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Base Case 2015 Emission Inventory Report for the Pinedale Anticline Record of Decision Milestone #3 Visibility Goal

Agreement: Use of 2015 Base Case Inventory Dated January 17, 2013 for Modeling Associated with Milestone #3 per the 2008 Pinedale Anticline Record of Decision

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List of Acronyms

AECOM	AECOM Technical Services, Inc.
AQD	Air Quality Division
BLM	Bureau of Land Management
BSFC	brake-specific fuel consumption
BTEX	benzene, toluene, ethylbenzene, and xylenes
CARB	California Air Resources Board
CGF	Central Gathering Facility
DA	Development Area
dehy	dehydration unit
EIS	Environmental Impact Statement
g/hp-hr	grams per horsepower hour
hp	horsepower
hr/yr	hour per year
lb/hr	pounds per hour
LCC	Lambert Conic Conformal
m	meter
Mgal	thousand gallons
mi^2	square mile
MMBtu	million British thermal units
MMscf	million standard cubic feet
NO	nitrogen oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
PAPA	Pinedale Anticline Project Area
PM	particulate matter
ppmw	parts per million by weight
QEP	QEP Resources
QEPFS	QEP Field Services
ROD	Record of Decision
SCAQMD	South Coast Air Quality Management District
scfh	standard cubic feet per hour
SCR	selective catalytic reduction
Shell	SWEPI LP

SO_2	sulfur dioxide
tpy	tons per year
Ultra	Ultra Petroleum
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
VRU	vapor recovery unit
WDEQ	Wyoming Department of Environmental Quality

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1.0 Introduction

On behalf of Ultra Petroleum (Ultra), SWEPI LP (Shell), and QEP Resources (QEP) (collectively referred to as the “Operators”), AECOM Technical Services, Inc. (AECOM) is submitting this emission inventory report to the Bureau of Land Management (BLM) and the Wyoming Department of Environmental Quality (WDEQ), Air Quality Division (AQD). The inventory represents the anticipated year 2015 base case emissions to be modeled using the CALPUFF dispersion model, as described in the final modeling protocol (AECOM 2012). Data were provided by the Operators and consolidated by AECOM in this report. AECOM has prepared, in consultation with the Operators, plots showing the source placement and allocations within the Pinedale Anticline Project Area (PAPA).

This document is organized into two chapters. Chapter 2.0 presents sample emission calculations and narrative descriptions of the calculations, plots showing source placement, and assumptions. Chapter 3.0 contains a list of references. Detailed emission summaries are contained in **Appendix A**.

2.0 2015 Base Case Emission Calculations

In accordance with the modeling protocol, emissions were developed for the anticipated 2015 base case operations for the following source categories listed in Chapter 4 of the protocol:

- Central Gathering Facilities (CGF) and other permitted liquids handling facilities;
- Well pad production sources;
- Well pad production controls;
- Drill rigs;
- Well completions;
- Compressor stations;
- Gas plants; and
- Construction mobile sources.

The categories are further delineated by the oil and gas operators bound by the 2008 Record of Decision (ROD) for the Pinedale Anticline Oil and Gas Exploration and Development Project Supplemental Environmental Impact Statement (EIS) listed below:

- Ultra;
- Shell;
- QEP;
- QEP Field Services (QEPFS);
- Enterprise;
- Anschutz;
- Yates; and
- Newfield.

The following subsections provide a description of the emission calculations, data sources, methods, and assumptions for each source category and Operator. Emissions are presented in pound per hour (lb/hr) rates for use in modeling visibility impacts based on the anticipated operations' durations and spatial allocations within the PAPA. Nitrogen oxides (NO_X) are the primary pollutant of concern for visibility modeling, and were the focus of the inventory development. Particulate matter (PM) and sulfur dioxide (SO_2), which also are visibility impairing pollutants, are quantified. Sample calculations are provided when emissions were not obtained directly from permit applications, final construction permits, or annual emission inventories. Plots are included following each discussion that illustrate the proposed source placement for each Operator and source category.

While the 2011 Annual Emissions Inventories reported to WDEQ served as a basis and starting point for the development of several aspects of the 2015 base case emissions inventory, it should be noted that inherent differences exist between the 2011 actual annual inventories and the 2015 base case inventories. First, the 2015 base case inventories represent projected development, which is anticipated to occur during the 2015 base year, and therefore includes considerations for differences such as the number of wells, number of drill rigs and drilling durations, anticipated changes to how exhaust streams are handled at well pads, different and more appropriate emission factors for various sources (for

example accounting for phasing in of newer equipment designs), seasonal and diurnal variations in operating conditions, and spreadsheet rounding.

Another key difference is in the temporal characterization of the 2015 emissions. The 2011 WDEQ inventories report emissions on a ton per year (tpy) and on a lb/hr basis. In the WDEQ inventories, the lb/hr emissions represent instantaneous emission rates. That is, emissions are reported on a lb/hr basis even if they lasted for only a few minutes. This is valuable for WDEQ as it allows them to track and monitor emissions from year to year. The lb/hr emission rates in the 2015 base case visibility modeling inventory represent average emission rates for all sources in the inventory over a 24-hour period, which also takes into account daylight hour operations for construction sources. These emission rates are developed specifically for use in visibility modeling, which is a daily (24-hour) air quality related value. This daily accounting of emissions is necessary to achieve representative and more accurate model predictions. This level of specificity also allows for a more rigorous accounting of seasonal and diurnal variations. As such, the lb/hr calculations in this report cannot be scaled up to a tpy basis without consideration of these seasonal and diurnal differences and quantification of specific operating conditions.

In addition to the use of the 2011 WDEQ inventories, some source categories used permitted emission limits in the 2015 base case emissions inventory. Similar to the discussion above regarding the extrapolation of lb/hr rates to tpy rates, some 2015 lb/hr emission rates were calculated from the permitted tpy rates and divided by appropriate annual operating hours to derive the modeled lb/hr emission rates. Therefore, the modeled lb/hr rates in this report may not match the maximum lb/hr rates listed in permits, or the 2011 WDEQ inventories.

Total summer and winter modeled emission rates are provided in **Appendix A**.

2.1 Central Gathering Facilities and Permitted Liquids Handling Facilities

Sources at CGFs consist primarily of permitted, internal combustion engines (engines), along with other equipment that emit combustion-related pollutants. Permitted, stationary sources at other liquids handling facilities are also described in this subsection. Haul truck emissions associated with liquids handling will not be modeled. During normal operations, all liquids will be transported to the CGFs via pipeline; therefore, there is minimal haul truck traffic. Each Operator's CGF and stationary engine emissions are described below.

2.1.1 Ultra

Ultra operates permitted sources at the following facilities under this source category:

- CGF#1;
- CGF#2;
- CGF#3;
- CGF#4;
- Boulder Section 8;
- Warbonnet 15-26; and
- Stud Horse Butte 14-21.

The CGF#1 facility is operated on line power. Therefore, the only emissions from the CGF#1 facility are associated with external combustion sources. The other facilities listed above are powered by natural gas-fired engines. Descriptions for the sources operating at each facility are provided in the following subsections. Emissions and stack parameters for each facility are provided in **Appendix A**.

2.1.1.1 Internal Combustion Engines

Natural gas-fired engines power the operations at CGF#2, CGF#3, CGF#4, Boulder Section 8, Warbonnet 15-26, and Stud Horse Butte 14-21. NO_X and PM lb/hr emission rates were obtained from the permit applications submitted for each facility, and confirmed against the final construction permits. SO_2 lb/hr emission rates were calculated using the emission factor from AP-42, Table 3.2-3. A sample calculation for SO_2 is provided below:

$$SO2(lb/hr) = EF\ (5.88x10^{-4}\ lb/MMBtu)\ x\ 7{,}000\ Btu/hp-hr\ x\ \frac{MMBtu}{10^6\ Btu}\ x\ Size(hp)$$

Stack parameters were obtained from information provided to the WDEQ during the construction permit application review process. Coordinates for each source were also obtained from the information previously provided to the WDEQ and will be converted to Lambert Conic Conformal (LCC) coordinates for input to the CALPUFF model. Emissions from primary engines will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year).

2.1.1.2 External Combustion Sources

External combustion sources consist of heated separators, heater treaters, line heaters, glycol reboiler burners, glycol dehydrator enclosed flare combustors, tank heaters, and benzene, toluene, ethylbenzene, and xylenes (BTEX) combustors. NO_X lb/hr emission rates were obtained from the permit applications submitted for each facility. The SO_2 and PM lb/hr emission rates were calculated using equipment input heat rating and emission factors from AP-42, Table 1.4-2. The SO_2 emission factor assumed 100 percent conversion of sulfur to SO_2, and 2,000 grains of sulfur per million standard cubic feet (MMscf). The PM emission factor represents the total PM (both filterable and condensable) factor listed in AP-42, Table 1.4-2. The AP-42 emission factors were divided by a natural gas heating value of 1,020 million British thermal units (MMBtu) per MMscf. Emission rates reflect those listed in the facility construction permits, as applicable. A sample calculation for SO_2 is provided below. The PM calculation is identical except for the emission factor.

$$SO2(lb/hr) = EF\ (0.6\ lb/MMscf)\ x\ \frac{MMscf}{1{,}020 MMBtu}\ x\ Size(MMBtu/hr)\ x\ (\#_of_units)$$

Stack parameters were obtained from information provided to the WDEQ during the construction permit application review process. Coordinates for each source were also obtained from the information previously provided to the WDEQ and will be converted to LCC coordinates for input to the CALPUFF model. Emissions from external combustion sources will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year), except for tank heaters which will be modeled during winter months only (November through April).

2.1.2 Shell

Shell operates permitted sources at the following facilities under this source category:

- North CGF;
- Central CGF;
- South CGF (this will be a new facility to be constructed by 2015);

- Big Piney Water Injection Facility; and
- Section 14/South Mesa.

The North CGF facility is operated on line power. Therefore, the only emissions from the North CGF facility are associated with external combustion sources. The other facilities listed above are powered by natural gas-fired engines, except the Big Piney facility, which is powered by diesel-fired engines. Descriptions for the sources operating at each facility are provided in the following subsections. Emissions and stack parameters for each facility are provided in **Appendix A**.

2.1.2.1 Internal Combustion Engines

Natural gas-fired engines power the operations at Central CGF, South CGF, and Section 14/South Mesa, while the Big Piney facility is powered by diesel-fired engines. The South CGF, at the time of this report, has not been constructed and does not have an air quality permit, but is anticipated to be permitted by 2015. The South CGF emissions were calculated based on anticipated throughput and compared to existing CGF facilities. Emissions from existing facilities were calculated using the maximum historical actual hours of operation from 2010 and 2011, horsepower (hp) ratings of each engine, NO_X emission factors in grams per hp-hour (g/hp-hr) determined from regulatory stack test results, manufacturer's engine specific PM emission factors, and AP-42 SO_2 emission factors, all which were utilized in the 2011 annual inventory submitted to WDEQ. In February 2012, the Central CGF engines were replaced with lower emitting engines. Emissions for the Central CGF were calculated based on historical actual hours of operation in 2011, hp ratings, NO_X emission factors in g/hp-hr determined from 2012 regulatory stack test results, manufacturer's engine specific PM emission factors, and AP-42 SO_2 emission factors. The SO_2 emission factors were taken from AP-42 Table 3.2-2 for natural gas-fired engines and AP-42 Table 3.3-1 for diesel-fired engines. A sample calculation for SO_2 from a natural gas-fired engine is provided below:

$$SO2(lb/hr) = EF\ (5.88x10^{-4}\ lb/MMBtu)\ x\ 7{,}000\ Btu/hp-hr\ x\ \frac{MMBtu}{10^6\ Btu}\ x\ Size(hp)$$

Stack parameters were obtained from information provided to the WDEQ during the construction permit application review process or provided by Shell. Coordinates for each source were also obtained from the information previously provided to the WDEQ or provided by Shell, and will be converted to LCC coordinates for input to the CALPUFF model. Emissions from primary engines will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year).

2.1.2.2 External Combustion Sources

External combustion sources consist of enclosed flares for combustion controls, volatile organic compound (VOC) combustors for tank controls, stabilization heaters, glycol heaters, and pilot gas from emergency flares. Emissions for enclosed flares and combustors were based on manufacturer's specifications, historical throughput, and NO_X emission factors from WDEQ (2010). First level of control at liquids gathering facilities is a vapor recovery unit (VRU), which results in no emissions. Historical downtime of VRU's was used to calculate emissions for the combustion unit. Emissions from stabilization heaters and glycol heaters were based on manufacturer's specifications. Pilot gas from the emergency flares was based on manufacturer's specifications and emission factors from WDEQ (2010).

Stack parameters were obtained from information provided to the WDEQ during the construction permit application review process or provided by Shell. Coordinates for each source were also obtained from the information previously provided to the WDEQ or provided by Shell, and will be converted to LCC coordinates for input to the CALPUFF model. Emissions from external combustion sources will be

modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year), except for glycol heaters which will be modeled during winter months only (November through April).

2.1.3 QEP

QEP operates a stationary natural gas-fired engine at the Mesa 8-30 SWD Facility under this source category. Central Gathering Facility emissions for QEPFS are discussed in the next section. The NO_X emission rate was obtained from permit number AP-12839. The permitted NO_X emission factor is 0.5 g/hp-hr and the unit rating is 546 hp. The SO_2 emission rate was calculated from AP-42, Table 3.2-3 and fuel consumption. The SO_2 emission factor assumed 100 percent conversion of sulfur to SO_2, and 2,000 grains of sulfur per MMscf. The PM emission rate was also calculated from AP-42, Table 3.2-3, fuel consumption, and used the sum of the PM_{10} filterable and PM condensable emission factors for the PM emission calculations. Sample calculations are provided below:

$$NOx(lb/hr) = Size\ (hp)\ x\ EF\ (0.5\ g/hp-hr)\ x\ \frac{lb}{453.59g}$$

$$SO2(lb/hr) = EF\ (5.88x10^{-4}\ lb/MMBtu)\ x\ 8{,}764\ Btu/hp-hr\ x\ \frac{MMBtu}{10^6\ Btu}\ x\ Size(hp)$$

$$PM\ (lb/hr) = EF\ (1.94x10^{-2}\ lb/MMBtu)\ x\ 8{,}764\ Btu/hp-hr\ x\ \frac{MMBtu}{10^6\ Btu}\ x\ Size(hp)$$

Stack parameters were provided by QEP. Coordinates for the engine were obtained from a survey of the facility and will be converted to LCC coordinates for input to the CALPUFF model. Emissions from engines will be modeled as a full-time source (i.e., 24 hour/day, 7 days/week, 365 days/year). Emissions and stack parameters for the Mesa 8-30 SWD Facility are provided in **Appendix A**.

2.1.4 QEPFS

QEPFS operates permitted sources at the following facilities under this source category:

- Mesa 14-16;
- Mesa 15-6;
- Pinedale Anticline Disposal Facility; and
- Stewart Point 16-18.

The Stewart Point 16-18 facility is operated on line power. Therefore, emissions from the Stewart Point 16-18 facility are assumed to be limited to those emitted from the heater. The Mesa 14-16 and Mesa 15-6 are powered by natural gas-fired engines. There are no engines at the Pinedale Anticline Disposal Facility.

Each facility uses a natural gas-fired engine to provide primary power (except the Stewart Point 16-18 and Pinedale Anticline Disposal facilities). Each facility also has flares and heaters to support liquids handling operations. Emissions provided by QEPFS represent lump-sum emissions for all sources operating at each facility.

The Mesa 14-16, Mesa 15-6, and Stewart Point 16-18 NO_X and SO_2 lb/hr emission rates were based on Table 1 – "Total Facility Emissions" in Air Quality Permits MD-1425, MD-1424, and CT-4062 respectively, when available. Otherwise, data from the permit applications were used. Emissions from these sources occur throughout the year (i.e. they are not seasonal). Therefore, the tpy emission rates were divided by 8,760 hours per year (hr/yr) to calculate the lb/hr emission rates for the modeling inventory. Particulate matter emissions are not quantified in the permits or applications. Therefore, PM emissions were calculated based on the AP-42, Table 3.2-3 and Table 1.4-2 for four-stroke rich burn engines and heaters, respectively. All PM emissions are assumed to be $PM_{2.5}$. Sample calculations for PM are provided below:

Engine:

$$PM\,(lb/hr) = \mathrm{Pr}\,ojected_Fuel_Consumption\,(MMBtu/yr)\ x\ EF\ (lb/MMBtu)\ x\ \frac{1yr}{8{,}760hr}$$

Heater:

$$PM\,(lb/hr) = \mathrm{Pr}\,ojected_Fuel_Consumption\,(MMscf/yr)\ x\ EF\ (lb/MMscf)\ x\ \frac{1yr}{8{,}760hr}$$

All emissions from the Mesa 14-16 and Mesa 15-6 facilities are assumed to be emitted from the natural gas-fired engine stack. Stack parameters were provided by QEPFS. Emissions from the Stewart Point 16-18 facility and the Anticline Disposal Facility are assumed to be emitted from the heater. Typical stack parameters were assumed for the heaters. Coordinates for each facility were obtained from the permit application and/or associated modeling analysis and will be converted to LCC coordinates for input to the CALPUFF model. Emissions from each facility will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year). Emissions and stack parameters for each facility are provided in **Appendix A**.

2.1.5 Central Gathering Facilities and Permitted Liquids Handling Summary

Table 2-1 presents a summary of the total lb/hr emission rates to be modeled for this source category. **Figure 2-1** is a plot showing all liquids handling facilities to be modeled in CALPUFF.

Table 2-1 Central Gathering and Permitted Liquids Handling Facilities Emissions Summary

Summer (May-Oct)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	13.24	0.16	1.59
Shell	5.07	0.04	0.39
QEP	0.60	3.00E-03	0.09
QEPFS	5.36	0.00	0.35
Total	24.27	0.20	2.41

Table 2-1 Central Gathering and Permitted Liquids Handling Facilities Emissions Summary

Winter (Nov-Apr)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	14.89	0.23	1.72
Shell	5.61	0.04	0.39
QEP	0.60	3.00E-03	0.09
QEPFS	5.36	0.00	0.35
Total	26.47	0.27	2.54

2.2 Well Pad Production Sources

Well pad production sources include natural gas-fired production heaters and dehydration unit (dehy) reboilers. These sources are highly intermittent and typical burner run times were accounted for in the calculations. The 2011 annual inventories submitted to WDEQ were the basis for projecting well pad production source emissions to 2015. Some heaters only operate during winter months, which will be modeled from November through April. Fugitive emissions from well pad production units consist of only VOCs, which will not be modeled for visibility. As stated in the previous section, haul truck emissions associated with liquids handling will not be modeled. During normal operations, all liquids will be transported to the CGFs via pipeline; therefore, there is minimal haul truck traffic. Each Operator's well pad production sources are described in this subsection.

