vehicle Manufacturing); added NAICS 336111 (Automobile Manufacturing) and NAICS 336211 (Motor Vehicle Body Manufacturing) to NAICS 336112 for SIC 3711.
[r] Original NAICS 336211 (Motor Vehicle Body Manufacturing) incorrectly matched to SIC 3713; changed to NAICS 336120 (Heavy Duty Truck Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3728	Aircraft Parts & Equipment, NEC	336413[s]	Other Aircraft Parts and Auxiliary Equipment Manufacturing	3364	Aerospace product and parts manufacturing
3731	Ship Building and Repairing	336611	Ship Building and Repairing	3366	Ship and boat building
3732	Boat Building and Repairing	336612	Boat Building	3366	Ship and boat building
3743	Railroad Equipment	336510	Railroad Rolling Stock Manufacturing	3365	Railroad rolling stock manufacturing
3792	Travel Trailers and Campers	336214	Travel Trailer and Camper Manufacturing	3362	Motor vehicle body and trailer manufacturing
3812	Search and Navigation Equipment	334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	3345	Navigational, measuring, electromedical, and control instruments manufacturing
3821	Laboratory Apparatus and Furniture	33911	Medical Equipment and Supplies Manufacturing	3391	Medical equipment and supplies manufacturing
3827	Optical Instruments and Lenses	333314	Optical Instrument and Lens Manufacturing	3333	Commercial and service industry machinery manufacturing
3949	Sporting & Athletic Goods, NEC	339920	Sporting and Athletic Goods Manufacturing	3399	Other miscellaneous manufacturing
3996	Hard Surface Floor Coverings	326199	All Other Plastics Product Manufacturing	3261	Plastics product manufacturing
3999	Manufacturing Industries, NEC	339999[t]	All Other Miscellaneous Manufacturing	3399	Other miscellaneous manufacturing
4212	Local trucking Without Storage	484110	General Freight Trucking, Local	4841	General freight trucking
4213	Trucking, Except Local	484230, 48412[u]	Specialized Freight (except Used Goods) Trucking, Long-Distance; General freight trucking, long-distance	4841 & 4842	(General freight trucking & Specialized freight trucking)
4214	Local Trucking With Storage	484110	General Freight Trucking, Local	4841	General freight trucking
4226	Special Warehousing and Storage	424710[v]	Petroleum Bulk Stations and Terminals	4247	Petroleum and petroleum products merchant wholesalers
4491	Marine Cargo Handling	488310	Port and Harbor Operations	4883	Support activities for water transportation

[s] Original NAICS 332912 (Fluid Power Valve and Hose Fitting Manufacturing) incorrectly matched to SIC 3728; changed to NAICS 336413 (Other Aircraft Parts and Auxiliary Equipment Manufacturing).
[t] Original NAICS 325998 (All Other Miscellaneous Chemical Product and Preparation Manufacturing) incorrectly matched to SIC 3999; changed to NAICS 339999 (All Other Miscellaneous Manufacturing).
[u] Added NAICS 48412 (General Freight Trucking, Long-Distance) to NAICS 484230 for SIC 4213.
[v] Original NAICS 493110 (General Warehousing and Storage) was matched to SIC 4226; changed to NAICS 424710 (Petroleum Bulk Stations and Terminals) based on discussion with TCEQ.

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
4512	Air Transportation, Scheduled	481111	Scheduled Passenger Air Transportation	4811	Scheduled air transportation
4581	Airports, Flying Fields, Service	488111	Air Traffic Control	4881	Support activities for air transportation
4612	Crude Petroleum Pipe Lines	486110	Pipeline Transportation of Crude Oil	4860	Pipeline transportation
4613	Refined Petroleum Pipelines	486910	Pipeline Transportation of Refined Petroleum Products	4860	Pipeline transportation
4619	Pipelines, NEC	486990	All Other Pipeline Transportation	4860	Pipeline transportation
4741	Rental Of Railroad Cars	532411	Commercial Air, Rail, and Water Transportation Equipment Rental and Leasing	5324	Commercial and industrial machinery and equipment rental and leasing
4789	Transportation Services, NEC	488999	All Other Support Activities for Transportation	4889	Other support activities for transportation
4911	Electric Services	*AEO*[w]	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)	*AEO*, by fuel type, with and without CPP	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)
4922	Natural Gas Transmission	486210	Pipeline Transportation of Natural Gas	4860	Pipeline transportation
4923	Gas Transmission and Distribution	486210, 221210[x]	Pipeline Transportation of Natural Gas; Natural Gas Distribution	2212 & 4860	(Natural gas distribution & Pipeline transportation)
4925	Gas Production and Distribution	221210	Natural Gas Distribution	2212	Natural gas distribution
4931	Electric and Other Services Combined	*AEO*[y]	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)	*AEO*, by fuel type, with and without CPP	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)
4939	Combination Utility, NEC	*AEO*[z]	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)	*AEO*, by fuel type, with and without CPP	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)
4941	Water Supply	221310	Water Supply and Irrigation Systems	2213	Water, sewage and other systems
4952	Sewerage Systems	221320	Sewage Treatment Facilities	2213	Water, sewage and other systems

[w] The growth factor surrogate assignment for SIC 4911 was changed from Economy.com gross product data to 2016 Early Releases *AEO* electricity forecasts, by fuel type, based on TCEQ recommendation.
[x] Added NAICS 221210 (Natural Gas Distribution) to NAICS 486210 for SIC 4923.
[y] The growth factor surrogate assignment for SIC 4931 was changed from Economy.com gross product data to *AEO* electricity forecasts, by fuel type, based on TCEQ recommendation.
[z] The growth factor surrogate assignment for SIC 4939 was changed from Economy.com gross product data to *AEO* electricity forecasts, by fuel type, based on TCEQ recommendation.

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
4953	Refuse Systems	562212	Solid Waste Landfill	5622	Waste treatment and disposal
4961	Steam and Air Conditioning Supply	221330	Steam and Air-Conditioning Supply	2213	Water, sewage and other systems
5032	Brick, Stone, Related Materials	423320[aa]	Brick, Stone, and Related Construction Material Merchant Wholesalers	4233	Lumber and other construction materials merchant wholesalers
5047	Medicinal and Hospital Equipment	423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers	4234	Professional and commercial equipment and supplies merchant wholesalers
5052	Coal & Other Minerals & Ores	423520	Coal and Other Mineral and Ore Merchant Wholesalers	4235	Metal and mineral (except petroleum) merchant wholesalers
5075	Warm Air Heat & Air Conditioning	423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	4237	Hardware, and plumbing and heating equipment and supplies merchant wholesalers
5153	Grain and Field Beans	424510	Grain and Field Bean Merchant Wholesalers	4245	Farm product raw material merchant wholesalers
5169	Chemicals and Allied Products, NEC	424690	Other Chemical and Allied Products Merchant Wholesalers	4246	Chemical and allied products merchant wholesalers
5171	Petroleum Bulk Stations & Terminals	424710	Petroleum Bulk Stations and Terminals	4247	Petroleum and petroleum products merchant wholesalers
5541	Gasoline Service Stations	447110	Gasoline Stations with Convenience Stores	4471	Gasoline stations
5983	Fuel Oil Dealers	454310	Fuel Dealers	4543	Direct selling establishments
6399	Insurance Carriers, NEC	524128	Other Direct Insurance (except Life, Health, and Medical) Carriers	5241	Insurance carriers
7374	Data Processing and Data Preparation Services	518210	Data Processing, Hosting, and Related Services	5182	Data processing, hosting, and related services
7389	Business Services, NEC	561499	All Other Business Support Services	5614	Business support services
7532	Top, Body and Upholstery Repair & Paint Shops	811121	Automotive Body, Paint, and Interior Repair and Maintenance	8111	Automotive repair and maintenance
7542	Car Washes	811192	Car Washes	8111	Automotive repair and maintenance
7699	Repair Services, NEC	811[bb]	Repair and Maintenance	811X	Repair and maintenance
8062	General Medical & Surgical Hospitals	622110	General Medical and Surgical Hospitals	6221	General medical and surgical hospitals

[aa] Original NAICS 444190 (Other Building Material Dealers) incorrectly matched to SIC 5032; changed to NAICS 423320 (Brick, Stone, and Related Construction Material Merchant Wholesalers).
[bb] Original NAICS 444120 (Paint and Wallpaper Stores) incorrectly matched to SIC 7699; changed to NAICS 811 (Repair and maintenance services).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
8221	Colleges and Universities, NEC	611310	Colleges, Universities, and Professional Schools	6113	Colleges, universities, and professional schools
8731	Commercial Physical and Biological Research	54171	Research and Development in the Physical, Engineering, and Life Sciences	5417	Scientific research and development services
8733	Noncommercial Research Organizations	541720	Research and Development in the Social Sciences and Humanities	5417	Scientific research and development services
8734	Testing Laboratories	541380	Testing Laboratories	5413	Architectural, engineering, and related services
9661	Space Research and Technology	927110	Space Research and Technology	5417	Scientific research and development services
9711	National Security	928110	National Security	NA	NA (Constant/No Growth Scenario)
9999	Nonclassifiable Establishments	Constant[cc]	Constant/No Growth Scenario	NA	NA (Constant/No Growth Scenario)

[cc] Original NAICS 339 (Miscellaneous Manufacturing) incorrectly matched to SIC 9999; changed to a constant/straight line with no growth.

APPENDIX C
AREA SOURCE GROWTH FACTOR SURROGATE ASSIGNMENTS

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2102004000	Industrial Fuel Combustion: Distillate Oil: Boilers/IC Eng.	*AEO* regional consumption data[a]	Industrial - Distillate Fuel Oil
2102005000	Industrial Fuel Combustion: Residual Oil	*AEO* regional consumption data	Industrial - Residual Fuel Oil
2102006000	Industrial Fuel Combustion: Natural Gas: Boilers/IC Eng.	*AEO* regional consumption data	Industrial - Natural Gas
2102006001	Industrial Fuel Combustion - Natural Gas (Boilers)	*AEO* regional consumption data	Industrial - Natural Gas
2102006002	Industrial Fuel Combustion - Natural Gas (IC Engines)	*AEO* regional consumption data	Industrial - Natural Gas
2102007000	Industrial Fuel Combustion: Liquefied Petroleum Gas (LPG)	*AEO* regional consumption data	Industrial - Liquefied Petroleum Gases
2102008000	Industrial Fuel Combustion: Wood	*AEO* regional consumption data	Industrial - Renewable Energy
2102011000	Industrial Fuel Combustion: Kerosene	*AEO* regional consumption data	Industrial - Distillate Fuel Oil
2103004000	Commercial/Institutional Fuel Combustion: Distillate Oil	*AEO* regional consumption data	Commercial - Distillate Fuel Oil
2103005000	Commercial/Institutional Fuel Combustion: Residual Oil	*AEO* regional consumption data	Commercial - Residual Fuel Oil
2103006000	Commercial/Institutional Fuel Combustion - Natural Gas	*AEO* regional consumption data	Commercial - Natural Gas
2103007000	Commercial/Institutional Fuel Combustion: Liquefied Petroleum Gas (LPG) Combustors	*AEO* regional consumption data	Commercial - Propane
2103008000	Commercial/Institutional Fuel Combustion: Wood	*AEO* regional consumption data	Commercial - Renewable Energy
2103011000	Commercial/Institutional Fuel Combustion: Kerosene Combustors	*AEO* regional consumption data	Commercial - Kerosene
2104004000	Residential Fuel Combustion - Distillate Oil	*AEO* regional consumption data	Residential - Distillate Fuel Oil
2104005000	Residential Fuel Combustion - Residual Oil	*AEO* regional consumption data	Residential - Distillate Fuel Oil
2104006000	Residential Fuel Combustion: Natural Gas All Combustors	*AEO* regional consumption data	Residential - Natural Gas
2104007000	Residential Fuel Combustion: Liquefied Petroleum Gas (LPG)	*AEO* regional consumption data	Residential - Propane
2104008100	Residential Wood Combustion: Fireplaces	*AEO* regional consumption data	Residential - Renewable Energy
2104008210	Residential Wood Combustion: Woodstove Fireplace Inserts Non-EPA Certified	*AEO* regional consumption data	Residential - Renewable Energy
2104008220	Residential Wood Combustion: Woodstove Fireplace Inserts EPA Certified Non-Catalytic	*AEO* regional consumption data	Residential - Renewable Energy
2104008230	Residential Wood Combustion: Woodstove Fireplace Inserts EPA Certified Catalytic	*AEO* regional consumption data	Residential - Renewable Energy