2.2.1 Ultra

Ultra provided emissions data for line heaters, separator heaters, heater treaters, and dehy reboilers. The numbers of each type of source in the 2011 annual inventory, along with the total number of sources, were used to determine the percentages of each heater type in the 2011 inventory. The total 2011 NO_X emissions were allocated to each source type based on the percentages, resulting in total tpy for each source type. Ultra had 995 wells operating in the 2011. The NO_X tpy emissions for a single well were calculated by dividing the tpy emissions by 995 wells, by source type. The NO_X tpy emissions for a single well, by source type, were converted to NO_X lb/hr emissions for a single well assuming 8,760 hr/yr operations.

The single well NO_X lb/hr rates for each source type were then multiplied by the projected number of wells in 2015 (1,328 wells). The number of wells projected for 2015 was estimated based on 1,120 wells operating at the beginning of 2015, with 208 additional wells being drilled throughout the year. The number of wells to be drilled in 2015 was determined from the number of drill rigs and drilling durations anticipated for 2015 (see **Section 2.4** for drill rigs). The total NO_X lb/hr rates for each source type were then summed, which will be input to the CALPUFF model for this source category.

Emissions of SO_2 and PM for each source category were calculated by scaling the 2015 total NO_X emissions by the ratio of the AP-42, Table 1.4-2 emission factors of 0.6 lb/MMscf and 7.6 lb/MMscf for SO_2 and PM, respectively to the AP-42, Table 1.4-1 NO_X emission factor of 100 lb/MMscf.

Based on the nature of Ultra's well pad operations, it was assumed that all sources in this category operated full time with no delineation between summer and winter operations. Emissions for each source type are provided in **Appendix A**.

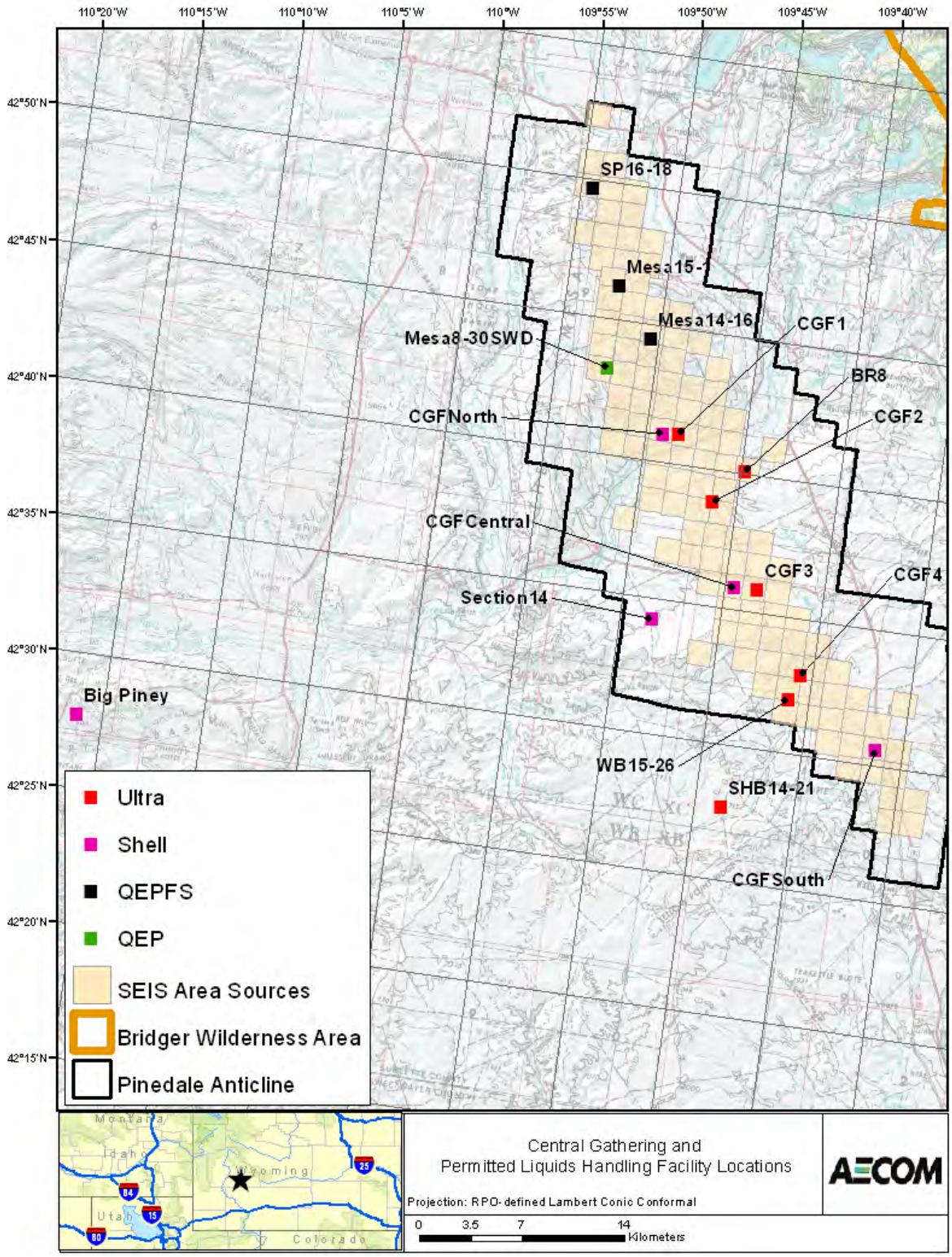

Figure 2-1 Central Gathering and Permitted Liquids Handling Facility Locations

The emissions will be modeled as 1 square mile (mi^2) area sources within the PAPA. To locate the emissions for well pad production sources, the total emissions from 995 wells operating in 2011 will be allocated evenly among 1 mi^2 areas that contained active wells in 2011, as provided in the 2011 annual inventory. Emissions from the additional 333 wells to be constructed and operating by the end of 2015 will be allocated among 1 mi^2 areas as follows:

- Two-thirds of the emissions from the additional 333 wells will be evenly allocated to 1 mi^2 areas within Development Area (DA) 3 where there are wells currently operating, per the 2011 annual inventory; and
- One-third of the emissions from the additional 333 wells will be evenly allocated to 1 mi^2 areas within DA4 where there are wells currently operating, per the 2011 annual inventory.

The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 meter (m) release height and initial sigma-z of 4.65 m. **Figure 2-2** is a plot showing the locations of Ultra's well pad production emissions to be modeled in CALPUFF. Well pad controls will be modeled at the same locations as pad production sources with the same release parameters, as described in the next source category subsection of this report.

2.2.2 Shell

Shell provided emissions data for production heaters, dehy reboilers, and winter heaters (glycol heaters for heat trace around the production site), along with the percentages of each heater type in the 2011 WDEQ Annual Inventory. The total 2011 NO_X emissions were allocated to each source type based on the percentages, resulting in total tpy for each source type. Shell had 484 full year equivalent wells operating in 2011. Full year equivalent wells are based on the approximated average amount of time a well is operated during a year, based on the timing of completions (for example, 5.5 months on average). The NO_X tpy emissions for a single well were calculated by dividing the tpy emissions by 484 wells, by source type. The NO_X tpy emissions for a single well, by source type, were converted to NO_X lb/hr emissions for a single well assuming 8,760 hr/yr operations for production heaters and dehy reboilers. The NO_X lb/hr emissions for a single winter heater were converted from tpy assuming 4,380 hr/yr for operations from November through April.

The single well NO_X lb/hr rates for each source type were then multiplied by the projected number of full year equivalent wells in 2015 (739 wells). The total NO_X lb/hr rates for each source type were then summed for full-time sources and winter-only sources separately, which will be input to the CALPUFF model for this source category.

Emissions of SO_2 and PM for each source category were calculated by scaling the 2015 total NO_X emissions by the ratio of the AP-42, Table 1.4-2 emission factors of 0.6 lb/MMscf and 7.6 lb/MMscf for SO_2 and PM, respectively to the AP-42, Table 1.4-1 NO_X emission factor of 100 lb/MMscf. Emissions for each source type are provided in **Appendix A**.

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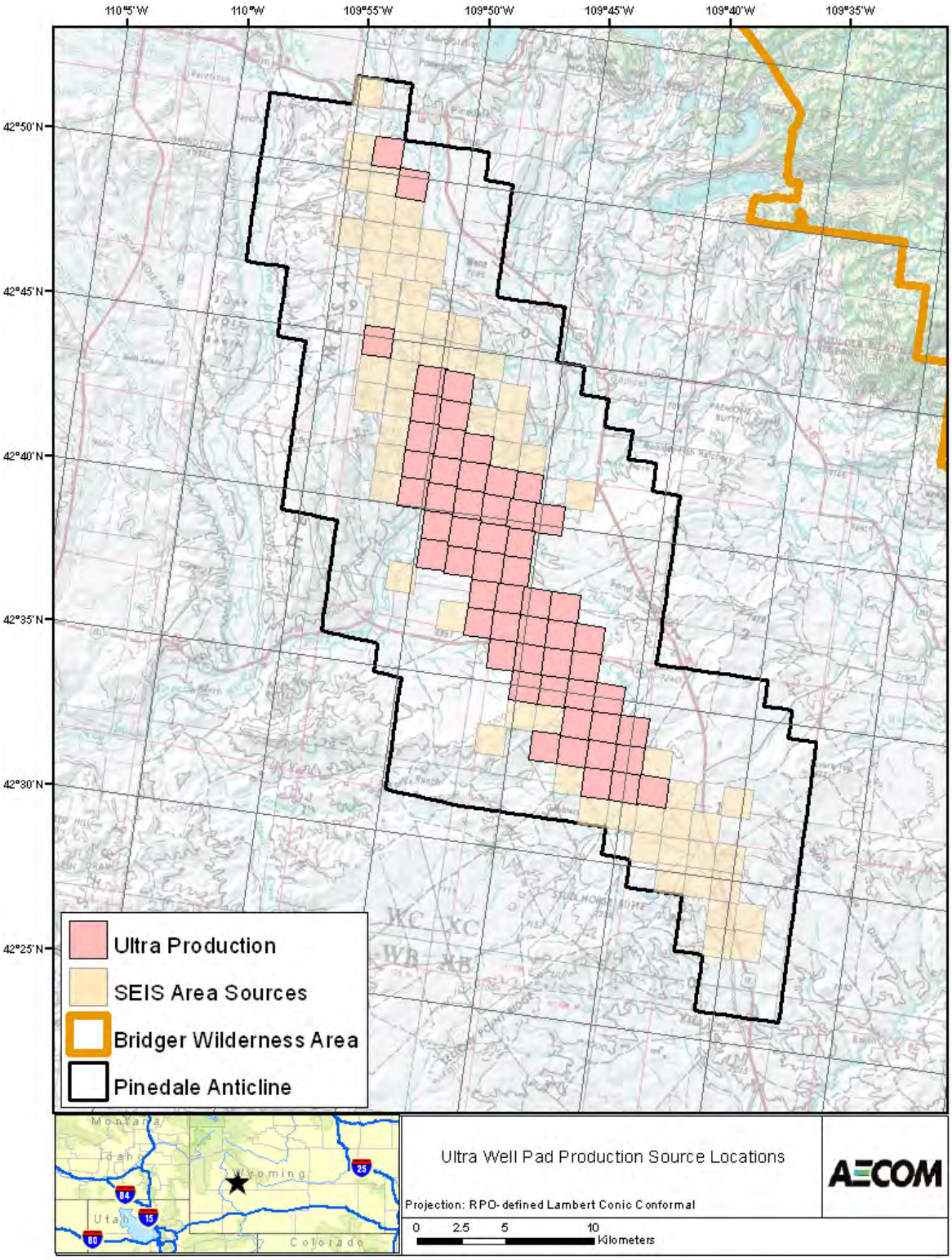

Figure 2-2 Ultra Well Pad Production Source Locations

The emissions will be modeled as 1 mi^2 area sources within the PAPA. To locate the emissions for well pad production sources, the total emissions from 484 wells operating in 2011 will be allocated evenly among 1 mi^2 areas that contained active wells in 2011, as provided in the 2011 annual inventory. Emissions from the additional 255 wells to be constructed and operating by the end of 2015 will be allocated among 1 mi^2 areas as follows:

- 5 percent of the emissions from the additional 255 wells will be evenly allocated to 1 mi^2 areas within DA1;
- 23 percent of the emissions from the additional 255 wells will be evenly allocated to 1 mi^2 areas within DA2;
- 42 percent of the emissions from the additional 255 wells will be evenly allocated to 1 mi^2 areas within DA3;
- 6 percent of the emissions from the additional 255 wells will be evenly allocated to 1 mi^2 areas within DA4; and
- 25 percent of the emissions from the additional 255 wells will be evenly allocated to 1 mi^2 areas within DA5.

The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-3** is a plot showing the locations of Shell's well pad production emissions to be modeled in CALPUFF. Well pad controls will be modeled at the same locations as pad production sources with the same release parameters, as described in the next source category subsection of this report.

2.2.3 QEP

QEP provided emissions data for production heaters, dehy reboilers, and winter heaters in the 2011 inventory. Winter heaters are comprised of tank heaters and heat trace glycol heaters. The emissions for each type of heater were based on estimates of firing time throughout 2011. The total 2011 NO_X emissions were allocated to each source type based on estimated fuel consumption, resulting in total tpy for each source type. QEP had 578 full year equivalent wells operating in the 2011. The NO_X tpy emissions for a single well were calculated by dividing the tpy emissions by 578 wells, by source type. The NO_X tpy emissions for a single well, by source type, were converted to NO_X lb/hr emissions for a single well assuming 8,760 hr/yr operations for production heaters and dehy reboilers. The NO_X lb/hr emissions for a single winter heater were converted from tpy assuming 4,380 hr/yr for operations from November through April.

The single well NO_X lb/hr rates for each source type were then multiplied by the projected number of full year equivalent wells in 2015 (1,156 wells). The total NO_X lb/hr rates for each source type were then summed for full-time sources and winter-only sources separately, which will be input to the CALPUFF model for this source category.

The number of full year equivalent wells for 2011 and 2015 is based on the assumption that wells completed in any given year are in production 5.5 months during that year. For example, 530 wells were in production at the end of 2010 and 105 wells were completed during 2011. The number of full year equivalent wells is calculated as: 530 + (105*5.5/12) = 578. At the end of 2014, 1069 wells are expected to be in production. One-hundred-ninety wells are expected to be completed in 2015. Therefore, the number of full year equivalent wells for 2015 is equal to 1,156.

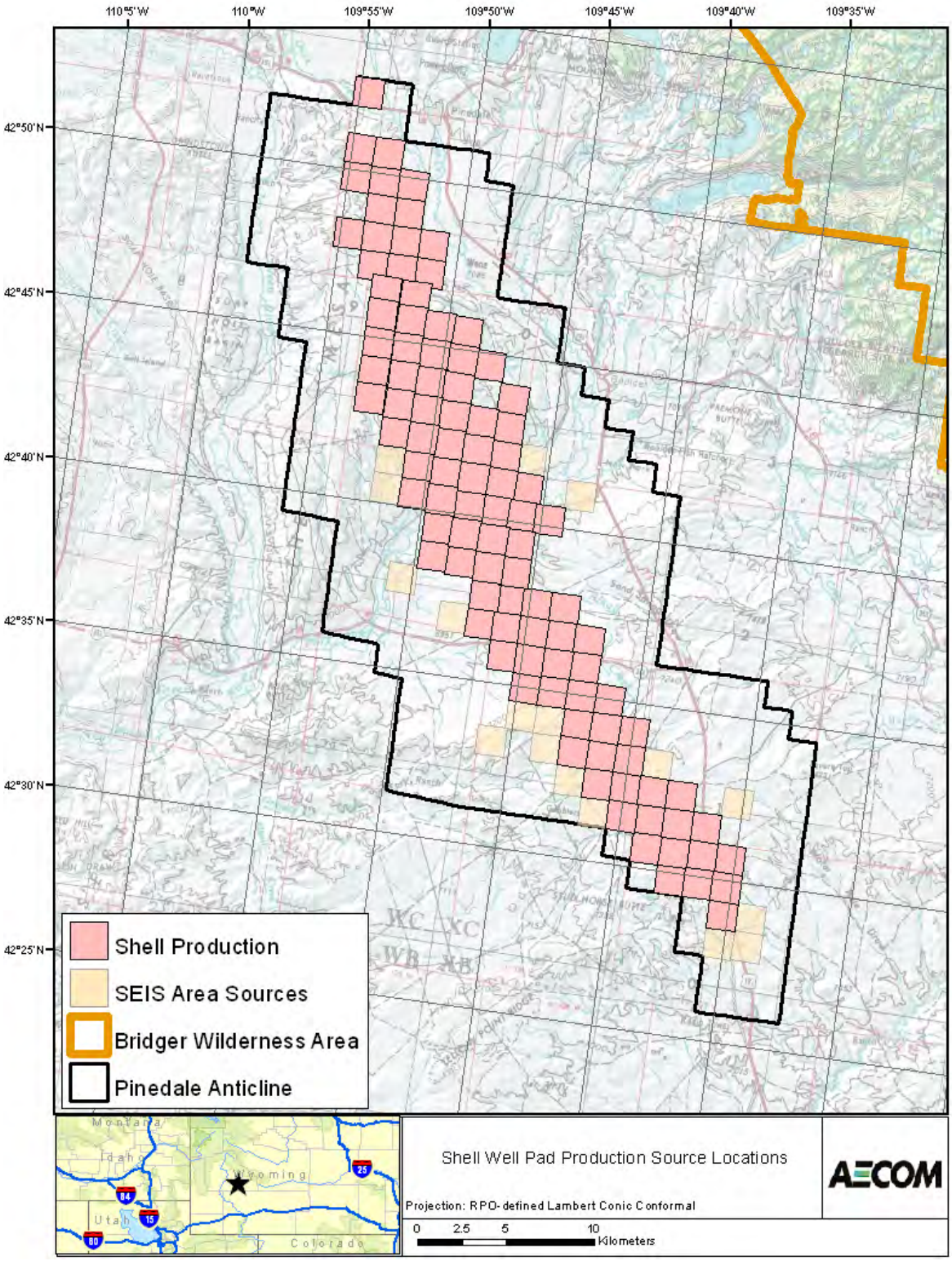

Figure 2-3 Shell Well Pad Production Source Locations

Emissions of SO_2 and PM for each source category were calculated by scaling the 2015 total NO_X emissions by the ratio of the AP-42, Table 1.4-2 emission factors of 0.6 lb/MMscf and 7.6 lb/MMscf for SO_2 and PM, respectively to the AP-42, Table 1.4-1 NO_X emission factor of 100 lb/MMscf. Emissions for each source type are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. To locate the emissions for well pad production sources, the total emissions from 578 wells operating in 2011 will be allocated evenly among 1 mi^2 areas that contained active wells in 2011, as provided in the 2011 annual inventory. Emissions from the additional 578 wells to be constructed and operating by the end of 2015 will be allocated among 1 mi^2 areas using locations provided by QEP within DA1.