[a] *Annual Energy Outlook* consumption data for West South Central Region (Arkansas, Louisiana, Oklahoma, and Texas) (quadrillion BTU) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2104008300	Residential Fuel Combustion - Wood - Woodstoves (Freestanding)	*AEO* regional consumption data	Residential - Renewable Energy
2104008310	Residential Wood Combustion: Woodstoves Freestanding Non-EPA Certified	*AEO* regional consumption data	Residential - Renewable Energy
2104008320	Residential Wood Combustion: Woodstoves: Freestanding EPA Certified Non-Catalytic	*AEO* regional consumption data	Residential - Renewable Energy
2104008330	Residential Wood Combustion: Woodstoves Freestanding EPA Certified Catalytic	*AEO* regional consumption data	Residential - Renewable Energy
2104008400	Residential Wood Combustion: Woodstove Pellet Fired, General	*AEO* regional consumption data	Residential - Renewable Energy
2104008610	Residential Wood Combustion: Hydronic Heater: Outdoor	*AEO* regional consumption data	Residential - Renewable Energy
2104008700	Residential Wood Combustion: Outdoor Wood Burning Devices	*AEO* regional consumption data	Residential - Renewable Energy
2104009000	Residential Fuel Combustion: Firelog	*AEO* regional consumption data	Residential - Renewable Energy
2104011000	Residential Fuel Combustion: Kerosene	*AEO* regional consumption data	Residential - Kerosene
2294000000	Paved Roads: All Paved Roads: Total: Fugitives	Population[b]	NA
2296000000	Unpaved Roads: All Unpaved Roads Total: Fugitives	Population	NA
2302002100	Commercial Cooking: Conveyorized Charbroiling	Economy.com data[c]	Special food services & Restaurants and other eating places
2302002200	Commercial Cooking: Under-Fired Charbroiling	Economy.com data	Special food services & Restaurants and other eating places
2302003000	Commercial Cooking - Deep Fat Frying	Economy.com data	Special food services & Restaurants and other eating places
2302003100	Commercial Cooking - Flat Griddle Frying	Economy.com data	Special food services & Restaurants and other eating places
2302003200	Commercial Cooking - Clamshell Griddle Frying	Economy.com data	Special food services & Restaurants and other eating places
2302010000	Food: Meat Products	Economy.com data	Animal slaughtering and processing
2302040000	Food: Grain Mill Products	Economy.com data	Grain and oilseed milling
2302050000	Food: Bakery Products	Economy.com data	Bakeries and tortilla manufacturing
2302070001	Food: Fermentation/Beverages: Breweries	Economy.com data	Beverage manufacturing
2302070005	Food: Fermentation/Beverages: Wineries	Economy.com data	Beverage manufacturing
2304050000	Secondary Metals: Nonferrous Foundries (Castings)	Economy.com data	Foundries
2305070000	Mineral Processes: Concrete Gypsum Plaster Products	Economy.com data	Cement and concrete product manufacturing & Lime and gypsum product manufacturing
2306010000	Petroleum Refining: Asphalt Paving/Roofing Materials	Economy.com data	Petroleum and coal products manufacturing
2307020000	Wood Products: Sawmills/Planing Mills	Economy.com data	Sawmills and wood preservation
2307060000	Wood Products: Miscellaneous Wood Products	Economy.com data	Other wood product manufacturing
2309000000	Fabricated Metals: Total	Economy.com data	Fabricated metal product manufacturing
2309100010	Fabricated Metals: Electroplating	Economy.com data	Coating; engraving; heat treating; and allied activities
2309100080	Fabricated Metals: Hot Dip Galvanizing (Zinc)	Economy.com data	Coating; engraving; heat treating; and allied activities
2310000000	Industrial Processes- Oil and Gas Exploration and Production- All Processes: Total: All Processes	Projected production levels[d]	Weighted oil and gas production forecast

[b] Texas State Data Center county-level population projections (TSDC, 2014).
[c] Economy.com county-level gross product data (million constant 2009 $) (Economy.com, 2016).
[d] Projected production levels based on analysis of curves developed using Hubbert's method (Hubbert, 1956; Hubbert, 1980).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310000220	Industrial Processes- Oil and Gas Exploration and Production- All Processes: Drill Rigs	Projected production levels	Weighted oil and gas production forecast
2310000230	Oil & Gas Exploration & Production /All Processes /Workover Rigs	Projected production levels	Weighted oil and gas production forecast
2310000330	Oil and Gas Exploration and Production Artificial Lift (Pumpjack)	Projected production levels	Oil production forecast
2310000440	Industrial Processes- Oil and Gas Exploration and Production- All Processes: Saltwater Disposal Engines	Projected production levels	Weighted oil and gas production forecast
2310000550	Produced Waters/ Saltwater Injection	Projected production levels	Weighted oil and gas production forecast
2310000660	Oil and Gas Exploration and Production: Hydraulic Fracturing Engines (Fracking)	Projected production levels	Weighted oil and gas production forecast
2310001000	Industrial Processes- Oil and Gas Exploration and Production- All Processes: On-Shore: Total: All Processes	Projected production levels	Weighted oil and gas production forecast
2310002000	Off Shore Oil & Gas Production All Processes	*AEO* offshore oil & gas production data[e]	Total offshore oil & gas production
2310002301	Off Shore Oil and Gas Production Flare Pilot Light	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002305	Off Shore Oil and Gas Production Flaring	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002401	Off Shore Oil and Gas Production Pneumatic Well Pumps	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002411	Off Shore Oil and Gas Production Pressure/Level Controllers	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002421	Off Shore Oil and Gas Production Cold Vents	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310010000	Industrial Processes- Oil and Gas Exploration and Production- Crude Petroleum: Total: All Processes	Projected production levels	Oil production forecast
2310010100	Oil Production Well Heaters	Projected production levels	Oil production forecast
2310010200	Oil Production Tanks Including Flashing	Projected production levels	Oil production forecast
2310010300	Oil Production Pneumatic Devices	Projected production levels	Oil production forecast
2310010700	Industrial Processes- Oil and Gas Exploration and Production- Crude Petroleum: Oil Well Fugitives	Projected production levels	Oil production forecast
2310010800	Industrial Processes- Oil and Gas Exploration and Production- Crude Petroleum: Oil Well Truck Loading	Projected production levels	Oil production forecast
2310011000	On Shore Crude Oil Production All Processes (Casinghead Gas)	Projected production levels	Oil production forecast
2310011020	On Shore Oil Production Crude Tanks (Including Flash)	Projected production levels	Oil production forecast
2310011100	On Shore Oil Production Heater Treater	Projected production levels	Oil production forecast

[e] *Annual Energy Outlook* combined offshore oil and natural gas production data for Gulf (quadrillion BTU) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310011201	On Shore Oil Production Truck/Rail Loading of Crude	Projected production levels	Oil production forecast
2310011450	On Shore Oil Production Wellhead	Projected production levels	Oil production forecast
2310011500	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Production: Fugitives: All Processes	Projected production levels	Oil production forecast
2310011501	On Shore Oil Production Fugitives Connectors	Projected production levels	Oil production forecast
2310011502	On Shore Oil Production Fugitives Flanges	Projected production levels	Oil production forecast
2310011503	On Shore Oil Production Fugitives Open Ended Lines	Projected production levels	Oil production forecast
2310011504	On Shore Oil Production Fugitives Pumps	Projected production levels	Oil production forecast
2310011505	On Shore Oil Production Fugitives Valves	Projected production levels	Oil production forecast
2310011506	On Shore Oil Production Fugitives Other	Projected production levels	Oil production forecast
2310011600	On-Shore Oil Production /Artificial Lift Engines	Projected production levels	Oil production forecast
2310012000	Off Shore Crude Oil Production Total All Processes	*AEO* offshore oil production data[f]	Total offshore oil production
2310012020	Off Shore Oil Production Crude Oil Storage	*AEO* offshore oil production data	Total offshore oil production
2310012201	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Production: Barge Loading: Crude Oil	*AEO* offshore oil production data	Total offshore oil production
2310012511	Off Shore Oil Production Fugitives Connectors Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012512	Off Shore Oil Production Fugitives Flanges Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012515	Off Shore Oil Production Fugitives Valves Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012516	Off Shore Oil Production Fugitives Other Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012521	Off Shore Oil Production Fugitives Connectors Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310012522	Off Shore Oil Production Fugitives Flanges Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310012525	Off Shore Oil Production Fugitives Valves Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310012526	Off Shore Oil Production Fugitives Other Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310020000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Total: All Processes	Projected production levels	Gas production forecast

[f] *Annual Energy Outlook* offshore oil production data for Gulf (million barrels/day) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310020600	Gas Production Compressor Engines	Projected production levels	Gas production forecast
2310020700	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Gas Well Fugitives	Projected production levels	Gas production forecast
2310020800	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Gas Well Truck Loading	Projected production levels	Condensate production forecast
2310021000	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Processes	Projected production levels	Gas production forecast
2310021010	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Storage Tanks: Condensate	Projected production levels	Gas production forecast
2310021011	On-Shore Gas Production / Condensate Tank Flaring	Projected production levels	Condensate production forecast
2310021030	On Shore Gas Production Truck and Rail Loading of Condensate	Projected production levels	Gas production forecast
2310021100	On-Shore Gas Production Heaters	Projected production levels	Gas production forecast
2310021101	On-Shore Gas Production: Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 hp	Projected production levels	Gas production forecast
2310021102	On-Shore Gas Production: Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 To 499 hp	Projected production levels	Gas production forecast
2310021103	On-Shore Gas Production Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 500+ hp	Projected production levels	Gas production forecast
2310021109	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Natural Gas Fired 2Cycle Lean Burn Compressor Engines	Projected production levels	Gas production forecast
2310021201	On-Shore Gas Production Natural Gas Fired 4-Cycle Lean Burn Compressor Engines <50 hp	Projected production levels	Gas production forecast
2310021202	On-Shore Gas Production Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 50 hp - 499 hp	Projected production levels	Gas production forecast
2310021203	On-Shore Gas Production Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ hp	Projected production levels	Gas production forecast
2310021209	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Natural Gas Fired 4Cycle Lean Burn Compressor Engines	Projected production levels	Gas production forecast
2310021251	Lateral/Gathering Line Compressors (4Cycle Lean)	Projected production levels	Gas production forecast
2310021300	On-Shore Gas Production Pneumatic Devices	Projected production levels	Gas production forecast
2310021301	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 hp	Projected production levels	Gas production forecast
2310021302	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 To 499 hp	Projected production levels	Gas production forecast
2310021303	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ hp	Projected production levels	Gas production forecast

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310021309	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Natural Gas Fired 4Cycle Rich Burn Compressor Engines	Projected production levels	Gas production forecast
2310021310	On-Shore Gas Production / Gas Well Pneumatic Pumps	Projected production levels	Gas production forecast
2310021351	Lateral/Gathering Line Compressors (4Cycle Rich)	Projected production levels	Gas production forecast
2310021400	On-Shore Gas Production Dehydrators	Projected production levels	Gas production forecast
2310021401	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Eng. <50 hp W/ Non Specific Catalytic Reduction	Projected production levels	Gas production forecast
2310021402	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Eng. 50-499 hp W/ Non Specific Catalytic Reduction	Projected production levels	Gas production forecast
2310021403	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Eng. 500+ hp W/ Non Specific Catalytic Reduction	Projected production levels	Gas production forecast
2310021409	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Nat Gas Fired 4Cycle Rich Burn Compressor Engines W/ Nscr	Projected production levels	Gas production forecast
2310021410	On-Shore Gas Production /Amine Unit	Projected production levels	Gas production forecast
2310021411	On-Shore Gas Production / Gas Well Dehydrators – Flaring	Projected production levels	Gas production forecast
2310021450	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Wellhead	Projected production levels	Gas production forecast
2310021500	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Gas Well Completion - Flaring and Venting	Projected production levels	Gas production forecast
2310021501	On-Shore Gas Production: Fugitives: Connectors	Projected production levels	Gas production forecast
2310021502	On-Shore Gas Production: Fugitives: Flanges	Projected production levels	Gas production forecast
2310021503	On-Shore Gas Production: Fugitives: Open Ended Lines	Projected production levels	Gas production forecast
2310021504	On-Shore Gas Production: Fugitives: Pumps	Projected production levels	Gas production forecast
2310021505	On-Shore Gas Production: Fugitives: Valves	Projected production levels	Gas production forecast
2310021506	On-Shore Gas Production: Fugitives: Other	Projected production levels	Gas production forecast
2310021509	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Fugitives: All Processes	Projected production levels	Gas production forecast
2310021600	On-Shore Gas Production Gas Well Venting	Projected production levels	Gas production forecast
2310021601	On-Shore Gas Production / Gas Well Venting - Initial Completions	Projected production levels	Gas production forecast
2310021602	On-Shore Gas Production / Gas Well Venting - Recompletions	Projected production levels	Gas production forecast

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310021603	Gas Well Venting – Blowdowns	Projected production levels	Gas production forecast
2310021604	On-Shore Gas Production / Gas Well Venting - Compressor Startups	Projected production levels	Gas production forecast
2310021605	On-Shore Gas Production / Gas Well Venting - Compressor Shutdowns	Projected production levels	Gas production forecast
2310021700	On-Shore Gas Production / Miscellaneous Engines	Projected production levels	Gas production forecast
2310022000	Off Shore Gas Production Total All Processes	*AEO* offshore natural gas production data[g]	Total offshore natural gas production
2310022010	Off-Shore Gas Production: Storage Tanks: Condensate	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022051	Off-Shore Gas Production: Turbines: Natural Gas	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022090	Off-Shore Gas Production: Boilers/Heaters: Natural Gas	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022105	Off-Shore Gas Production: Diesel Engines	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022300	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Production: Compressor Engines: 4Cycle Rich	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022410	Off-Shore Natural Gas Production Amine Unit	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022420	Off-Shore Gas Production: Dehydrator	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022501	Off-Shore Gas Production: Fugitives: Connectors: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022502	Off-Shore Gas Production: Fugitives: Flanges: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022505	Off-Shore Gas Production: Fugitives: Valves: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022506	Off-Shore Gas Production: Fugitives: Other: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production