The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-4** is a plot showing the locations of QEP's well pad production emissions to be modeled in CALPUFF. Well pad controls will be modeled at the same locations as pad production sources with the same release parameters, as described in the next source category subsection of this report.

2.2.4 Anschutz, Yates, and Newfield

Well pad production sources for Anschutz, Yates, and Newfield were obtained from the 2011 annual inventories submitted to the WDEQ. The "Heater" and "Dehydration Units" lb/hr emissions for each operator will be allocated to 1 mi^2 area sources that coincide with the coordinates provided in the 2011 inventories. The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. The sources will be modeled assuming year-round operations. Emissions for each operator are provided in **Appendix A**.

Figure 2-5 is a plot showing the locations of Anschutz, Yates and Newfield's well pad production emissions to be modeled in CALPUFF. Well pad controls will be modeled at the same locations as pad production sources with the same release parameters, as described in the next source category subsection of this report.

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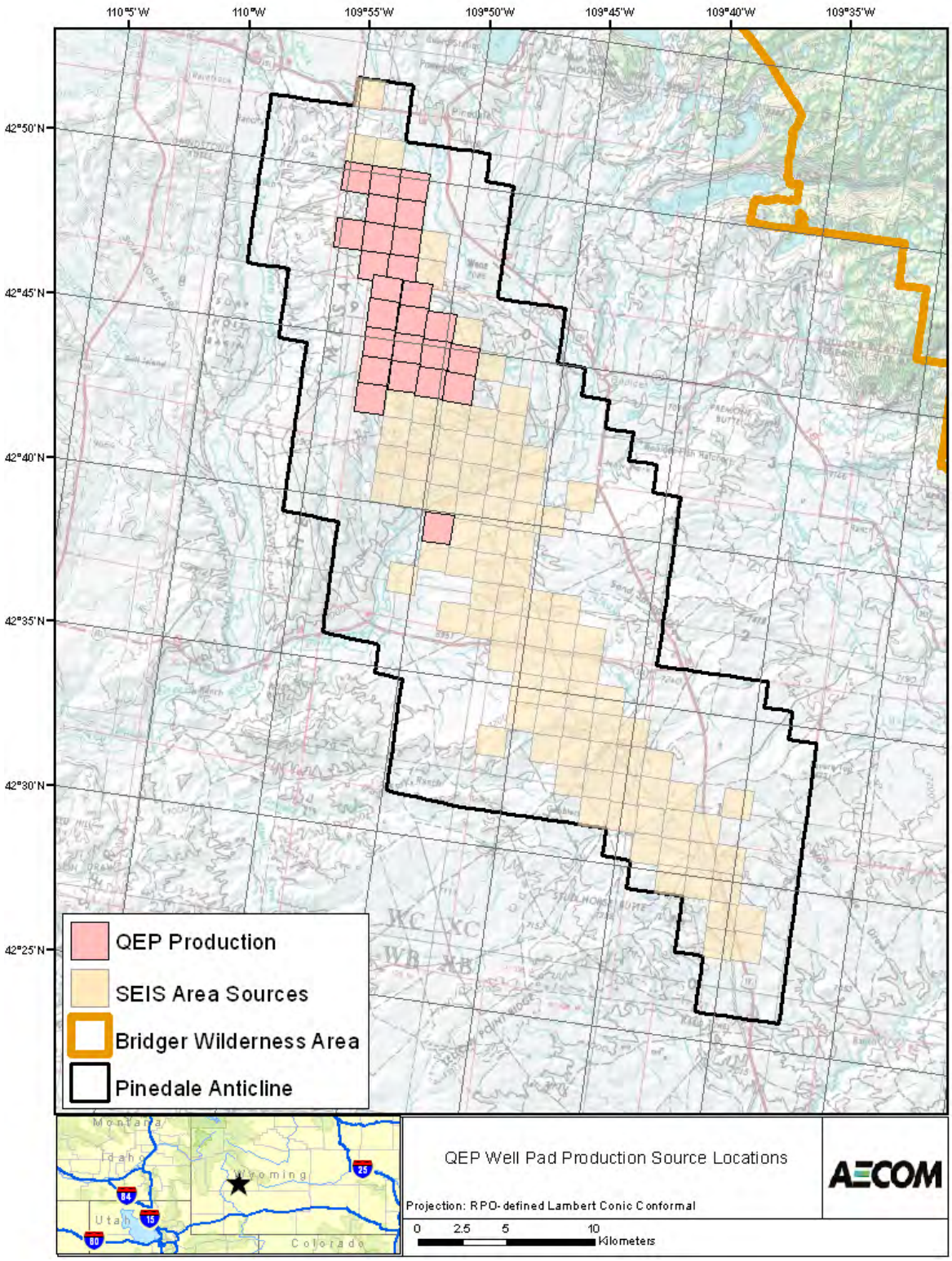

Figure 2-4 QEP Well Pad Production Source Locations

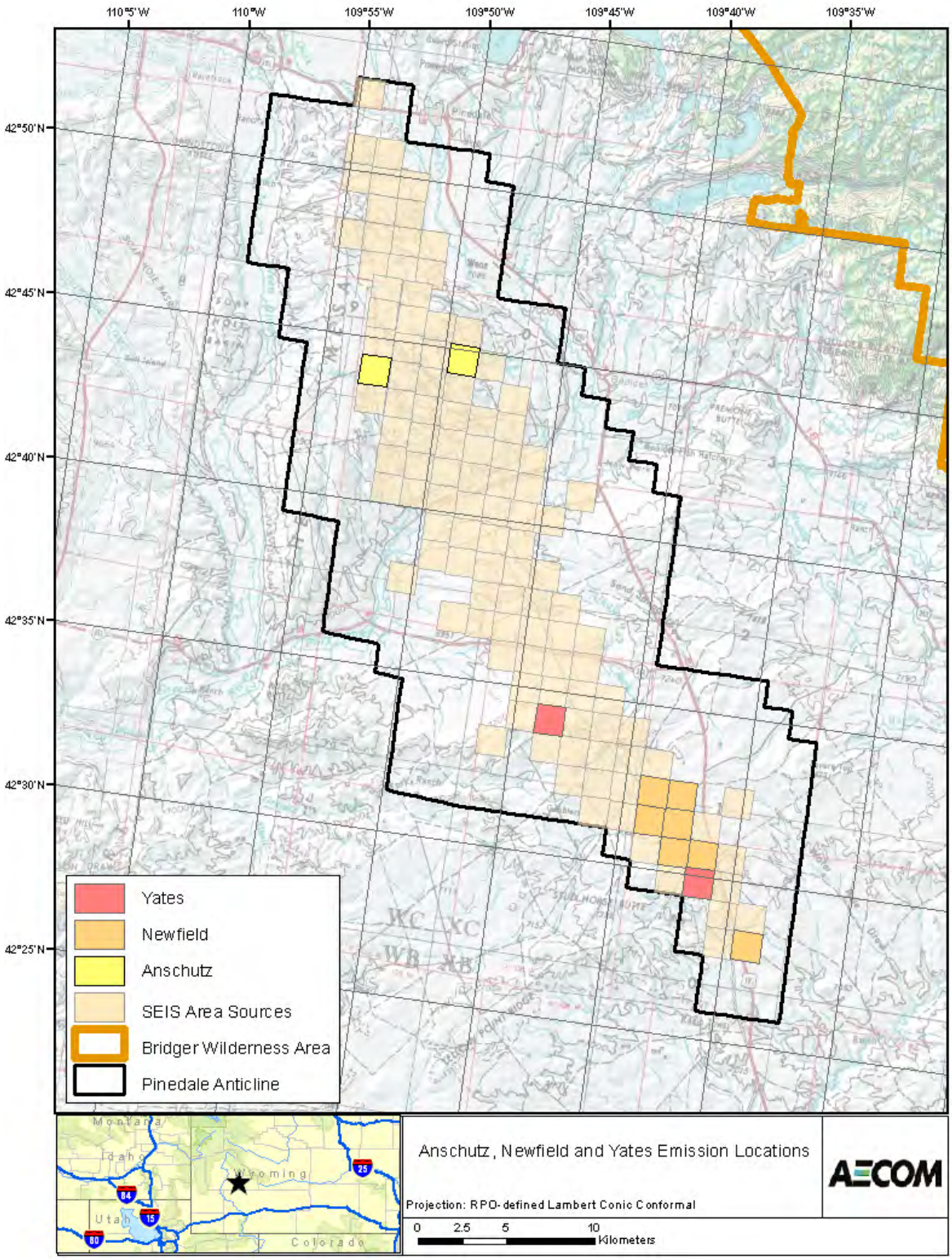

Figure 2-5 Anschutz, Newfield, and Yates Well Pad Production Source Locations

2.2.5 Well Pad Production Sources Summary

Table 2-2 presents a summary of the total lb/hr emission rates to be modeled for this source category.

Table 2-2 Well Pad Production Emissions Summary

Summer (May-Oct)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	34.25	0.21	2.60
Shell	9.52	0.06	0.72
QEP	16.41	0.10	1.25
Anschutz	0.94	0.01	0.06
Yates	3.58	0.02	0.20
Newfield	3.16	0.02	0.21
Total	67.86	0.40	5.05
Winter (Nov-Apr)	**Emission Rates (lb/hr)**		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	34.25	0.21	2.60
Shell	15.87	0.10	1.21
QEP	17.44	0.10	1.33
Anschutz	0.94	0.01	0.06
Yates	3.58	0.02	0.20
Newfield	3.16	0.02	0.21
Total	75.24	0.44	5.61

2.3 Well Pad Production Controls

Well pad production controls include BTEX combustors for controlling dehy emissions, pneumatic pumps, and VOC combustors for controlling tank emissions. The 2011 annual inventories submitted to WDEQ were the basis for projecting well pad control source emissions to 2015. Some control devices only operate during winter months, which will be modeled from November through April. Each Operator's well pad production control sources are described in this subsection.

2.3.1 Ultra

Ultra provided emissions data for BTEX combustors for controlling dehy emissions, pneumatic pumps, and VOC combustors for controlling tank emissions. The same general methodology for well pad production sources was used to project well pad control emissions to year 2015, except that the 2011 total NO_X emissions were based on the 2011 annual inventory, adjusted for the actual pilot fuel gas flow rate on the BTEX combustors (30 standard cubic feet per hour [scfh]). There were no emissions of SO_2 or PM from well pad controls in the 2011 annual inventory since these emissions are negligible; therefore no emission projections to 2015 were performed for these pollutants.

All well pad control sources were assumed to run full-time (i.e., 8,760 hr/yr) except pneumatic pumps which operate only during winter months (November through April). Emissions for each source type are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. Well pad controls in 2015 will be placed at the same locations as Ultra's 2015 well pad production sources, using the same release parameters, described in the previous subsection.

2.3.2 Shell

Shell provided emissions data for BTEX combustors, pneumatic pumps, and VOC combustors for controlling tank emissions. The same general methodology for well pad production sources was used to project well pad control emissions to year 2015. The NO_X ton/well "emission factors" for the tank controls were developed from the 2011 inventory for wells not connected to the CGFs, which results in minimal emissions from on-pad tanks. In addition, the NO_X ton/well factors for pneumatic pumps took into account Shell's recent retrofits to the pneumatic pumps, which utilize exhaust as a fuel gas in the heaters. The retrofits occurred at the end of 2011 and during 2012 at the majority of Shell's locations and eliminates the NO_X previously associated with the combustion destruction of the exhaust gas. The emissions associated with combusting the gas in the heaters is accounted for in the production sources emissions. There were no emissions of SO_2 or PM from well pad controls in the 2011 annual inventory since these emissions are negligible; therefore no emission projections to 2015 were performed for these pollutants.

All well pad control sources were assumed to run full-time (i.e., 8,760 hr/yr) except pneumatic pumps which operate only during winter months (November through April). Emissions for each source type are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. Well pad controls in 2015 will be placed at the same locations as Shell's 2015 well pad production sources, using the same release parameters, described in the previous subsection.

2.3.3 QEP

QEP provided emissions data for BTEX combustors and pneumatic pumps. The same general methodology for well pad production sources was used to project BTEX combustors and pneumatic pump emissions to year 2015. The number full year equivalent wells for 2015 used to project BTEX combustors is 1,156 wells. The 2015 full year equivalent wells for pneumatic pumps is 635 because beginning in 2012, QEP is routing pneumatic pump discharge streams to the closed loop fuel gas systems, thereby minimizing pneumatic pump emissions from new wells.

There are only two well pads with VOC combustors for controlling tank emissions (Sidewinder 3-15D and Mesa 8-30 SWD). Emissions for VOC combustors in 2015 were assumed to be equal to 2011 emissions. There were no emissions of SO_2 or PM from well pad controls in the 2011 annual inventory since these emissions are negligible; therefore no emission projections to 2015 were performed for these pollutants.

All well pad control sources were assumed to run full-time (i.e., 8,760 hr/yr) except pneumatic pumps which operate only during winter months (November through April). Emissions for each source type are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. Well pad controls in 2015 will be placed at the same locations as QEP's 2015 well pad production sources, using the same release parameters, described in the previous subsection.

2.3.4 Anschutz, Yates, and Newfield

Well pad controls sources for Anschutz, Yates, and Newfield were obtained from the 2011 annual inventories submitted to the WDEQ. The “Tank & Pressurized Vessel” and “Pneumatic” lb/hr emissions for each operator will be allocated to 1 mi^2 area sources. Well pad controls in 2015 will be placed at the same locations as these operators’ 2015 well pad production sources, using the same release parameters, described in the previous subsection. The sources will be modeled assuming year-round operations. Emissions for each operator are provided in **Appendix A**.

2.3.5 Well Pad Production Controls Summary.

Table 2-3 presents a summary of the total lb/hr emission rates to be modeled for this source category.

Table 2-3 Well Pad Production Controls Emissions Summary

Summer (May-Oct)	**Emission Rates (lb/hr)**		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	13.80	0.00	0.00
Shell	7.57	0.00	0.00
QEP	14.69	0.00	0.00
Anschutz	0.19	0.00	0.00
Yates	0.35	0.00	0.00
Newfield	4.91	0.00	0.00
Total	41.51	0.00	0.00
Winter (Nov-Apr)	**Emission Rates (lb/hr)**		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	19.79	0.00	0.00
Shell	9.66	0.00	0.00
QEP	24.86	0.00	0.00
Anschutz	0.19	0.00	0.00
Yates	0.35	0.00	0.00
Newfield	4.91	0.00	0.00
Total	59.77	0.00	0.00

2.4 Drill Rigs

Drill rigs include engines (3 per rig) and boilers (1 per rig). Recent stack tests and AP-42 emission factors were used to calculate drill rig emissions for 2015. Drill rig boilers only operate during winter months, which will be modeled from November through April. Drill rig emissions were calculated based on fuel consumption; therefore load factors were not used in the calculations. Each Operator’s drill rig emissions are described in this subsection.

2.4.1 Ultra

Drill rig engine NO_X emissions for a single rig (three diesel-fired engines total, each equipped with selective catalytic reduction [SCR] controls) were calculated using stack test results (in g/hp-hr) from tests conducted in 1st and 2nd quarters, 2012. The engine PM emissions were calculated using the manufacturer's "not to exceed" factor (in g/hp-hr). The SO_2 emissions were calculated assuming 15 parts per million by weight (ppmw) of sulfur in diesel fuel. Annual fuel usage was estimated based on the 2011 average engine fuel use per well drilled, the number of wells drilled, and the number of rigs operated in 2011. The per-rig fuel use was combined with the emission factors to estimate annual emissions for each pollutant for a single rig. The annual emissions were divided by 8,760 hr/yr to estimate the lb/hr emission rates to be used in CALPUFF for each drill rig. Sample calculations for engine NO_X for a single drill rig are provided below:

Engine Fuel Use:

$$Annual_Fuel_Use(gal/rig-yr) = Gallon_Per_Well_Drilled\,(gal/well)\ x\ No._Wells_Drilled \div No._Rigs$$

Engine NO_X Emissions:

$$NOx(lb/hr-rig) = EF\ (0.176\,g/hp-hr)\ x\ \frac{hp-hr}{6682\,Btu}\ x\ heat_content\ (Btu/gal)\ x\ Fuel_Use(gal/yr-rig)\ x\ \frac{lb}{453.59\,g}\ x\ \frac{yr}{8760\,hr}$$

Drill rig boiler NO_X, SO_2, and PM emissions for a single rig (one diesel-fired boiler, uncontrolled) were calculated using emission factors from AP-42 Table 1.3-1, total rig boiler fuel use for 2011, and the anticipated number wells to be drilled in 2015 from November through April. The total fuel use was multiplied by the emission factors and divided by the number of wells drilled in 2011, for each pollutant, to estimate the average lb per well emission rates. The lb per well emission rates were multiplied by the number of wells to be drilled in 2015 from November through April, then divided by the number of rigs anticipated in 2015 and operating hours (4,380 for winter operations) to be used in CALPUFF for each drill rig. Sample calculations for boiler NO_X for a single drill rig are provided below:

Boiler Emission Factor:

$$NOx(lb/well) = Total_Fuel_Use(gal/yr)\ x\ heat_content\ (Btu/gal)\ \ x\ \frac{MMBtu}{10^6\,Btu}\ x\ EF\,(0.145\,lb/MMBtu) \div No._Wells_per_Year$$

Boiler NO_X Emissions:

$$NOx(lb/hr-rig) = NOx(lb/well)\ x\ No._of\ _Wells_2015 \div No._rigs\ x\ \frac{yr}{4380hr}$$

Emissions and stack parameters for a single drill rig are provided in **Appendix A**. Stack parameters were obtained from the source test reports or otherwise confirmed by Ultra. A total of eight drill rigs will be modeled at locations provided by Ultra in DA3 and DA4 shown in **Figure 2-6**. Locations will be provided in LCC coordinates for input to the CALPUFF model. Emissions from the engines will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year), while the boilers will be modeled only during winter months (November through April).