[g] *Annual Energy Outlook* offshore natural gas production data for Gulf (trillion dry cubic feet) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310023000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Cbm Gas Well - Dewatering Pump Engines	Projected production levels	Gas production forecast
2310030000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Total: All Processes	Projected production levels	Condensate production forecast
2310030210	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Gas Well Tanks - Flashing & Standing/Working/Breathing, Uncontrolled	Projected production levels	Condensate production forecast
2310030220	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Gas Well Tanks - Flashing & Standing/Working/Breathing, Controlled	Projected production levels	Condensate production forecast
2310030230	Natural Gas Liquids / Gas Well Tanks - Flaring	Projected production levels	Gas production forecast
2310030300	Natural Gas Liquids / Gas Well Water Tank Losses	Projected production levels	Gas production forecast
2310030400	Natural Gas Liquids / Truck Loading	Projected production levels	Gas production forecast
2310030401	Natural Gas Liquids / Gas Plant Truck Loading	Projected production levels	Gas production forecast
2310031000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: On-Shore: Total: All Processes	Projected production levels	Condensate production forecast
2310032000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Off-Shore: Total: All Processes	*AEO* offshore natural gas production data	Total offshore natural gas production
2310111000	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Exploration: All Processes	Projected production levels	Oil production forecast
2310111100	On-Shore Oil Exploration: Mud Degassing	Projected production levels	Oil production forecast
2310111401	On-Shore Oil Exploration: Oil Well Pneumatic Pumps	Projected production levels	Oil production forecast
2310111700	On-Shore Oil Exploration: Oil Well Completion: All Processes	Projected production levels	Oil production forecast
2310111701	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Exploration: Oil Well Completion: Flaring	Projected production levels	Oil production forecast
2310111702	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Exploration: Oil Well Completion: Venting	Projected production levels	Oil production forecast
2310112000	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: All Processes	*AEO* offshore oil production data	Total offshore oil production
2310112100	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Mud Degassing Activities	*AEO* offshore oil production data	Total offshore oil production
2310112401	Off-Shore Oil Exploration: Oil Well Pneumatic Pumps	*AEO* offshore oil production data	Total offshore oil production
2310112700	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Oil Well Completion: All Processes	*AEO* offshore oil production data	Total offshore oil production
2310112701	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Oil Well Completion: Flaring	*AEO* offshore oil production data	Total offshore oil production

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310112702	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Oil Well Completion: Venting	*AEO* offshore oil production data	Total offshore oil production
2310121000	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: All Processes	Projected production levels	Gas production forecast
2310121100	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Mud Degassing	Projected production levels	Gas production forecast
2310121401	On-Shore Gas Exploration: Gas Well Pneumatic Pumps	Projected production levels	Gas production forecast
2310121700	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Gas Well Completion: All Processes	Projected production levels	Gas production forecast
2310121701	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Gas Well Completion: Flaring	Projected production levels	Gas production forecast
2310121702	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Gas Well Completion: Venting	Projected production levels	Gas production forecast
2310122000	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: All Processes	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122100	Off-Shore Gas Exploration: Mud Degassing	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122401	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Pneumatic Pumps	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122700	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Completion: All Processes	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122701	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Completion: Flaring	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122702	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Completion: Venting	*AEO* offshore natural gas production data	Total offshore natural gas production
2311010000	Residential Construction: Total	Economy.com data	Residential building construction
2311020000	Industrial/Commercial/Institutional Construction: Total	Economy.com data	Nonresidential building construction
2311030000	Road Construction: Total	Economy.com data	Highway; street; and bridge construction
2325000000	Mining & Quarrying: All Processes	Economy.com data	Mining (except oil and gas)
2325020000	Mining & Quarrying: Crushed and Broken Stone	Economy.com data	Nonmetallic mineral mining and quarrying
2325050000	Mining & Quarrying - Chemical and Fertilizer Materials	Economy.com data	Nonmetallic mineral mining and quarrying
2399000000	Industrial Processes - Not Elsewhere Classified	Economy.com data	Miscellaneous manufacturing
2401001000	Surface Coating: Architectural Coatings: Total: All Solvent Types	Population	NA
2401005000	Surface Coating: Auto Refinishing: Total: All Solvent Types	Economy.com data	Automotive repair and maintenance
2401008000	Surface Coating: Traffic Markings: Total: All Solvent Types	Economy.com data	Highway; street; and bridge construction
2401010000	Surface Coating: Textile Products: Total: All Solvent Types	Economy.com data	Textile mills & Textile product mills
2401015000	Surface Coating: Factory Finished Wood: Total: All Solvent Types	Economy.com data	Wood product manufacturing
2401020000	Surface Coating: Wood Furniture: Total: All Solvent Types	Economy.com data	Furniture and related product manufacturing
2401025000	Surface Coating: Metal Furniture: Total: All Solvent Types	Economy.com data	Furniture and related product manufacturing

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2401030000	Surface Coating: Paper: Total: All Solvent Types	Economy.com data	Paper manufacturing
2401035000	Surface Coating: Plastics: Total: All Solvent Types	Economy.com data	Plastics product manufacturing
2401040000	Surface Coating: Metal Cans: Total: All Solvent Types	Economy.com data	Boiler; tank; and shipping container manufacturing
2401045000	Surface Coating: Metal Coils: Total: All Solvent Types	Economy.com data	Spring and wire product manufacturing
2401050000	Surface Coating: Misc. Finished Metals: Total: All Solvent Types	Economy.com data	Fabricated metal product manufacturing
2401055000	Surface Coating: Machinery & Equipment: Total: All Solvent Types	Economy.com data	Machinery manufacturing
2401060000	Surface Coating: Large Appliances: Total: All Solvent Types	Economy.com data	Household appliance manufacturing
2401065000	Surface Coating: Electronic & Other Electrical: Total: All Solvent Types	Economy.com data	Computer and electronic product manufacturing & Electrical equipment; appliance; and component manufacturing
2401070000	Surface Coating: Motor Vehicles: Total: All Solvent Types	Economy.com data	Motor vehicle manufacturing, Motor vehicle body and trailer manufacturing, and Motor vehicle parts manufacturing
2401075000	Surface Coating: Aircraft: Total: All Solvent Types	Economy.com data	Aerospace product and parts manufacturing
2401080000	Surface Coating: Marine: Total: All Solvent Types	Economy.com data	Ship and boat building
2401085000	Surface Coating: Railroad: Total: All Solvent Types	Economy.com data	Railroad rolling stock manufacturing
2401090000	Surface Coating: Misc. Manufacturing: Total: All Solvent Types	Economy.com data	Miscellaneous manufacturing
2401100000	Surface Coating: Industrial Maintenance: Total: All Solvent Types	Economy.com data	Manufacturing, 3XX
2401200000	Surface Coating: Special Purpose: Total: All Solvent Types	Economy.com data	Manufacturing, 3XX
2401990000	All Surface Coating Categories	Economy.com data	Manufacturing, 3XX
2415000000	Degreasing: All Processes: All Industries: Total: All Solvent Types	Economy.com data	Manufacturing, 3XX
2415100000	Degreasing (Open Top) - All Industries	Economy.com data	Manufacturing, 3XX
2415105000	Degreasing (Open Top) - Furniture & Fixtures	Economy.com data	Furniture and related product manufacturing
2415110000	Degreasing (Open Top) - Primary Metal Ind.	Economy.com data	Primary metal manufacturing
2415120000	Degreasing (Open Top) - Fabricated Metal	Economy.com data	Fabricated metal product manufacturing
2415125000	Degreasing (Open Top) - Industrial Machinery & Equip	Economy.com data	Machinery manufacturing
2415130000	Degreasing (Open Top) - Electronic & Other Electric	Economy.com data	Computer and electronic product manufacturing & Electrical equipment; appliance; and component manufacturing
2415135000	Degreasing (Open Top) - Transportation Equipment	Economy.com data	Transportation equipment manufacturing
2415140000	Degreasing (Open Top) - Instruments & Related Products	Economy.com data	Navigational; measuring; electromedical; and control instruments manufacturing, Medical equipment and supplies manufacturing, and Commercial and service industry machinery manufacturing
2415145000	Degreasing (Open Top) - Misc. Manufacturing	Economy.com data	Miscellaneous manufacturing
2415300000	Degreasing (Cold Cleaning) - All Industries	Economy.com data	Manufacturing, 3XX
2415305000	Degreasing (Cold Cleaning) - Furniture & Fixtures	Economy.com data	Furniture and related product manufacturing
2415310000	Degreasing (Cold Cleaning) - Primary Metal Ind.	Economy.com data	Primary metal manufacturing
2415320000	Degreasing (Cold Cleaning) - Fabricated Metal	Economy.com data	Fabricated metal product manufacturing
2415325000	Degreasing (Cold Cleaning) - Industrial Machinery & Equipment	Economy.com data	Machinery manufacturing
2415330000	Degreasing (Cold Cleaning) - Electronic & Other Electric	Economy.com data	Computer and electronic product manufacturing & Electrical equipment; appliance; and component manufacturing
2415335000	Degreasing (Cold Cleaning) - Transportation Equipment	Economy.com data	Transportation equipment manufacturing
2415340000	Degreasing (Cold Cleaning) - Instruments & Related Products	Economy.com data	Navigational; measuring; electromedical; and control instruments manufacturing, Medical equipment and supplies manufacturing, and Commercial and service industry machinery manufacturing
2415345000	Degreasing (Cold Cleaning) - Misc. Manufacturing	Economy.com data	Miscellaneous manufacturing
2415355000	Degreasing (Cold Cleaning) - Automotive Dealers	Economy.com data	Motor vehicle and parts dealers
2415360000	Degreasing (Cold Cleaning) - Auto Repair Services	Economy.com data	Automotive repair and maintenance

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2415365000	Degreasing (Cold Cleaning) - Misc. Repair Services	Economy.com data	Electronic and precision equipment repair and maintenance, Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance, and Personal and household goods repair and maintenance
2420000000	Dry Cleaning: All Processes: All Solvent Types	Economy.com data	Drycleaning and laundry services
2420010055	Dry Cleaning - Commercial/Industrial (Perchloroethylene)	Economy.com data	Drycleaning and laundry services
2420010370	Dry Cleaning - Commercial/Industrial (Special Naphthas)	Economy.com data	Drycleaning and laundry services
2420020055	Dry Cleaning - Coin Operated (Perchloroethylene)	Economy.com data	Drycleaning and laundry services
2425000000	Graphic Arts: All Processes: All Solvent Types	Economy.com data	Printing and related support activities
2430000000	Rubber/Plastics: All Processes: Total - All Solvent Types	Economy.com data	Plastics and rubber products manufacturing
2440020000	Misc. Industrial: Total: All Solvent Types	Economy.com data	Miscellaneous manufacturing
2460100000	Consumer/Commercial: All Personal Care Products	Population	NA
2460200000	Consumer/Commercial: All Household Products	Population	NA
2460400000	Consumer/Commercial: All Automotive Aftermarket Products	Population	NA
2460500000	Consumer/Commercial: All Coatings and Related Products	Population	NA
2460520000	Consumer/Commercial Solvent Use (Coatings Related Products)	Population	NA
2460600000	Consumer/Commercial: All Adhesives and Sealants	Population	NA
2460800000	Consumer/Commercial: All Fifra Related Products	Population	NA
2460900000	Consumer/Commercial: Miscellaneous Products: Nec	Population	NA
2461021000	Commercial Products: Cutback Asphalt: All Solvent Types	Economy.com data	Highway; street; and bridge construction
2461022000	Commercial Products: Emulsified Asphalt: All Solvent Types	Economy.com data	Highway; street; and bridge construction
2461023000	Asphalt Application - Asphalt Roofing	Economy.com data	Nonresidential building construction
2461800000	Commercial Solvent Use - Pesticides (All)	Population	NA
2461850000	Commercial Products: Pesticides: Herbicides: All Processes	Population	NA
2465000000	Consumer Solvent Use (Total)	Population	NA
2465100000	Consumer Solvent Use (Personal Care Products)	Population	NA
2501000090	Petroleum Product Storage and Transport (Breathing) - Distillate Oil	*AEO* regional consumption data	Total - Distillate Fuel Oil (Consumption, quadrillion BTU)
2501000120	Petroleum Product Storage and Transport (Breathing) - Gasoline	*AEO* regional consumption data	Total - Motor Gasoline (Consumption, quadrillion BTU)
2501000150	Petroleum Product Storage and Transport (Breathing) - Jet Naphtha	*AEO* regional consumption data	Total - Jet Fuel (Consumption, quadrillion BTU)
2501000180	Petroleum Product Storage and Transport (Breathing) - Kerosene	*AEO* regional consumption data	Total - Kerosene (Consumption, quadrillion BTU)
2501010030	Petroleum Product Storage and Transport (Breathing) - Crude Oil	*AEO* regional consumption data	Total Crude production - Offshore and Onshore, (million barrels)
2501010060	Petroleum Product Storage and Transport (Breathing) - Residual Oil	*AEO* regional consumption data	Total - Residual Fuel Oil (Consumption, quadrillion BTU)
2501011011	Residential Portable Gas Cans: Permeation	Population	NA
2501011012	Residential Portable Gas Cans: Evaporation	Population	NA
2501011013	Residential Portable Gas Cans: Spillage During Transport	Population	NA
2501011014	Residential Portable Gas Cans: Refilling at the Pump- Vapor Displacement	Population	NA
2501011015	Residential Portable Gas Cans: Refilling at the Pump- Spillage	Population	NA
2501012011	Commercial Portable Gas Cans: Permeation	Population	NA