2.4.2 Shell

Drill rig engine NO_X emissions for a single rig (three diesel-fired engines total, each equipped with SCR controls) were calculated using stack test results (in g/hp-hr) from tests conducted in 2011, which included SCR down time. The engine PM emissions were calculated using the manufacturer's "not to exceed" factor (in g/hp-hr). The SO_2 emissions were calculated assuming 15 ppmw of sulfur in diesel fuel. The per-well fuel use was calculated by dividing the 2011 total fuel consumption by the number of wells drilled in 2011. A NO_X emission factor, on a per-well basis, was calculated based on per-well fuel use, brake-specific fuel consumption (BSFC) of the drill rig engines, and the engine emission factor (in g/hp-hr). The per-well emissions were then multiplied by the number of new wells to be drilled in 2015. These total emissions were divided by 8,760 hr/yr and the number of drill rigs anticipated in 2015 (four rigs), to estimate the lb/hr emission rates to be used in CALPUFF for each drill rig. Sample calculations for engine NO_X for a single drill rig are provided below:

Engine Emission Factor:

$$NOx(ton/well) = Fuel\ _Use(gal/well)\ x\ EF(g/hp-hr)\ x\ heat\ _content\ (Btu/gal) \div [BSFC\ (Btu/hp-hr)\ x\ \frac{453.59g}{lb}\ x\ \frac{2000lb}{ton}]$$

Engine NO_X Emissions:

$$NOx(lb/hr-rig) = ton/well\ x\ No._of\ _Wells(well/yr)\ x\ \frac{yr}{8760hr}\ x\ \frac{2000lb}{ton} \div No._of\ _rigs$$

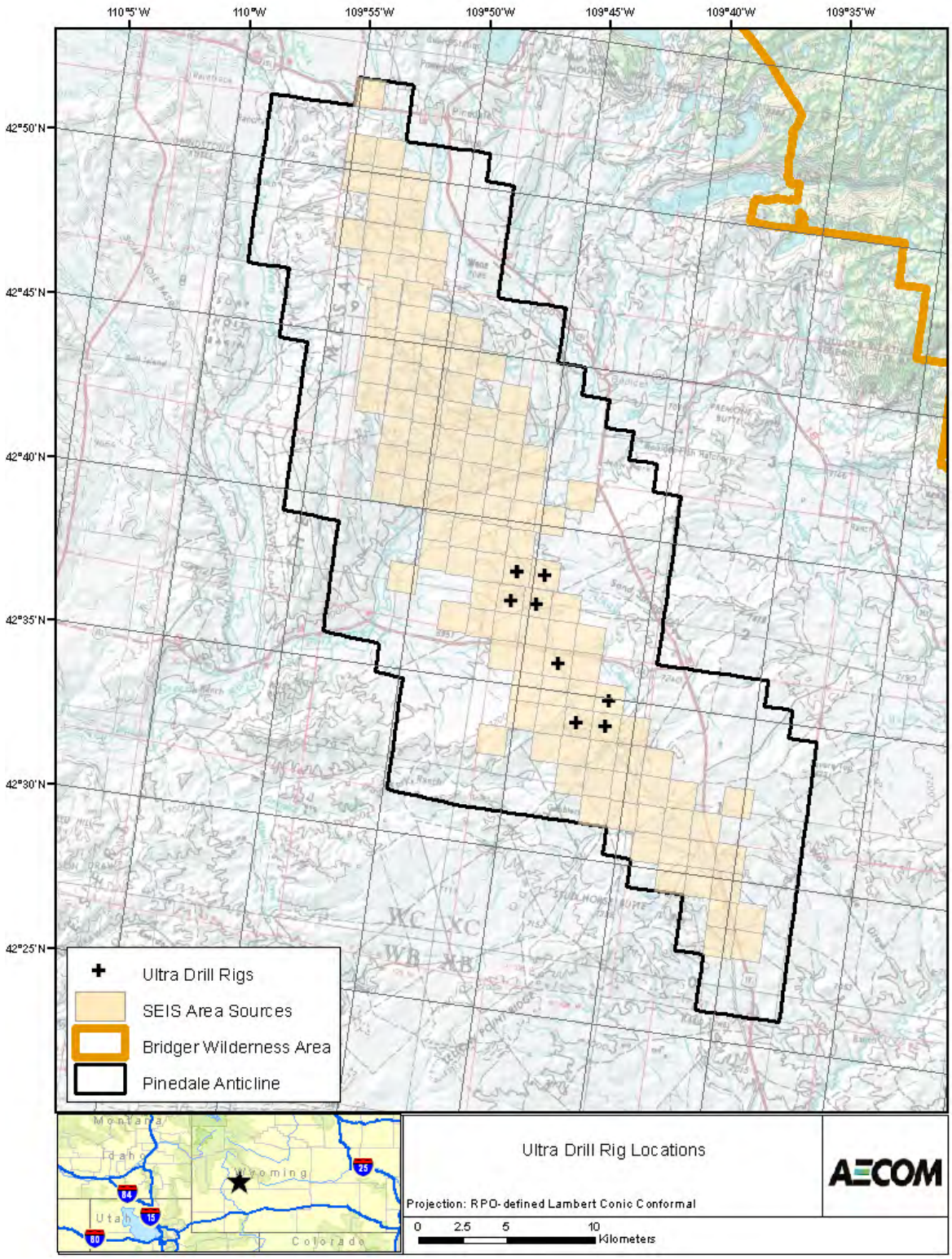

Figure 2-6 Ultra Drill Rig Locations

Drill rig boiler NO_X, SO_2, and PM emissions for a single rig (one diesel-fired boiler, uncontrolled) were calculated using emission factors from AP-42 Table 1.3-1 and historical operating hours from 2011. Sample calculations for boiler NO_X for a single drill rig are provided below:

Boiler Emission Factor:

$$NOx(lb/well) = Total_Fuel_Use(gal/yr)\ x\ heat_content\ (Btu/gal)\ \ x\ \frac{MMBtu}{10^6\ Btu}\ x\ EF(0.145 lb/MMBtu) \div No._Wells_per_Year$$

Boiler NO_X Emissions:

$$NOx(lb/hr-rig) = NOx(lb/well)\ x\ No._of_Wells_2015 \div No._rigs\ x\ \frac{yr}{4380hr}$$

Emissions and stack parameters for a single drill rig are provided in **Appendix A**. Stack parameters were obtained from the source test reports or otherwise confirmed by Shell. A total of four drill rigs will be modeled at locations provided by Shell in DAs 1, 3, 4, and 5 shown in **Figure 2-7**. Locations will be provided in LCC coordinates for input to the CALPUFF model. Emissions from the engines will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year), while the boilers will be modeled only during winter months (November through April).

2.4.3 QEP

Drill rig engine NO_X emissions for a single rig (three diesel-fired engines total, each equipped with SCR controls) were calculated using an average emission factor of 0.34 g/hp-hr from source tests conducted in 2011. The engine PM emissions were calculated using the United States Environmental Protection Agency (USEPA) non-road diesel engine emissions standard factor of 0.15 g/hp-hr. The SO_2 emissions were calculated assuming 15 ppmw of sulfur in diesel fuel. Per-well NO_X and PM emissions were calculated using the 2011 annual fuel usage (29,906 gallons per well), the emission factors, and heat content of diesel fuel. QEP expects to drill 194 wells with eight rigs in 2015, which yields annual total emissions. The annual emissions are divided by 8,760 hr/yr and eight rigs to calculate the lb/hr emission rates to be used in CALPUFF for each drill rig. Sample calculations for engine NO_X for a single drill rig are provided below:

Engine Emission Factor:

$$NOx(lb/well) = Fuel_Use(gal/well)\ x\ EF(0.34 g/hp-hr)\ x\ heat_content\ (Btu/gal) \div [BSFC\ (Btu/hp-hr)\ x\ \frac{453.59 g}{lb}]$$

Engine NO_X Emissions:

$$NOx(lb/hr-rig) = lb/well\ x\ No._of_Wells(well/yr)\ x\ \frac{yr}{8760hr} \div No._of_rigs$$

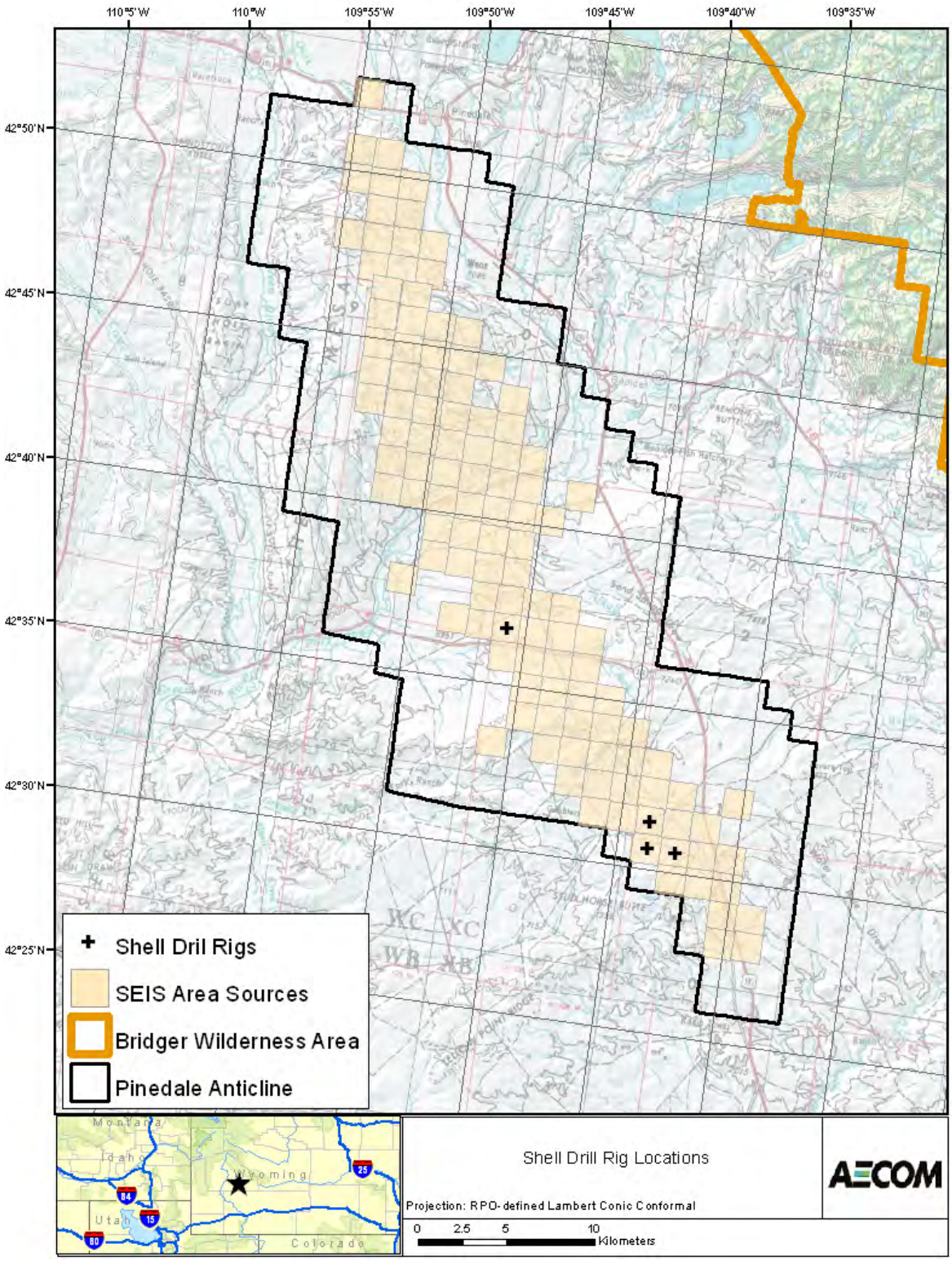

Figure 2-7 Shell Drill Rig Locations

Drill rig boiler NO_X, SO_2, and PM emissions for a single rig (one natural gas-fired boiler, uncontrolled) were calculated using emission factors from AP-42 Tables 1.4-1 and 1.4-2, a fuel consumption rate per well drilled in 2011, the number of wells to be drilled in 2015, and operating hours. The AP-42 emission factors were converted to lb/MMBtu using 1,020 MMBtu/MMscf prior to use in the emission calculations. The lb per well emission rates were multiplied by the number of wells to be drilled in 2015 from November through April, then divided by the number of rigs anticipated in 2015 (eight rigs) and operating hours (4,380 for winter operations) to be used in CALPUFF for each drill rig. A site-specific heat content of 1,080 MMBtu/MMscf was then used to calculate emissions as shown in the following sample calculations for NO_X:

Boiler Emission Factor:

$$NOx(lb/well) = EF(0.098 lb/MMBtu)\ x\ heat_content\ (1{,}080 MMBtu/MMscf)\ x\ Fuel\quad Use(MMscf/well)$$

Boiler NO_X Emissions:

$$NOx(lb/hr-rig) = lb/well\ x\ No._of_Wells(well/yr)\ x\ \frac{yr}{4380hr} \div No._of_rigs$$

Emissions and stack parameters for a single drill rig are provided in **Appendix A**. Stack parameters were obtained from QEP. A total of eight drill rigs will be modeled at locations provided by QEP at specified well pads within DA1 shown in **Figure 2-8**. Locations will be provided in LCC coordinates for input to the CALPUFF model. Emissions from the engines will be modeled as full-time sources (i.e., 24 hour/day, 7 days/week, 365 days/year), while the boilers will be modeled only during winter months (November through April).

2.4.4 Drill Rig Summary

Table 2-4 presents a summary of the total lb/hr emission rates to be modeled for this source category.

Table 2-4 Drill Rig Emissions Summary

Summer (May-Oct)	**Emission Rates (lb/hr)** [1]		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	4.61	0.12	2.09
Shell	4.01	0.07	0.72
QEP	10.56	0.16	4.64
Total	19.18	0.35	7.45
Winter (Nov-Apr)	**Emission Rates (lb/hr)** [1]		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	8.05	0.15	2.43
Shell	5.49	0.59	0.88
QEP	14.72	0.18	4.96
Total	28.26	0.92	8.27

[1] Emission rates are totals for Ultra (8 rigs), Shell (4 rigs), and QEP (8 rigs).

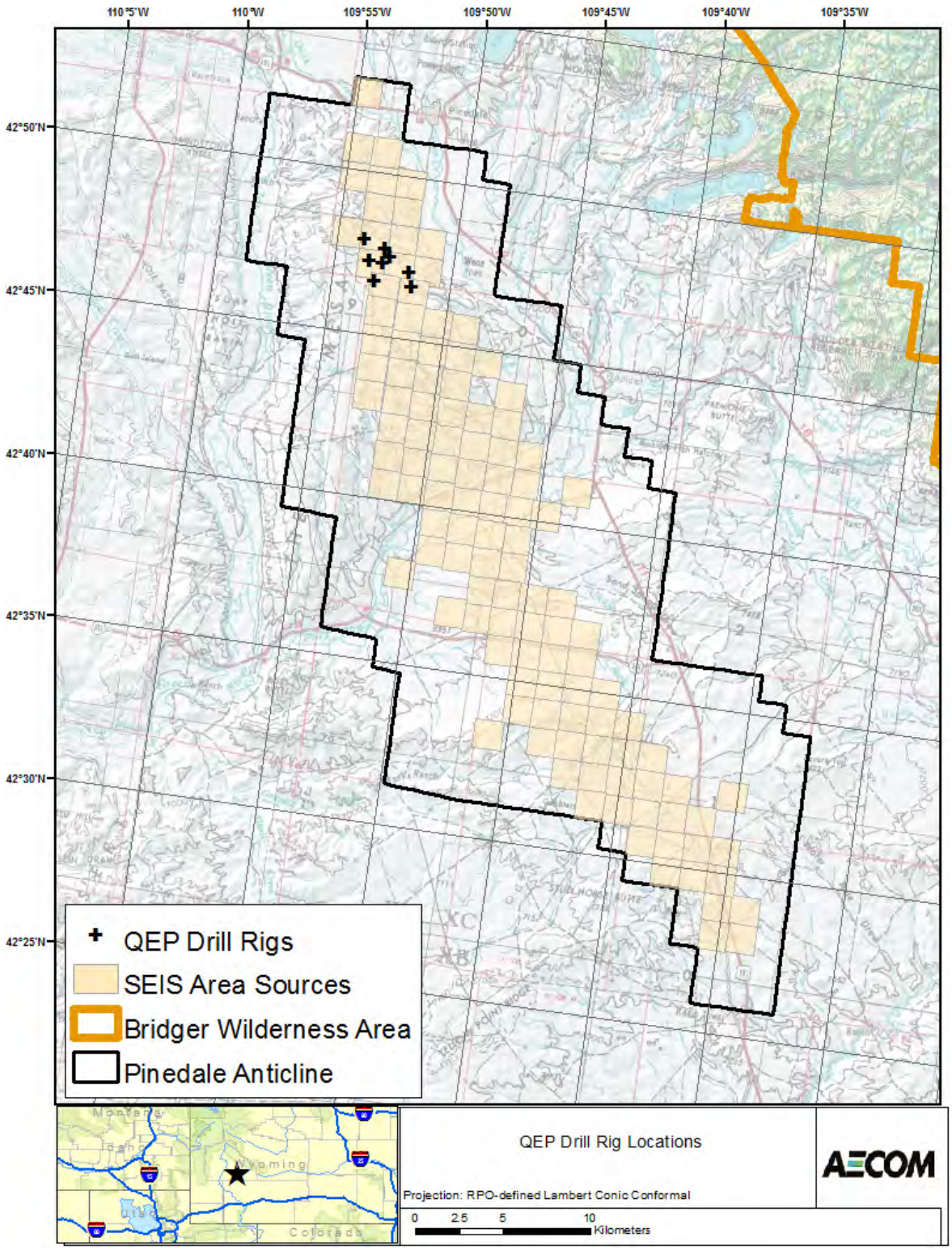

Figure 2-8 QEP Drill Rig Locations

2.5 Well Completions

The primary source of combustion emissions from well completions are diesel-fired engines driving the hydraulic fracturing process. Other auxiliary and support equipment accompany a completion crew to a well pad site. The time it takes to complete a well varies, but a typical duration is about 2 to 3 days. Once a well is completed, the crew may stay on-site to complete another well, move to a new well pad, or cease operations for a prolonged period of time. As such, the time a crew spends on a given well pad is highly speculative for future years. Completion mobile and production mobile sources were not included in the emission inventory because the emissions from these sources are negligible. The majority of emissions from completions are from completions equipment, which is accounted for in the inventory. Each Operator's drill rig emissions are described in this subsection.

2.5.1 Ultra

Ultra's completion emissions were calculated using average ton-per-well emission factors derived from the 2011 annual inventory. The factors were calculating by dividing the 2011 tpy emission rates for NO_X, SO_2, and PM by the 2011 number of completions. The ton-per-well factor was then multiplied by the number of wells anticipated to be completed in 2015 to estimate the total annual emissions. Ultra anticipates having a maximum of two completion crews in the PAPA at any one time. The annual emissions were divided by 8,760 hr/yr operations to obtain modeled lb/hr rates. Total completion emissions are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. Due to the uncertainty in the exact location of completion operations and specific wells to be completed in any given day within a 1 mi^2 area, completion emissions will be located at the 1 mi^2 areas that coincide with the drill rig locations shown in **Figure 2-6**.

The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-9** is a plot showing the locations of Ultra's well completion emissions to be modeled in CALPUFF.

2.5.2 Shell

Shell's completion emissions were calculated using average ton-per-well emission factors derived from the 2011 WDEQ Annual Inventory. The factors used in the 2011 inventory were developed by tracking engine hp and fuel usage during completions to determine a typically ton per well completion. The factors for the 2015 emissions were calculated by dividing the 2011 tpy emission rates for NO_X, SO_2, and PM by the 2011 number of completions. The ton-per-well factor was then multiplied by the number of wells anticipated to be completed in 2015 to estimate the total annual emissions. Shell anticipates having a maximum of one completion crew in the PAPA at any one time. The annual emissions were divided by 8,760 hr/yr operations to obtain modeled lb/hr rates. Total completion emissions are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. Due to the uncertainty in the exact location of completion operations and specific wells to be completed in any given day within a 1 mi^2 area, completion emissions will be located at the 1 mi^2 area that coincide with the drill rig locations shown in **Figure 2-7**.

The 1 mi^2 area source release parameters from SEIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-10** is a plot showing the location of Shell's well completion emissions to be modeled in CALPUFF.

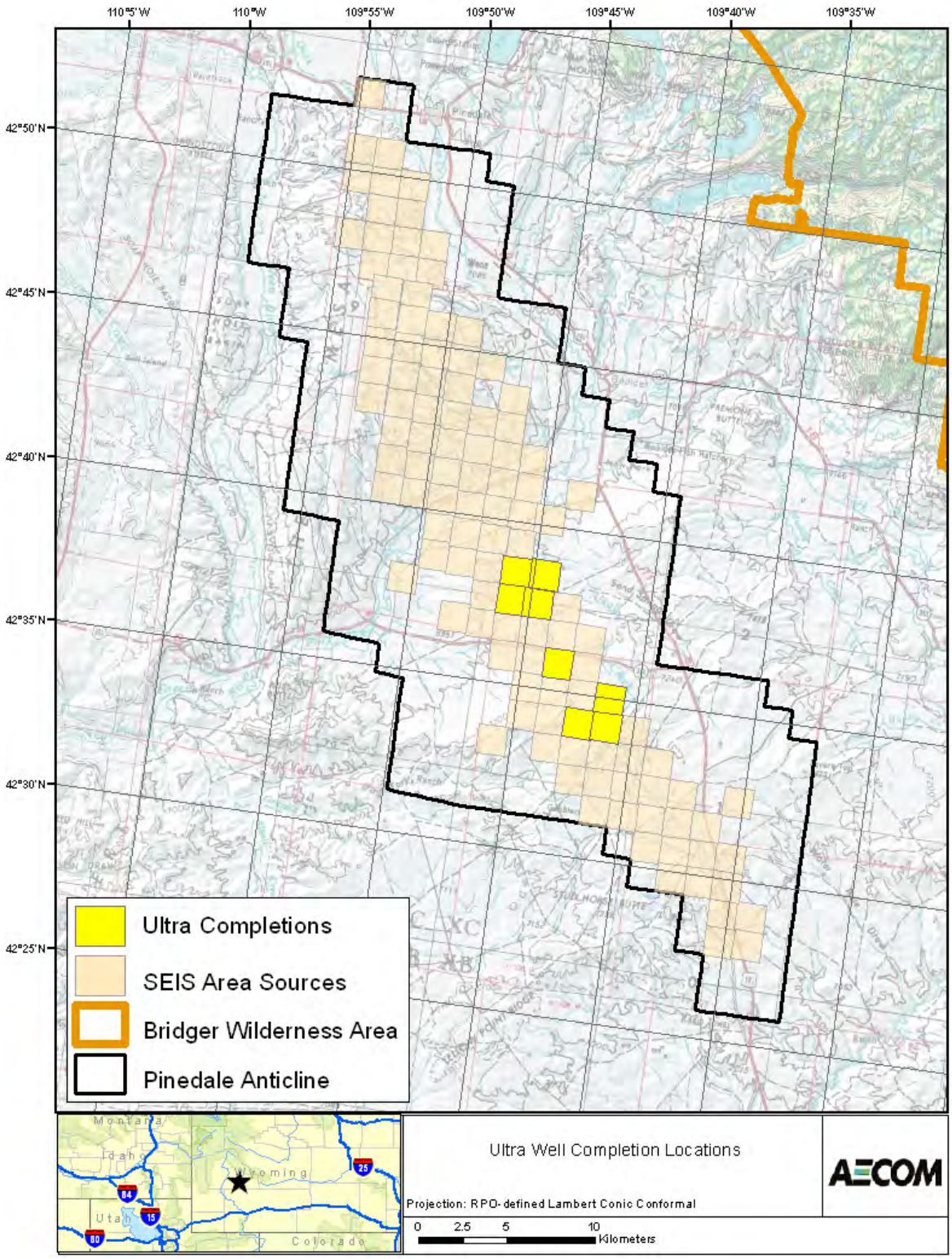

Figure 2-9 Ultra Well Completion Locations

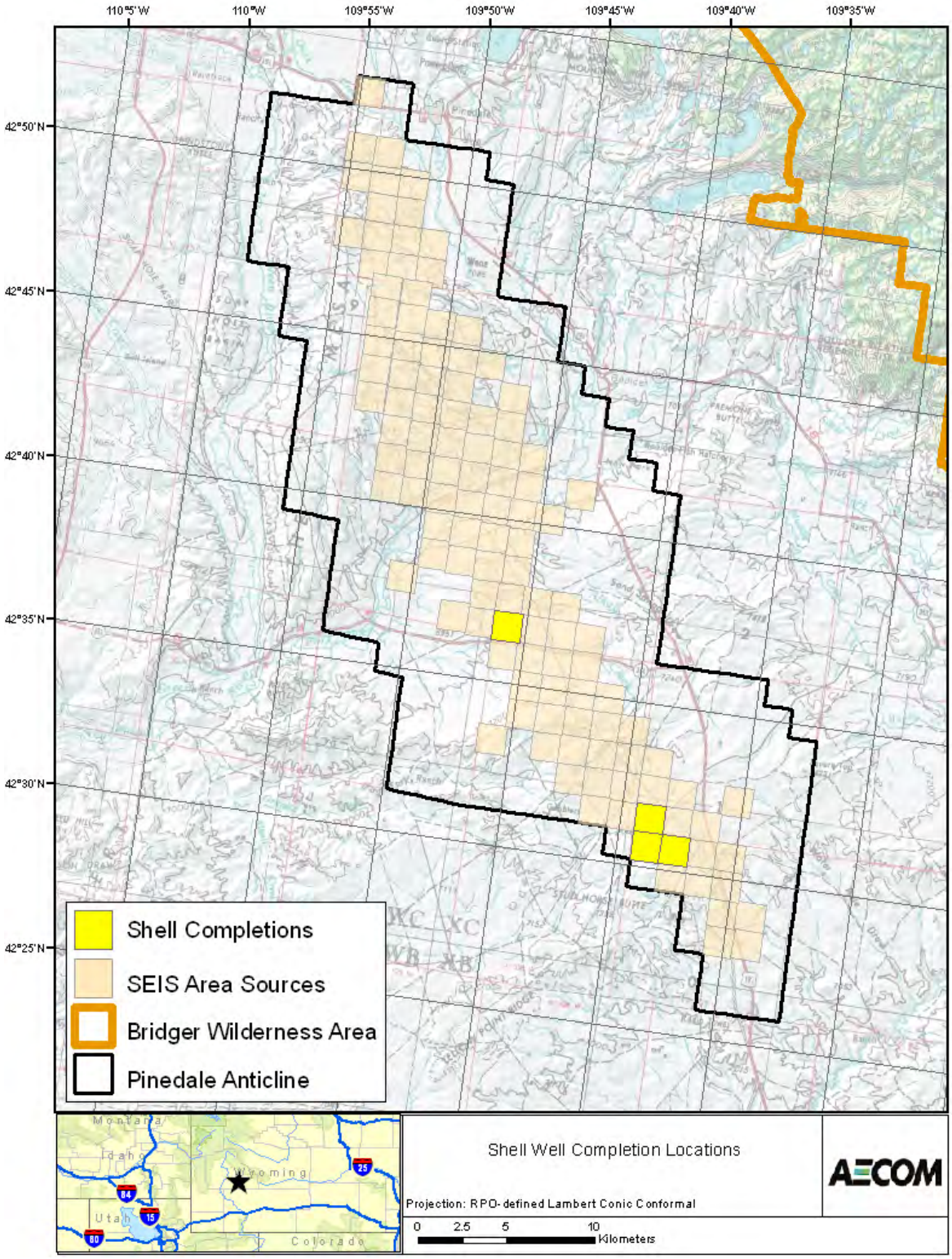

Figure 2-10 Shell Well Completion Locations

2.5.3 QEP

QEP's completion emissions were calculated using emission factors derived from the 2011 annual inventory. Emissions sources associated with completions are propane-fired heaters and diesel engines. Emission factors for propane-fired heaters are 13.0 lb NO_X per thousand gallons (Mgal) and 0.8 lb PM/Mgal. Emissions of SO_2 are considered to be negligible. In 2011, 5,349 gallons of propane was consumed per completion. Therefore, NO_X and PM emissions were 70.0 and 4.3 lb/completion, respectively.

Emissions from diesel engines were calculated using the following Tier II emission factors: 4.8 g NO_X/hp-hr, 0.0048 g SO_2/hp-hr, and 0.15 g PM/hp-hr. In 2011, the diesel consumption rate was 7,935 gallons/completion. A sample calculation for engine NO_X for a single completion is provided below:

$$NOx(lb/compl.) = 7{,}935\,gal/compl.\ x\ EF(4.8g/hp-hr)\ x\ heat_content(137{,}000\,Btu/gal) \div [BSFC(7{,}000\,Btu/hp-hr)\ x\ \frac{453.59g}{lb}]$$

Combining emissions from the heaters and the engines gives the following emission factors:

- 1,714 lb NO_X/completion;
- 55.7 lb PM/completion; and
- 1.64 lb SO_2/completion.

One-hundred-ninety completions are expected to occur in 2015. The emission factors listed above were used to estimate total emissions. The emission rate is based on 8,760 hours/year. A sample calculation for NO_X emissions for a single completion is provided below:

$$NOx(lb/hr) = 1{,}714lb/compl.\ x\ No._of_Compl.(190Compl./yr) \div \frac{yr}{8{,}760hr}$$

Total completion emissions are provided in **Appendix A**. The emissions will be modeled as 1 mi^2 area sources within the PAPA. Due to the uncertainty in the exact location of completion operations and specific wells to be completed in any given day within a 1 mi^2 area, completion emissions will be located at the 1 mi^2 area that coincide with the drill rig locations shown in **Figure 2-8**.

The 1 mi^2 area source release parameters from the Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-11** is a plot showing the location of QEP's well completion emissions to be modeled in CALPUFF.

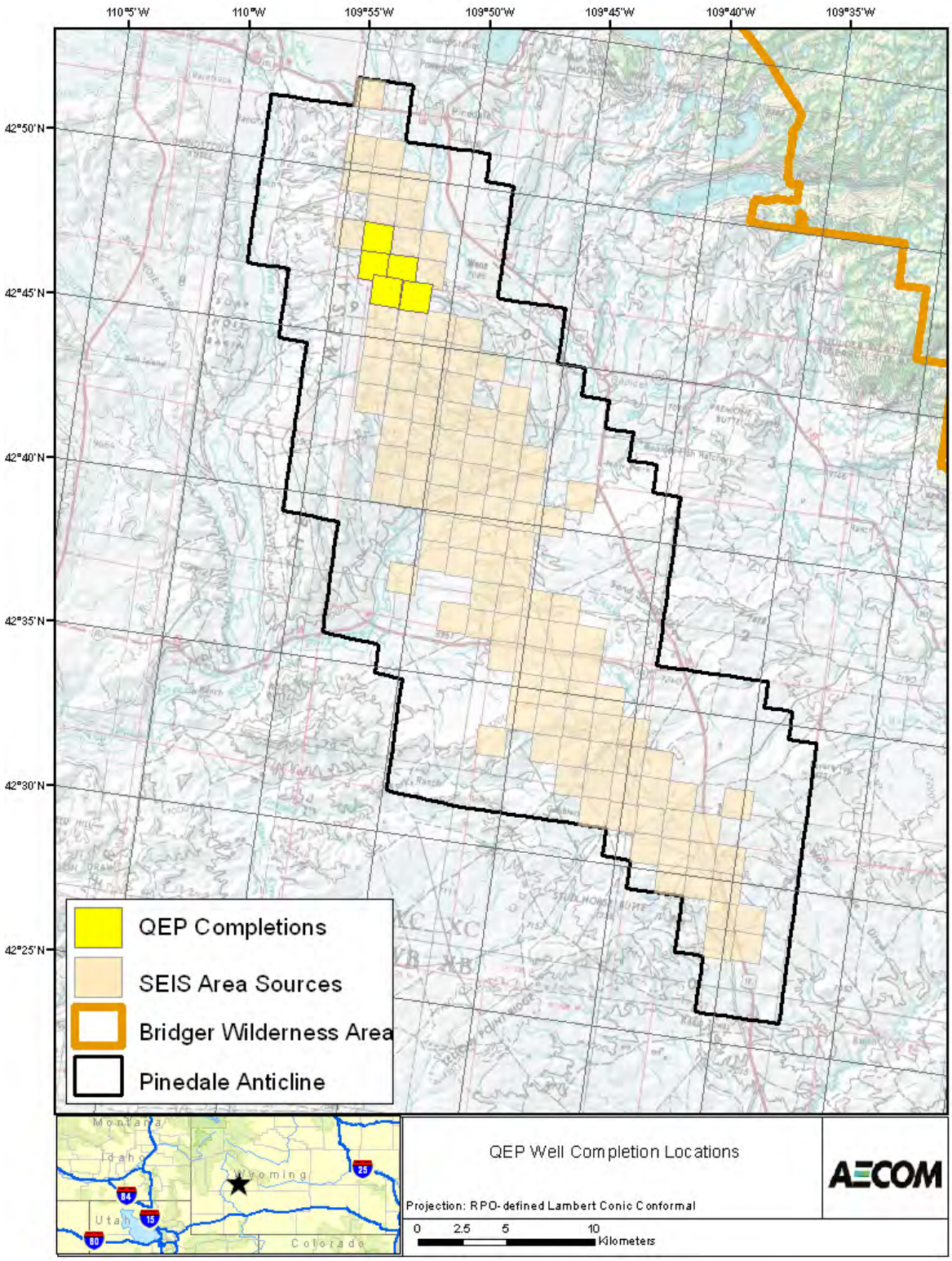

Figure 2-11 QEP Well Completion Locations

2.5.4 Anschutz, Yates, and Newfield

Emissions contained in the "Completion Emissions" tab in the 2011 annual inventories were assumed to be associated with re-completions or work-overs of existing wells. For purposes of estimating 2015 completion emissions, the 2011 emissions will be used to represent 2015 emissions. Anschutz and Yates had completion emissions reported in 2011, whereas Newfield did not. The modeled lb/hr emission rates for Anschutz and Yates were derived in the same manner as Ultra and Shell based on the tpy rates in the 2011 inventory.

The emissions will be modeled at the 1 mi^2 area sources for each operator that are closest to Bridger Wilderness Area shown in **Figure 2-5**. The same area source release parameters as production sources will be used. Emissions for each operator are provided in **Appendix A**.

2.5.5 Well Completion Summary

Table 2-5 presents a summary of the total lb/hr emission rates to be modeled for this source category.

Table 2-5 Well Completion Emissions Summary

Year-Round (Jan-Dec)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	63.94	0.15	1.89
Shell	23.15	0.07	0.66
QEP	37.18	0.04	1.21
Anschutz	0.13	0.04	0.01
Yates	0.01	0.00	0.00
Total	124.40	0.29	3.76

2.6 Compressor Stations

Compressor stations and support facilities that serve the PAPA are listed below by Operator:

- Pinedale Complex operated by QEPFS, which consists of the Gobbler's Knob compressor station and the Pinedale Stabilization Plant; and
- Paradise compressor station operated by Enterprise.

Emissions from the Falcon compressor station, which was included in the Supplemental EIS modeling and is no longer in operation due to a catastrophic fire and destruction of the facility, will be accounted for by assuming the facility will be re-built by 2015 in accordance with the latest facility permit. Each Operator's compression emissions are described in this subsection.