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2501012012	Commercial Portable Gas Cans: Evaporation (Includes Diurnal Losses)	Population	NA
2501012013	Commercial Portable Gas Cans: Spillage During Transport	Population	NA
2501012014	Commercial Portable Gas Cans: Refilling at the Pump- Vapor Displacement	Population	NA
2501012015	Commercial Portable Gas Cans: Refilling at the Pump- Spillage	Population	NA
2501050120	Petroleum Product Storage Gasoline Bulk Terminals All Evaporative Losses.	*AEO* regional consumption data	Total - Motor Gasoline
2501055120	Petroleum Product Storage Gasoline Bulk Plants All Evaporative Losses	*AEO* regional consumption data	Total - Motor Gasoline
2501060051	Petroleum Products: Gasoline Service Stations: Stage 1: Submerged Filling	*AEO* regional consumption data	Total - Motor Gasoline
2501060052	Petroleum Products: Gasoline Service Stations: Stage 1: Splash Filling	*AEO* regional consumption data	Total - Motor Gasoline
2501060053	Petroleum Products: Gasoline Service Stations: Stage 1: Balanced Submerged Filling	*AEO* regional consumption data	Total - Motor Gasoline
2501060100	Gasoline Service Stations - Stage 2 (Total)	*AEO* regional consumption data	Total - Motor Gasoline
2501060101	Petroleum Products: Gasoline Service Stations: Stage 2: Displacement Loss/Uncontrolled	*AEO* regional consumption data	Total - Motor Gasoline
2501060102	Petroleum Products: Gasoline Service Stations: Stage 2: Displacement Loss/Controlled	*AEO* regional consumption data	Total - Motor Gasoline
2501060103	Petroleum Products: Gasoline Service Stations: Stage 2: Spillage	*AEO* regional consumption data	Total - Motor Gasoline
2501060200	Petroleum Products: Gasoline Service Stations: Underground Tank: Total	*AEO* regional consumption data	Total - Motor Gasoline
2501060201	Gasoline Service Stations - Underground Tank Breathing and Emptying	*AEO* regional consumption data	Total - Motor Gasoline
2501070100	Petroleum Products: Diesel Service Stations: Stage 2: Total	*AEO* regional consumption data	Total - Distillate Fuel Oil
2501080050	Airports Aviation Gasoline Stage 1 Total	*AEO* regional consumption data	Total - Jet Fuel
2501080100	Airports Aviation Gasoline Stage 2 Total	*AEO* regional consumption data	Total - Jet Fuel
2501995120	Petroleum Product Storage and Transport (Working Loss) - Gasoline	*AEO* regional consumption data	Total - Motor Gasoline
2505020000	Petroleum Products: Marine Vessel Transport: Total: All Products	*AEO* regional production data[h]	Total Crude production - Offshore and Onshore
2505030120	Petroleum Products: Truck Transport: Gasoline	*AEO* regional consumption data	Total - Motor Gasoline
2505040120	Petroleum Products: Pipeline Transport: Gasoline	*AEO* regional consumption data	Total - Motor Gasoline
2515040000	Organic Chemical Transport: Pipelines: Total: All Products	Economy.com data	Pipeline transportation
2515040045	Organic Chemical Transport: Pipelines: 1,3-Butadiene	Economy.com data	Pipeline transportation

[h] *Annual Energy Outlook* offshore and onshore oil production data (million barrels/day).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2515040190	Organic Chemical Transport: Pipelines: Ethylene	Economy.com data	Pipeline transportation
2515040348	Organic Chemical Transport: Pipelines: Propylene	Economy.com data	Pipeline transportation
2601010000	Waste Disposal Treatment: On-Site Incineration: Industrial	Economy.com data	Waste treatment and disposal
2601020000	Waste Disposal Treatment: On-Site Incineration: Commercial/Institutional	Population	NA
2610000100	Open Burning: Yard Waste: Leaves: Unspecified	Population	NA
2610000400	Open Burning: Yard Waste: Brush: Unspecified	Population	NA
2610000500	Open Burning: Land Clearing Debris Except Logging Debris	Economy.com data	Other specialty trade contractors
2610030000	Open Burning: Residential: Household Wastes	Population	NA
2620000000	Landfills – All	Population	NA
2620030000	Landfills: Municipal: Total	Population	NA
2630000000	Wastewater Treatment – All	Population	NA
2630020000	Wastewater Treatment: Public Owned: Total Processed	Population	NA
2660000000	Leaking Underground Storage Tanks: All Types	Economy.com data	Remediation and other waste management services
2801000000	Agriculture Production (Total)	Constant[i]	Constant/No Growth Scenario
2801000003	Agriculture: Crops: Tilling	Constant	Constant/No Growth Scenario
2801500000	Agriculture: Field Burning: Total All Crop Types	Constant	Constant/No Growth Scenario
2801700001	Agriculture: Fertilizer Application: Anhydrous Ammonia	Constant	Constant/No Growth Scenario
2801700002	Agriculture: Fertilizer Application: Aqua Ammonia	Constant	Constant/No Growth Scenario
2801700003	Agriculture: Fertilizer Application: Nitrogen Solutions	Constant	Constant/No Growth Scenario
2801700004	Agriculture: Fertilizer Application: Urea	Constant	Constant/No Growth Scenario
2801700005	Agriculture: Fertilizer Application: Ammonium Nitrate	Constant	Constant/No Growth Scenario
2801700006	Agriculture: Fertilizer Application: Ammonium Sulfate	Constant	Constant/No Growth Scenario
2801700007	Agriculture: Fertilizer Application: Ammonium Thiosulfate	Constant	Constant/No Growth Scenario
2801700008	Fertilizer Application - Other Straight Nitrogen	Constant	Constant/No Growth Scenario
2801700009	Fertilizer Application - Ammonium Phosphates	Constant	Constant/No Growth Scenario
2801700010	Agriculture: Fertilizer Application: N-P-K	Constant	Constant/No Growth Scenario
2801700011	Agriculture: Fertilizer Application: Calcium Ammonium Nitrate	Constant	Constant/No Growth Scenario
2801700012	Agriculture: Fertilizer Application: Potassium Nitrate	Constant	Constant/No Growth Scenario
2801700013	Agriculture: Fertilizer Application: Diammonium Phosphate	Constant	Constant/No Growth Scenario
2801700014	Agriculture: Fertilizer Application: Monoammonium Phosphate	Constant	Constant/No Growth Scenario
2801700015	Agriculture: Fertilizer Application: Liquid Ammonium Polyphosphate	Constant	Constant/No Growth Scenario
2801700099	Agriculture: Fertilizer Application: Miscellaneous Fertilizers	Constant	Constant/No Growth Scenario
2805001000	Beef Cattle Feedlots – Total	Constant	Constant/No Growth Scenario
2805001100	Agriculture: Beef Cattle Feedlots: Confinement	Constant	Constant/No Growth Scenario
2805001200	Agriculture: Beef Cattle Feedlots: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805001300	Agriculture: Beef Cattle Feedlots: Land Application of Manure	Constant	Constant/No Growth Scenario
2805002000	Agriculture: Beef Cattle Production Composite Nec	Constant	Constant/No Growth Scenario
2805003100	Agriculture: Beef Cattle Pasture/Range: Confinement	Constant	Constant/No Growth Scenario
2805007100	Agriculture: Poultry Prod. Layers W/ Dry Manure Mgmt Confinment	Constant	Constant/No Growth Scenario
2805007300	Agriculture: Poultry Prod - Land Application of Manure	Constant	Constant/No Growth Scenario