2.6.1 QEPFS

Natural gas-fired engines and a turbine are the primary source of emissions from the Pinedale Complex. Other sources include heaters and a low pressure flare. Emission rates were obtained from WDEQ permit No. MD-11378. Emissions from these sources occur throughout the year (i.e. they are not seasonal). Therefore, the tpy emission rates were divided by 8,760 hours per year to calculate the lb/hr emission rates for the modeling inventory. Emissions from engines E-3, E-4, E-5, and E-6, which share a total operating hour limit, were divided evenly amongst the four engines. All sources operate full time and stack parameters were provided by QEPFS. Emissions and stack parameters are provided in **Appendix A**. Source locations will be provided in LCC coordinates for input to the CALPUFF model. **Figure 2-12** shows the location of the QEPFS Pinedale Complex.

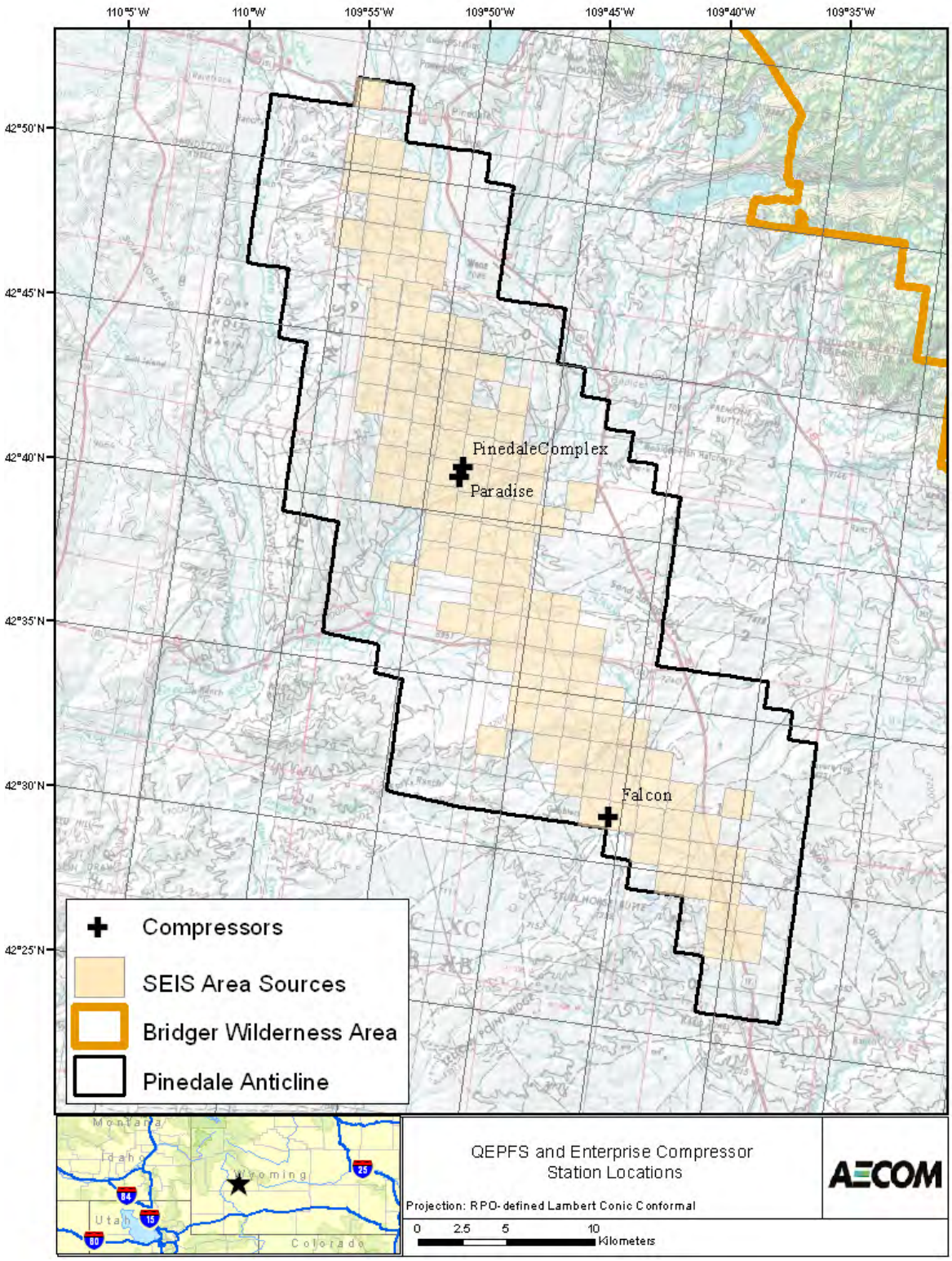

Figure 2-12 QEPFS and Enterprise Compressor Station Locations

2.6.2 Enterprise

Natural gas-fired engines are the primary source of emissions from the Paradise compressor station. Other sources include heaters, a vapor recovery unit, a tank combustor, and an emergency flare. Emission rates for NO_X were obtained from WDEQ permit No. MD-11562 and reflect the facility's total emissions. PM emissions were obtained from the 2009 annual inventory; SO_2 was assumed to be negligible. All sources will be assumed to operate full time. Stack parameters were obtained from the Supplemental EIS modeling files. Emissions and stack parameters are provided in **Appendix A**. Source locations will be provided in LCC coordinates for input to the CALPUFF model. **Figure 2-12** shows the location of the Paradise compressor station.

For the purposes of the ROD visibility modeling, it is assumed that the Falcon compressor station will be re-built. Natural gas-fired engines are the primary source of emissions from the Falcon compressor station. Other sources include heaters, a vapor recovery unit, a tank combustor, and an emergency flare. Emission rates for NO_X were obtained from WDEQ permit No. MD-11561 and reflect the facility's total emissions. PM emissions were obtained from the 2009 annual inventory; SO_2 was assumed to be negligible. All sources will be assumed to operate full time. Stack parameters were obtained from the Supplemental EIS modeling files. Emissions and stack parameters are provided in **Appendix A**. Source locations will be provided in LCC coordinates for input to the CALPUFF model. **Figure 2-12** shows the location of the Falcon compressor station.

2.6.3 Compressor Station Summary

Table 2-6 presents a summary of the total lb/hr emission rates to be modeled for this source category.

Table 2-6 Compressor Station Emissions Summary

Year-Round (Jan-Dec)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
QEPFS	29.29	0.00	0.89
Enterprise	99.30	0.00	3.50
Total	128.59	0.00	4.39

2.7 Gas Plants

The only natural gas processing plant in the region that serves the PAPA is the expansion at the Black's Fork gas plant (Black's Fork [Expansion]). This facility consists of natural gas-fired turbines and an emergency flare. NO_X emission rates were obtained from WDEQ permit No. MD-11019A. The facility emits negligible amounts of SO_2. Turbine PM emissions were calculated using an emission factor from AP-42 Table 3.1-2a and the turbine ratings. The PM emission calculation is provided below:

$$PM\,(lb/hr) = EF\,(6.6E-03 lb/MMBtu)\ x\ 15{,}088 hp\ x\ \frac{7{,}463 Btu}{hp-hr}\ x\ \frac{MMBtu}{10^6\,Btu}$$

All sources operate full time and stack parameters were provided by QEPFS. Emissions and stack parameters are provided in **Appendix A**. Source locations will be provided in LCC coordinates for input to the CALPUFF model. **Figure 2-13** shows the location of the QEPFS Black's Fork (Expansion). **Table 2-7** presents a summary of the total lb/hr emission rates to be modeled for this source category.

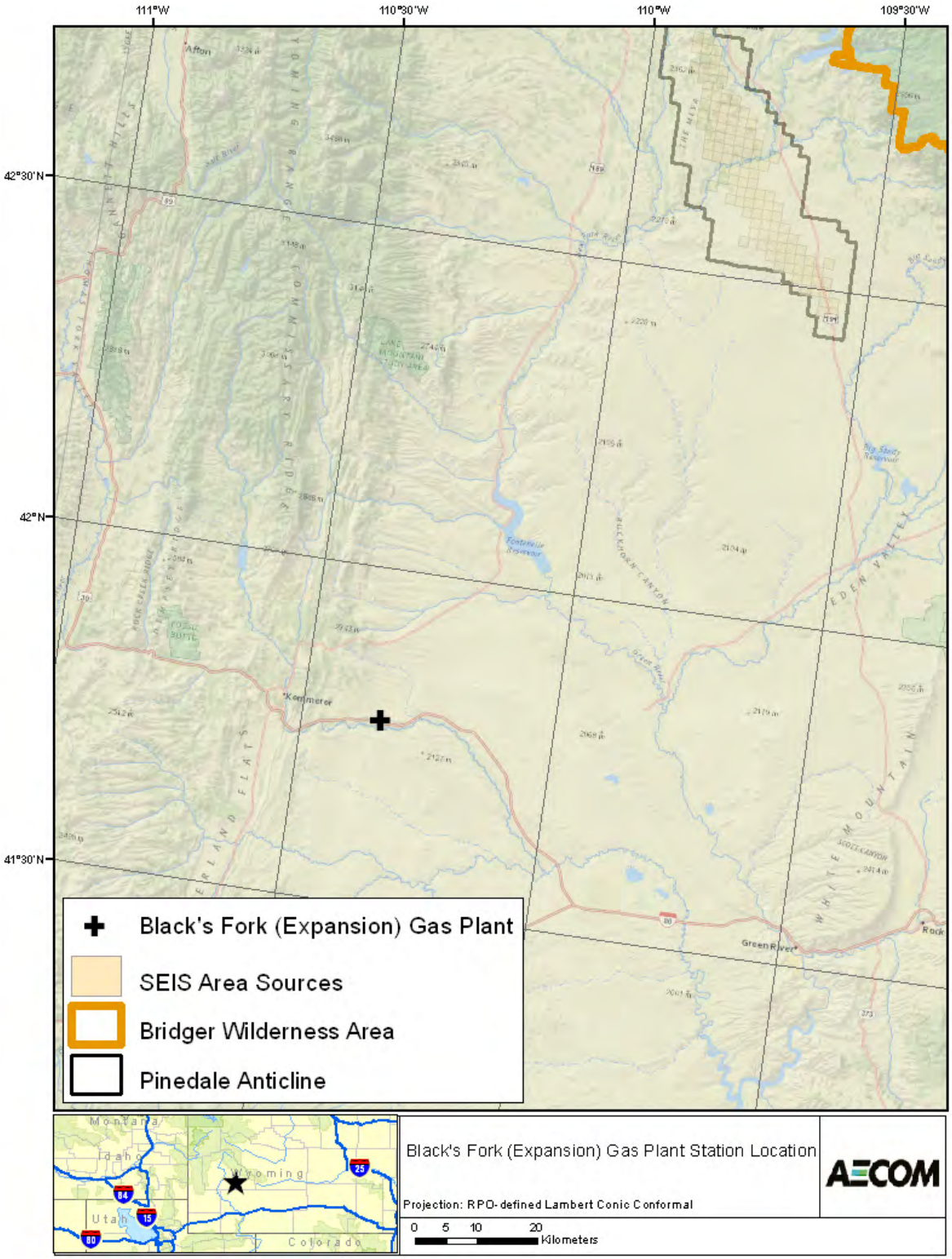

Figure 2-13 Black's Fork (Expansion) Gas Plant Station Location

Table 2-7 Gas Plant Emissions Summary

Year-Round (Jan-Dec)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
QEPFS	35.10	0.00	2.97
Total	35.10	0.00	2.97

2.8 Construction Mobile Sources

Well pad construction sources consist of tailpipe emissions from non-road mobile equipment. Construction activities occur only during warm months, roughly from May through October, and only during daylight hours. Since ammonium nitrate (from NO_X emissions) is the primary pollutant of concern in the CALPUFF modeling for visibility, and fugitive PM emissions from construction activities are negligible, fugitive PM emissions were not quantified. Each Operator's construction mobile emissions are described in this subsection.

2.8.1 Ultra

Ultra's construction mobile emissions were calculated using average types and numbers of construction equipment for a typical well pad construction project in 2011, along with emission factors. The emission factors are horsepower based off-road emission factors originally developed in 2007 (and updated annually) for the South Coast Air Quality Management District (SCAQMD) by the California Air Resources Board (CARB). The 2010 updates to the emission factors were used to develop the 2011 WDEQ Annual Inventory, which was the basis for the 2015 emission rates for construction mobile equipment. The emission factors can be found here and are provided in **Appendix A**: http://www.aqmd.gov/ceqa/handbook/offroad/offroad.html.

Total lb/hr rates for NO_X, SO_2, and PM were derived based on the average types and number of equipment used for pad construction (19.2 lb/hr, 0.14 lb/hr, and 0.85 lb/hr, respectively). Total tons/pad construction for each pollutant was calculated based on an average 10 hours/day and 10 total construction days for each pad. The modeled lb/hr rates were then scaled for four anticipated pads constructed in 2015 and 7 days/week, 6am-6pm, May through October, or 2,208 hours. A sample calculation for NO_X emissions is provided below:

$$NOx(lb/hr) = 19.2 lb/hr \ x \ \frac{10hr}{day} \ x \ \frac{10days}{pad} \ x \ \frac{4pads}{yr} \ x \ \frac{yr}{2{,}208hr}$$

Total construction mobile emissions are provided in **Appendix A**. The emissions will be modeled as 1 mi^2 area sources within the PAPA. Due to the uncertainty in the exact location of new pads to be built in 2015, construction mobile emissions will be allocated to four 1 mi^2 areas that coincide with the four drill rig locations in DA3 and DA4 shown in **Figure 2-6** that are closest to the Bridger Wilderness Area.

The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-14** is a plot showing the locations of Ultra's construction mobile emissions to be modeled in CALPUFF.

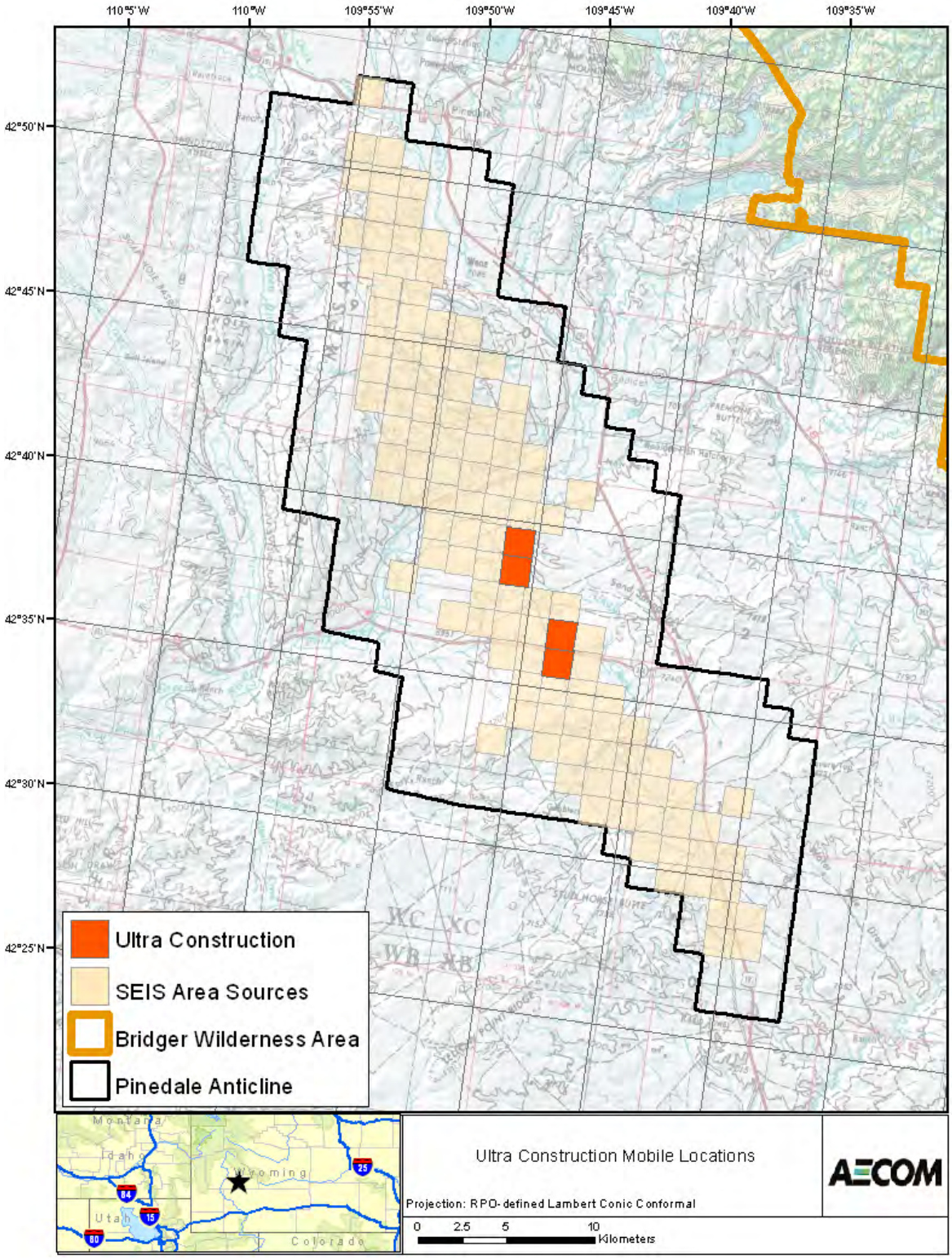

Figure 2-14 Ultra Construction Mobile Locations

2.8.2 Shell

Shell used the same emission factors as Ultra described above from the SCAQMD and CARB. The off-road emission factors were derived based on the equipment categories (tractor, dozer, scraper, etc.) and historic average equipment age and ratings, within the horsepower ranges for equipment operated in 2011. Average emissions for well pad construction in 2011 were applied to anticipated construction in 2015. Total construction mobile emissions are provided in **Appendix A**.

The emissions will be modeled as 1 mi^2 area sources within the PAPA. Due to the uncertainty in the exact location of new pad to be built in 2015, construction mobile emissions will be allocated to three 1 mi^2 areas within DA 5 that approximate the locations for new pad construction. The 1 mi^2 area source release parameters from Supplemental EIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-15** is a plot showing the locations of Shell's construction mobile emissions to be modeled in CALPUFF.

2.8.3 QEP

QEP used the same emission factors as Ultra described above from the SCAQMD and CARB. The off-road emission factors were derived based on the equipment categories (tractor, dozer, scraper, etc.), number of each piece of equipment, and the anticipated daily and annual operating hours for construction activities.

In 2015, QEP expects to expand three existing well pads. Construction of new pads is not expected. One hundred ninety four wells are expected to be drilled, which equates to 25 well pods. Based on experience, each pod will result in approximately 5 acres of disturbance, with the total disturbance expected to be 125 acres. Construction is expected to occur 7 days per week during the months of May through October, 12 hours per day. Therefore, the hourly emission rate is based on 2,208 hours. A sample calculation for NO_X emissions for well pad construction is provided below:

$$NOx(lb/hr) = EF(13.4lb/hr)\ x\ \frac{12hr}{day}\ x\ \frac{5day}{pod}\ x\ \frac{25\,pods}{yr} \div \frac{2{,}208hr}{yr}$$

The drilling of holes for conductor and surface casings was included in construction emissions. Emissions from diesel engines are based on the following factors and data:

- NO_X emission factor: 4.8 g/hp-hr;
- SO_2 emission factor: 0.0015 g/hp-hr;
- PM emission factor: 0.15 g/hp-hr;
- BSFC: 7000 Btu/hp-hr; and
- Heat content 137,000 Btu/gal.

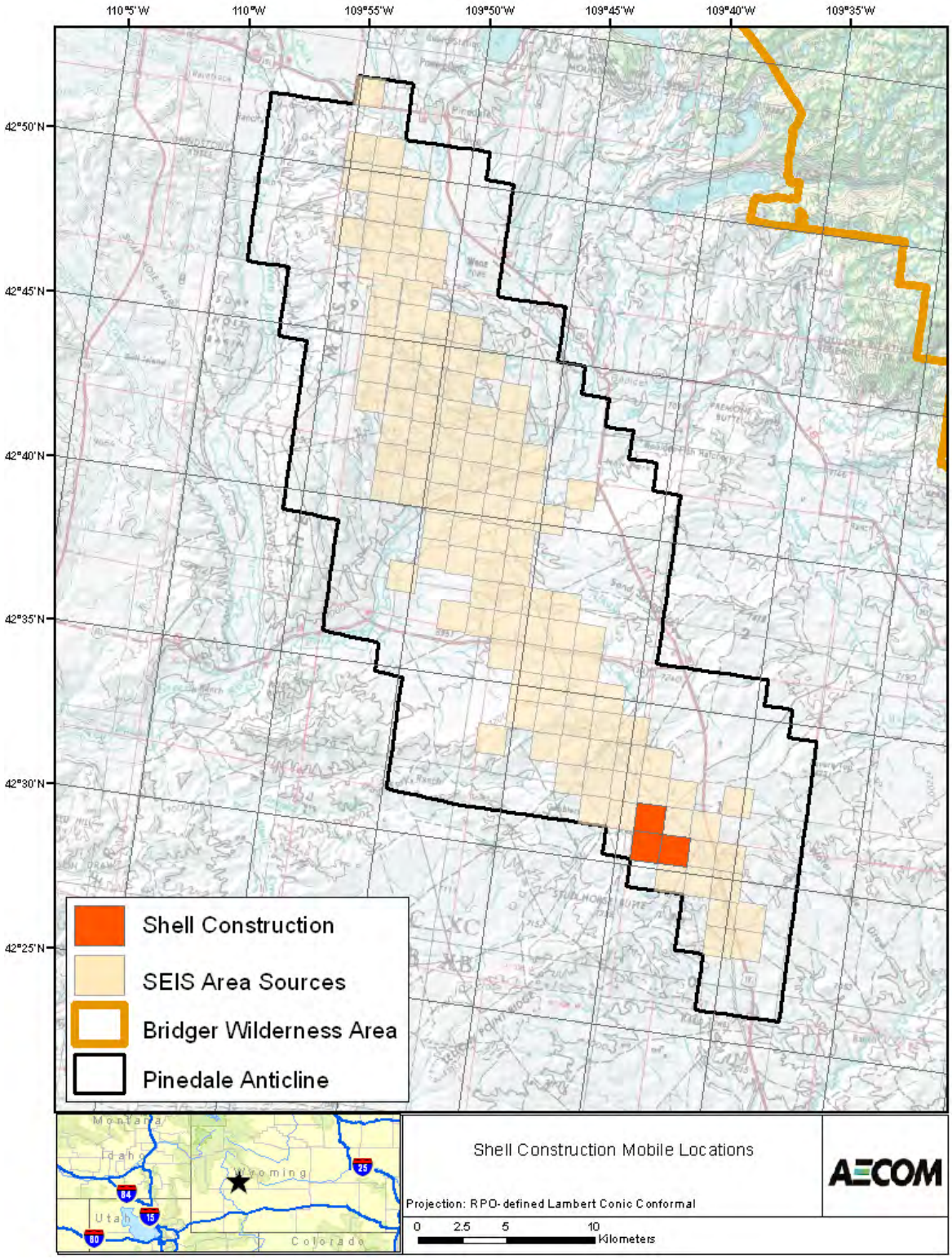

Figure 2-15 Shell Construction Mobile Locations

In 2011, 36 gallons of diesel fuel was used for each conductor casing and 1,000 gallons was used for each surface casing. Sample calculations for NO_X emissions for surface casings are provided below:

Emission Factor:

$$NOx(lb/CASING) = 1{,}000\,gal/CASING\ x\ \frac{4.8g}{hp-hr}\ x\ \frac{137{,}000\,Btu}{gal} \div [\frac{7{,}000\,Btu}{hp-hr}\ x\ \frac{453.59\,g}{lb}]$$

NO_X Emissions:

$$NOx(lb/hr) = 207.1lb/CASING\ x\ \frac{194CASINGS}{yr}\ x\ \frac{yr}{4{,}416hr}$$

Total construction mobile emissions are provided in **Appendix A**. The emissions will be modeled as 1 mi^2 area sources within the PAPA. The emissions will be allocated to areas that coincide with anticipated location of well pad construction activities in 2015 as follows:

- 40 percent of the emissions allocated to the 1 mi^2 area nearest well pad SP 16-29;
- 20 percent of the emissions allocated to the 1 mi^2 area nearest well pad SP 12-29; and
- 40 percent of the emissions allocated to the 1 mi^2 area nearest well pad SP 7-28.

The 1 mi^2 area source release parameters from SEIS will be used and include a 5 m release height and initial sigma-z of 4.65 m. **Figure 2-16** is a plot showing the locations of QEP's construction mobile emissions to be modeled in CALPUFF.

(Blank space intentional here to preserve table/figure formatting on subsequent pages)

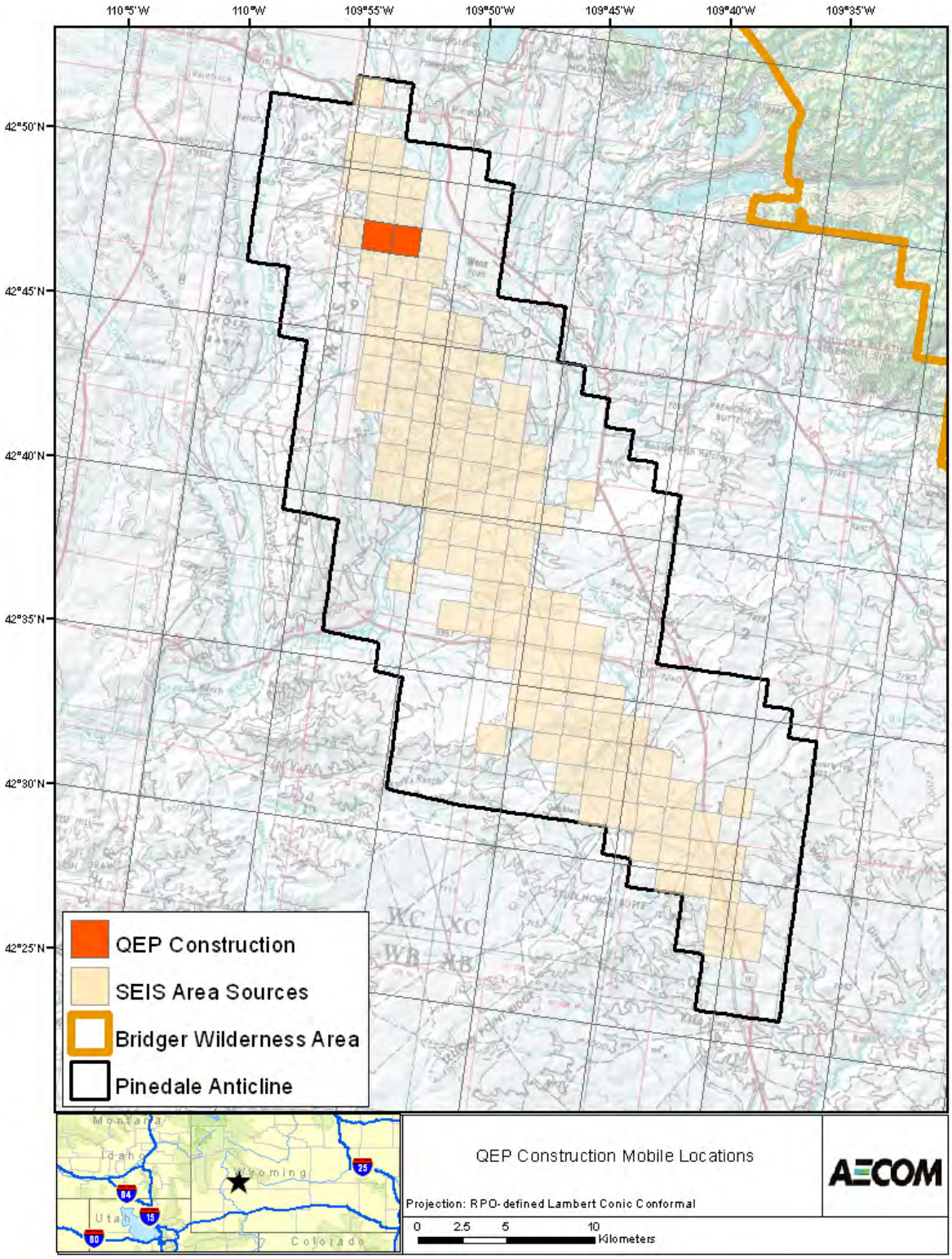

Figure 2-16 QEP Construction Mobile Locations

2.8.4 Construction Mobile Summary

Table 2-8 presents a summary of the total lb/hr emission rates to be modeled for this source category.

Table 2-8 Construction Mobile Emissions Summary

Summer (May-Oct)	Emission Rates (lb/hr)		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	3.48	0.03	0.15
Shell	3.11	0.04	0.13
QEP	18.85	0.09	0.71
Total	25.44	0.16	0.99
Winter (Nov-Apr)	**Emission Rates (lb/hr)**		
Operator	**NO_X**	**SO_2**	**PM**
Ultra	0.00	0.00	0.00
Shell	0.00	0.00	0.00
QEP	0.00	0.00	0.00
Total	0.00	0.00	0.00

2.9 Nitrogen Oxide/Nitrogen Dioxide Speciation for RIVAD Chemistry

The NO_X emissions will be speciated to nitrogen oxide (NO) and nitrogen dioxide (NO_2) for use in CALPUFF when the MCHEM option is set to 3, which invokes the RIVAD gas-phase chemical mechanism. The NO/NO_2 split for all source categories will be 90 percent of emitted NO_X as NO, and 10 percent of emitted NO_X as NO_2. This split was obtained from review of emissions processing methods used in photochemical grid modeling using the SMOKE emissions[1].

[1] See:
ftp://ftp.epa.gov/EmisInventory/emch_latest_ancillary/smoke_format/gsref_static_nox_hono_pf4_12nov2008_v2.txt
ftp://ftp.epa.gov/EmisInventory/emch_latest_ancillary/smoke_format/gspro_nox_hono_pf4_06aug2008_v0.txt

3.0 References

AECOM Technical Services, Inc. (AECOM). 2012. Modeling Protocol for the Pinedale Anticline Record of Decision Milestone #3 Visibility Goal. August 16, 2012.

Wyoming Department of Environmental Quality (WDEQ). 2010. 3/10 Oil and Gas Production Facilities Chapter 6, Section 2 Permitting Guidance. http://deq.state.wy.us/aqd/oilgas.asp

Appendix A

Emissions by Operator

Total Summer and Winter Modeled Emission Rates

Summary of Emissions (Summer)

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
Ultra	Well Pad Controls	13.80	0.00	0.00	1.74E+00	0.00E+00	0.00E+00	continuously emitting/May-Oct
Ultra	Well Pad Production	34.25	0.21	2.60	4.32E+00	2.59E-02	3.28E-01	continuously emitting/May-Oct
Ultra	Drill Rig Engines	4.61	0.12	2.09	5.81E-01	1.52E-02	2.63E-01	continuously emitting/May-Oct
Ultra	Drill Rig Boilers	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in summer
Ultra	Completions	63.94	0.15	1.89	8.06E+00	1.89E-02	2.38E-01	continuously emitting/May-Oct
Ultra	Central Gathering: 1 (Electric)	1.93	0.01	0.12	2.43E-01	1.19E-03	1.55E-02	continuously emitting/May-Oct
Ultra	Central Gathering: 2	2.77	0.01	0.71	3.49E-01	1.51E-03	8.99E-02	continuously emitting/May-Oct
Ultra	Central Gathering: 3	4.25	0.02	0.26	5.35E-01	2.49E-03	3.26E-02	continuously emitting/May-Oct
Ultra	Central Gathering: 4	1.54	0.10	0.17	1.94E-01	1.32E-02	2.14E-02	continuously emitting/May-Oct
Ultra	Stationary Source: Boulder Sect8	0.80	0.003	0.10	1.01E-01	3.75E-04	1.24E-02	continuously emitting/May-Oct
Ultra	Stationary Source: WB15_26	1.40	0.01	0.18	1.76E-01	6.80E-04	2.24E-02	continuously emitting/May-Oct
Ultra	Stationary Source: SHB14-21	0.54	0.002	0.05	6.85E-02	2.40E-04	6.40E-03	continuously emitting/May-Oct
Ultra	Construction Mobile	3.48	0.03	0.15	4.39E-01	3.30E-03	1.94E-02	daylight hrs only/May-Oct
Ultra	**Sum**	**133.32**	**0.66**	**8.32**	**1.68E+01**	**8.29E-02**	**1.05E+00**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
Shell	Well Pad Controls	7.57	0.00	0.00	9.54E-01	0.00E+00	0.00E+00	continuously emitting/May-Oct
Shell	Well Pad Production	9.52	0.06	0.72	1.20E+00	7.20E-03	9.12E-02	continuously emitting/May-Oct
Shell	Drill Rig Engines	4.01	0.07	0.72	5.05E-01	8.82E-03	9.07E-02	continuously emitting/May-Oct
Shell	Drill Rig Boilers	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in summer
Shell	Completions	23.15	0.07	0.66	2.92E+00	8.32E-03	8.32E-02	continuously emitting/May-Oct
Shell	Central Gathering: Central	1.17	0.00	0.08	1.48E-01	5.04E-04	1.01E-02	continuously emitting/May-Oct
Shell	Central Gathering: North (Electric)	1.18	0.00	0.00	1.49E-01	0.00E+00	0.00E+00	continuously emitting/May-Oct
Shell	Central Gathering: South	1.88	0.00	0.08	2.37E-01	5.04E-04	1.01E-02	continuously emitting/May-Oct
Shell	Stationary Source: Big Piney	0.16	0.03	0.01	2.00E-02	3.78E-03	6.30E-04	continuously emitting/May-Oct
Shell	Stationary Source: Sect. 14/S. Mesa	0.67	0.00	0.22	8.49E-02	0.00E+00	2.77E-02	continuously emitting/May-Oct
Shell	Construction Mobile	3.11	0.04	0.13	3.92E-01	5.04E-03	1.64E-02	daylight hrs only/May-Oct
Shell	**Sum**	**52.42**	**0.27**	**2.62**	**6.60E+00**	**3.42E-02**	**3.30E-01**	

Summary of Emissions (Summer)

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
QEP	Well Pad Controls	14.69	0.00	0.00	1.85E+00	0.00E+00	0.00E+00	continuously emitting/May-Oct
QEP	Well Pad Production	16.41	0.10	1.25	2.07E+00	1.24E-02	1.57E-01	continuously emitting/May-Oct
QEP	Drill Rig Engines	10.56	0.16	4.64	1.33E+00	2.02E-02	5.85E-01	continuously emitting/May-Oct
QEP	Drill Rig Boilers	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in summer
QEP	Completions	37.18	0.04	1.21	4.68E+00	4.41E-03	1.52E-01	continuously emitting/May-Oct
QEP	Mesa 8-30 SWD Facility	0.60	0.003	0.09	7.56E-02	3.78E-04	1.13E-02	continuously emitting/May-Oct
QEP	Construction Mobile (Well Pads)	9.10	0.09	0.41	1.15E+00	1.13E-02	5.17E-02	daylight hrs only/May-Oct
QEP	Conductor Holes	0.65	0.0002	0.02	8.19E-02	2.65E-05	2.52E-03	daylight hrs only/May-Oct
QEP	Surface Holes	9.10	0.003	0.28	1.15E+00	3.65E-04	3.53E-02	continuously emitting/May-Oct
QEP	**Sum**	**98.29**	**0.39**	**7.90**	**1.24E+01**	**4.91E-02**	**9.95E-01**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
QEPFS	Central Gathering: Mesa14-16	2.49	0.00	0.16	3.14E-01	0.00E+00	2.01E-02	continuously emitting/May-Oct
QEPFS	Central Gathering: Mesa15-6	2.58	0.00	0.16	3.25E-01	0.00E+00	2.01E-02	continuously emitting/May-Oct
QEPFS	Central Gathering: SP16-18	0.24	0.00	0.01	2.96E-02	0.00E+00	1.73E-03	continuously emitting/May-Oct
QEPFS	Pinedale Anticline Disposal Facility	0.06	0.00	0.01	7.56E-03	0.00E+00	1.73E-03	continuously emitting/May-Oct
QEPFS	Compression: Pinedale Complex	29.29	0.00	0.89	3.69E+00	0.00E+00	1.12E-01	continuously emitting/May-Oct
QEPFS	Gas Plants: Black Forks (Expansion)	35.10	0.00	2.97	4.42E+00	0.00E+00	3.75E-01	continuously emitting/May-Oct
QEPFS	**Sum**	**69.76**	**0.00**	**4.21**	**8.79E+00**	**0.00E+00**	**5.30E-01**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
Enterprise	Compression: Paradise	55.70	0.00	1.96	7.02E+00	0.00E+00	2.47E-01	continuously emitting/May-Oct
Enterprise	Compression: Falcon	43.60	0.00	1.54	5.49E+00	0.00E+00	1.94E-01	continuously emitting/May-Oct
Enterprise	**Sum**	**99.30**	**0.00**	**3.50**	**1.25E+01**	**0.00E+00**	**4.41E-01**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
Anschutz	Well Pad Controls	0.19	0.00	0.00	2.38E-02	0.00E+00	0.00E+00	continuously emitting/May-Oct
Anschutz	Well Pad Production	0.94	0.01	0.06	1.18E-01	6.37E-04	8.07E-03	continuously emitting/May-Oct
Anschutz	Completions	0.13	0.04	0.01	1.60E-02	4.75E-03	8.63E-04	continuously emitting/May-Oct
Anschutz	**Sum**	**1.26**	**0.04**	**0.07**	**1.58E-01**	**5.38E-03**	**8.93E-03**	