[i] Emissions are assumed to be constant over time (i.e., growth factor is 1.0000).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2805008100	Agriculture: Poultry Production: Layers with Wet Manure Confinment	Constant	Constant/No Growth Scenario
2805008200	Agriculture: Poultry Production: Wet Manure Handling and Storage	Constant	Constant/No Growth Scenario
2805008300	Agriculture: Poultry Prod. Land Application of Wet Manure	Constant	Constant/No Growth Scenario
2805009100	Agriculture: Poultry: Confinement	Constant	Constant/No Growth Scenario
2805009200	Agriculture: Poultry: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805009300	Agriculture: Poultry: Land Application of Manure	Constant	Constant/No Growth Scenario
2805010100	Agriculture: Turkey Production: Confinement	Constant	Constant/No Growth Scenario
2805010200	Agriculture: Turkey Production: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805010300	Agriculture: Turkey Production: Land Application of Manure	Constant	Constant/No Growth Scenario
2805018000	Agriculture: Dairy Cattle: Composite: Nec	Constant	Constant/No Growth Scenario
2805019100	Agriculture: Dairy Cattle: Flush Dairy: Confinement	Constant	Constant/No Growth Scenario
2805019200	Agriculture: Dairy Cattle: Flush Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805019300	Agriculture: Dairy Cattle: Flush Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805021100	Agriculture: Dairy Cattle: Scrape Dairy: Confinement	Constant	Constant/No Growth Scenario
2805021200	Agriculture: Dairy Cattle: Scrape Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805021300	Agriculture: Dairy Cattle: Scrape Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805022100	Agriculture: Dairy Cattle: Deep Pit Dairy: Confinement	Constant	Constant/No Growth Scenario
2805022200	Agriculture: Dairy Cattle: Deep Pit Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805022300	Agriculture: Dairy Cattle: Deep Pit Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805023100	Agriculture: Dairy Cattle: Drylot/Pasture Dairy: Confinement	Constant	Constant/No Growth Scenario
2805023200	Agriculture: Dairy Cattle: Drylot/Pasture Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805023300	Agriculture: Dairy Cattle: Drylot/Pasture Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805025000	Hogs & Pigs - Composite	Constant	Constant/No Growth Scenario
2805030000	Agriculture: Poultry & Chickens: Composite	Constant	Constant/No Growth Scenario
2805030007	Agriculture: Poultry & Chickens: Ducks	Constant	Constant/No Growth Scenario
2805030008	Agriculture: Poultry & Chickens: Geese	Constant	Constant/No Growth Scenario
2805035000	Agriculture: Horses & Ponies: Composite	Constant	Constant/No Growth Scenario
2805039100	Agriculture: Swine Production: Lagoons: Confinement	Constant	Constant/No Growth Scenario
2805039200	Agriculture: Swine Production: Lagoons: Manure Handling & Storage	Constant	Constant/No Growth Scenario
2805039300	Agriculture: Swine Production: Lagoons: Land Application of Manure	Constant	Constant/No Growth Scenario
2805040000	Agriculture: Sheep & Lambs: Composite	Constant	Constant/No Growth Scenario
2805045000	Agriculture: Goats: Waste Emissions Nec	Constant	Constant/No Growth Scenario
2805047100	Agriculture: Swine Production: Deep-Pit House: Land Application of Manure: Confinement	Constant	Constant/No Growth Scenario
2805047300	Agriculture: Swine Production: Deep-Pit House: Land Application of Manure	Constant	Constant/No Growth Scenario

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2805053100	Agriculture: Swine Production: Out Door Operations: Land Application of Manure	Constant	Constant/No Growth Scenario
2806010000	Domestic Animals: Waste Emissions: Cats: Total	Population	NA
2806015000	Domestic Animals: Waste Emissions: Dogs: Total	Population	NA
2807025000	Wild Animals: Waste Emissions: Elk: Total	Constant	Constant/No Growth Scenario
2807030000	Wild Animals: Waste Emissions: Deer: Total	Constant	Constant/No Growth Scenario
2810001000	Other Combustion - Forest Wildfires	Constant	Constant/No Growth Scenario
2810005000	Other Combustion: Managed Burning: Slash: Logging Debris	Constant	Constant/No Growth Scenario
2810015000	Other Combustion - Prescribed Burning for Forest Management	Constant	Constant/No Growth Scenario
2810020000	Other Combustion - Prescribed Burning of Rangeland	Constant	Constant/No Growth Scenario
2810025000	Other Combustion: Charcoal Grilling	Population	NA
2810030000	Other Combustion: Structure Fires	Population	NA
2810040000	Other Combustion - Aircraft/Rocket Engine Firing and Testing	Constant	Constant/No Growth Scenario
2810050000	Other Combustion: Motor Vehicle Fires	Population	NA
2810060100	Miscellaneous Area Sources: Other Combustion: Human Cremation	Population	NA
2830000000	All Catastrophic / Accidental Releases	Constant	Constant/No Growth Scenario