Summary of Emissions (Summer)

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	**Activity/Source**	**lb/hr**	**lb/hr**	**lb/hr**	**g/s**	**g/s**	**g/s**	**(Emissions Represent Season, As Noted)**
Yates	Well Pad Controls	0.35	0.00	0.00	4.44E-02	0.00E+00	0.00E+00	continuously emitting/May-Oct
Yates	Well Pad Production	3.58	0.02	0.20	4.52E-01	1.99E-03	2.52E-02	continuously emitting/May-Oct
Yates	Completions	0.01	0.00	0.00	9.53E-04	0.00E+00	1.12E-05	continuously emitting/May-Oct
Yates	**Sum**	**3.94**	**0.02**	**0.20**	**4.97E-01**	**1.99E-03**	**2.53E-02**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	**Activity/Source**	**lb/hr**	**lb/hr**	**lb/hr**	**g/s**	**g/s**	**g/s**	**(Emissions Represent Season, As Noted)**
Newfield	Well Pad Controls	4.91	0.00	0.00	6.19E-01	0.00E+00	0.00E+00	continuously emitting/May-Oct
Newfield	Well Pad Production	3.16	0.02	0.21	3.98E-01	2.13E-03	2.69E-02	continuously emitting/May-Oct
Newfield	**Sum**	**8.07**	**0.02**	**0.21**	**1.02E+00**	**2.13E-03**	**2.69E-02**	

	2015	2015	2015	2015	2015	2015
	Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM
All Operators Combined	**lb/hr**	**lb/hr**	**lb/hr**	**g/s**	**g/s**	**g/s**
Total Summer Emissions	**466.35**	**1.39**	**27.03**	**5.88E+01**	**1.76E-01**	**3.41E+00**

Summary of Emissions (Winter)

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
Ultra	Well Pad Controls	19.79	0.00	0.00	2.49E+00	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
Ultra	Well Pad Production	34.25	0.21	2.60	4.32E+00	2.59E-02	3.28E-01	continuously emitting/Nov-Apr
Ultra	Drill Rig Engines	4.61	0.12	2.09	5.81E-01	1.52E-02	2.63E-01	continuously emitting/Nov-Apr
Ultra	Drill Rig Boilers	3.43	0.03	0.34	4.33E-01	3.26E-03	4.33E-02	continuously emitting/Nov-Apr
Ultra	Completions	63.94	0.15	1.89	8.06E+00	1.89E-02	2.38E-01	continuously emitting/Nov-Apr
Ultra	Central Gathering: 1 (Electric)	1.93	0.01	0.12	2.43E-01	1.19E-03	1.55E-02	continuously emitting/Nov-Apr
Ultra	Central Gathering: 2	2.77	0.01	0.71	3.49E-01	1.51E-03	8.99E-02	continuously emitting/Nov-Apr
Ultra	Central Gathering: 3	4.25	0.02	0.26	5.35E-01	2.49E-03	3.26E-02	continuously emitting/Nov-Apr
Ultra	Central Gathering: 4	1.54	0.10	0.17	1.94E-01	1.32E-02	2.14E-02	continuously emitting/Nov-Apr
Ultra	Stationary Source: Boulder Sect8	1.19	0.01	0.13	1.50E-01	6.72E-04	1.61E-02	continuously emitting/Nov-Apr
Ultra	Stationary Source: WB15_26	2.18	0.01	0.24	2.75E-01	1.27E-03	3.00E-02	continuously emitting/Nov-Apr
Ultra	Stationary Source: SHB14-21	1.02	0.07	0.09	1.28E-01	8.76E-03	1.09E-02	continuously emitting/Nov-Apr
Ultra	Construction Mobile	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in winter
Ultra	**Sum**	**140.92**	**0.73**	**8.64**	**1.78E+01**	**9.23E-02**	**1.09E+00**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	Activity/Source	lb/hr	lb/hr	lb/hr	g/s	g/s	g/s	(Emissions Represent Season, As Noted)
Shell	Well Pad Controls	9.66	0.00	0.00	1.22E+00	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
Shell	Well Pad Production	15.87	0.10	1.21	2.00E+00	1.20E-02	1.52E-01	continuously emitting/Nov-Apr
Shell	Drill Rig Engines	4.01	0.07	0.72	5.05E-01	8.82E-03	9.07E-02	continuously emitting/Nov-Apr
Shell	Drill Rig Boilers	1.48	0.52	0.16	1.86E-01	6.55E-02	2.02E-02	continuously emitting/Nov-Apr
Shell	Completions	23.15	0.07	0.66	2.92E+00	8.32E-03	8.32E-02	continuously emitting/Nov-Apr
Shell	Central Gathering: Central	1.36	0.004	0.08	1.71E-01	5.04E-04	1.01E-02	continuously emitting/Nov-Apr
Shell	Central Gathering: North (Electric)	1.36	0.00	0.00	1.72E-01	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
Shell	Central Gathering: South	2.06	0.004	0.08	2.60E-01	5.04E-04	1.01E-02	continuously emitting/Nov-Apr
Shell	Stationary Source: Big Piney	0.16	0.03	0.01	2.00E-02	3.78E-03	6.30E-04	continuously emitting/Nov-Apr
Shell	Stationary Source: Sect. 14/S. Mesa	0.67	0.00	0.22	8.49E-02	0.00E+00	2.77E-02	continuously emitting/Nov-Apr
Shell	Construction Mobile	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in winter
Shell	**Sum**	**59.77**	**0.79**	**3.13**	**7.53E+00**	**9.94E-02**	**3.94E-01**	

Summary of Emissions (Winter)

Operator	Activity/Source	2015 Sum of NOx lb/hr	2015 Sum of SO2 lb/hr	2015 Sum of PM lb/hr	2015 Sum of NOx g/s	2015 Sum of SO2 g/s	2015 Sum of PM g/s	Temporal Variability in Model (Emissions Represent Season, As Noted)
QEP	Well Pad Controls	24.86	0.00	0.00	3.13E+00	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
QEP	Well Pad Production	17.44	0.10	1.33	2.20E+00	1.32E-02	1.67E-01	continuously emitting/Nov-Apr
QEP	Drill Rig Engines	10.56	0.16	4.64	1.33E+00	2.02E-02	5.85E-01	continuously emitting/Nov-Apr
QEP	Drill Rig Boilers	4.16	0.02	0.32	5.24E-01	3.02E-03	4.03E-02	continuously emitting/Nov-Apr
QEP	Completions	37.18	0.04	1.21	4.68E+00	4.41E-03	1.52E-01	continuously emitting/Nov-Apr
QEP	Mesa 8-30 SWD Facility	0.60	0.003	0.09	7.56E-02	3.78E-04	1.13E-02	continuously emitting/Nov-Apr
QEP	Construction Mobile (Well Pads)	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in winter
QEP	Conductor Holes	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in winter
QEP	Surface Holes	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	not modeled in winter
QEP	**Sum**	**94.80**	**0.33**	**7.59**	**1.19E+01**	**4.12E-02**	**9.56E-01**	

Operator	Activity/Source	2015 Sum of NOx lb/hr	2015 Sum of SO2 lb/hr	2015 Sum of PM lb/hr	2015 Sum of NOx g/s	2015 Sum of SO2 g/s	2015 Sum of PM g/s	Temporal Variability in Model (Emissions Represent Season, As Noted)
QEPFS	Central Gathering: Mesa14-16	2.49	0.00	0.16	3.14E-01	0.00E+00	2.01E-02	continuously emitting/Nov-Apr
QEPFS	Central Gathering: Mesa15-6	2.58	0.00	0.16	3.25E-01	0.00E+00	2.01E-02	continuously emitting/Nov-Apr
QEPFS	Central Gathering: SP16-18	0.24	0.00	0.01	2.96E-02	0.00E+00	1.73E-03	continuously emitting/Nov-Apr
QEPFS	Pinedale Anticline Disposal Facility	0.06	0.00	0.01	7.56E-03	0.00E+00	1.73E-03	continuously emitting/Nov-Apr
QEPFS	Compression: Pinedale Complex	29.29	0.00	0.89	3.69E+00	0.00E+00	1.12E-01	continuously emitting/Nov-Apr
QEPFS	Gas Plants: Black Forks (Expansion)	35.10	0.00	2.97	4.42E+00	0.00E+00	3.75E-01	continuously emitting/Nov-Apr
QEPFS	**Sum**	**69.76**	**0.00**	**4.21**	**8.79E+00**	**0.00E+00**	**5.30E-01**	

Operator	Activity/Source	2015 Sum of NOx lb/hr	2015 Sum of SO2 lb/hr	2015 Sum of PM lb/hr	2015 Sum of NOx g/s	2015 Sum of SO2 g/s	2015 Sum of PM g/s	Temporal Variability in Model (Emissions Represent Season, As Noted)
Enterprise	Compression: Paradise	55.70	0.00	1.96	7.02E+00	0.00E+00	2.47E-01	continuously emitting/Nov-Apr
Enterprise	Compression: Falcon	43.60	0.00	1.54	5.49E+00	0.00E+00	1.94E-01	continuously emitting/Nov-Apr
Enterprise	**Sum**	**99.30**	**0.00**	**3.50**	**1.25E+01**	**0.00E+00**	**4.41E-01**	

Operator	Activity/Source	2015 Sum of NOx lb/hr	2015 Sum of SO2 lb/hr	2015 Sum of PM lb/hr	2015 Sum of NOx g/s	2015 Sum of SO2 g/s	2015 Sum of PM g/s	Temporal Variability in Model (Emissions Represent Season, As Noted)
Anschutz	Well Pad Controls	0.19	0.00	0.00	2.38E-02	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
Anschutz	Well Pad Production	0.94	0.01	0.06	1.18E-01	6.37E-04	8.07E-03	continuously emitting/Nov-Apr
Anschutz	Completions	0.13	0.04	0.01	1.60E-02	4.75E-03	8.63E-04	continuously emitting/Nov-Apr
Anschutz	**Sum**	**1.26**	**0.04**	**0.07**	**1.58E-01**	**5.38E-03**	**8.93E-03**	

Summary of Emissions (Winter)

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	**Activity/Source**	**lb/hr**	**lb/hr**	**lb/hr**	**g/s**	**g/s**	**g/s**	**(Emissions Represent Season, As Noted)**
Yates	Well Pad Controls	0.35	0.00	0.00	4.44E-02	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
Yates	Well Pad Production	3.58	0.02	0.20	4.52E-01	1.99E-03	2.52E-02	continuously emitting/Nov-Apr
Yates	Completions	0.01	0.00	0.00	9.53E-04	0.00E+00	1.12E-05	continuously emitting/Nov-Apr
Yates	**Sum**	**3.94**	**0.02**	**0.20**	**4.97E-01**	**1.99E-03**	**2.53E-02**	

		2015	2015	2015	2015	2015	2015	
		Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM	Temporal Variability in Model
Operator	**Activity/Source**	**lb/hr**	**lb/hr**	**lb/hr**	**g/s**	**g/s**	**g/s**	**(Emissions Represent Season, As Noted)**
Newfield	Well Pad Controls	4.91	0.00	0.00	6.19E-01	0.00E+00	0.00E+00	continuously emitting/Nov-Apr
Newfield	Well Pad Production	3.16	0.02	0.21	3.98E-01	2.13E-03	2.69E-02	continuously emitting/Nov-Apr
Newfield	**Sum**	**8.07**	**0.02**	**0.21**	**1.02E+00**	**2.13E-03**	**2.69E-02**	

	2015	2015	2015	2015	2015	2015
	Sum of NOx	Sum of SO2	Sum of PM	Sum of NOx	Sum of SO2	Sum of PM
All Operators Combined	**lb/hr**	**lb/hr**	**lb/hr**	**g/s**	**g/s**	**g/s**
Total Winter Emissions	**477.82**	**1.92**	**27.55**	**6.02E+01**	**2.42E-01**	**3.47E+00**

Ultra

Ultra Central Gathering Facilities, and Other Stationary Engines and Heaters

Facility Listing

Facility	Electric?
CGF#1	Yes
CGF#2	No
CGF#3	No
CGF#4	No
Boulder Section 8	No
Warbonnet 15-26	No
SHB 14-21	No

CGF#1	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Seven Heated Separators (1.0 MMBtu/hr)	0.70	4.12E-03	0.05	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMSCF; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
Two Heater Treaters (2.5 MMBtu/hr)	0.50	2.94E-03	0.04	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	
Five Line Heaters (0.75 MMBtu/hr)	0.50	2.21E-03	0.03	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	
Four Glycol Reboiler Burners (0.085 MMBtu/hr)	0.03	2.00E-04	3.00E-03	6.10	339	5.18	0.15	24 hr/day 7 day/wk 365 day/yr	
Two Glycol BTEX Combustor (no rating)	0.20	0.00	0.00	9.15	533	6.47	0.30	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Based on 178 scf/hr vent gas derived from GLYCalc 4.0 and a heat rating of 1,061 Btu/scf

CGF#2	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Nine Heater Treaters (H11-H19, 1.0 MMBtu/hr)	0.90	5.29E-03	0.10	3.66	366	8.73	0.20	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMSCF; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
Nine Line Heaters (H2-H10, 0.75 MMBtu/hr)	0.66	3.97E-03	0.50	3.66	366	10.35	0.15	24 hr/day 7 day/wk 365 day/yr	
One Low-Pressure Separator Heater (H1, 0.085 MMBtu/hr)	0.01	5.00E-05	6.33E-04	3.66	355	6.47	0.15	24 hr/day 7 day/wk 365 day/yr	
Nine Glycol Reboiler Heaters (D1b-D9b, 0.085 MMBtu/hr)	0.10	4.50E-04	0.01	3.66	355	6.47	0.15	24 hr/day 7 day/wk 365 day/yr	
Nine Glycol Dehydrator Enclosed Flare Combustors (no rating)	0.60	0.00	0.03	9.14	366	3.56	0.30	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Based on 178 scf/hr vent gas derived from GLYCalc 4.0 and a heat rating of 1,061 Btu/scf
Natural Gas-Fired Caterpillar Generator Engine (466 bhp)	0.50	2.25E-03	0.07	6.40	755	28.83	0.20	24 hr/day 7 day/wk 365 day/yr	0.5 g/bhp-hr NOx @ 100% engine load and horsepower - 466 bhp; Manufacturer specs and the permitted emissions limit; SO2 based on AP-42 Table 3.2-3 - 5.88 E-04 lb/MMBtu SO2; PM based on AP-42, or 0.02 lb/mmBtu

Ultra Central Gathering Facilities, and Other Stationary Engines and Heaters

CGF#3	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Six Heater Treaters (H1-H5, H13, 1.0 MMBtu/hr)	0.60	3.53E-03	0.04	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMSCF; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
Five Line Heaters (H6-H10, 0.75 MMBtu/hr)	0.40	2.21E-03	0.03	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	
Two Low-Pressure Separator Heater (H11-H12, 0.085 MMBtu/hr)	0.01	1.00E-04	1.27E-03	3.66	355	6.47	0.15	24 hr/day 7 day/wk 365 day/yr	
Four Heater Treaters (H14-H17, 2.5 MMBtu/hr)	1.00	5.88E-03	0.07	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	
Five Glycol Reboiler Burners (0.085 MMBtu/hr each)	0.04	2.50E-04	3.29E-03	6.10	339	5.18	0.15	24 hr/day 7 day/wk 365 day/yr	
Glycol BTEX Combustor (no rating)	0.20	0.00E+00	0.01	9.15	533	6.47	0.30	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Based on 178 scf/hr vent gas derived from GLYCalc 4.0 and a heat rating of 1,061 Btu/scf
One Natural Gas-Fired Generator Engine (1,818 bhp)	2.00	7.76E-03	0.10	6.10	796	58.79	0.30	24 hr/day 7 day/wk 365 day/yr	0.5 g/bhp-hr NOx @ 1,818 horsepower; BACT permitted emissions limit; SO2 based on AP-42 Table 3.2-2 - 5.88 E-04 lb/MMBtu SO2; PM based on AP-42 Table 3.2-2, or 0.01 lb/mmBtu

CGF#4	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Four Heater Treaters (H6-H9, 1.0 MMBtu/hr)	0.40	2.35E-03	0.03	3.66	366	8.73	0.20	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMSCF; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
Four Line Heaters (H2-H5, 0.75 MMBtu/hr)	0.30	1.76E-03	0.02	3.66	366	10.35	0.15	24 hr/day 7 day/wk 365 day/yr	
One Low-Pressure Separator Heater (H1, 0.085 MMBtu/hr)	0.01	5.00E-05	6.33E-04	3.66	355	6.47	0.15	24 hr/day 7 day/wk 365 day/yr	
Four Glycol Reboiler Heaters (0.085 MMBtu/hr)	0.03	2.00E-04	2.53E-03	3.66	355	6.47	0.15	24 hr/day 7 day/wk 365 day/yr	
Four Glycol Dehydrator Enclosed Flare Combustors (no rating)	0.30	0.00E+00	0.01	9.14	366	3.56	0.30	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Based on 178 scf/hr vent gas derived from GLYCalc 4.0 and a heat rating of 1,061 Btu/scf
Natural Gas-Fired Caterpillar Generator Engine	0.50	1.00E-01	0.1	6.40	755	28.83	0.20	24 hr/day 7 day/wk 365 day/yr	0.5 g/bhp-hr NOx @ 100% engine load and horsepower - 466 bhp; Manufacturer specs and the permitted emissions limit; SO2 based on AP-42 Table 3.2-3 - 5.88 E-04 lb/MMBtu SO2; PM based on AP-42, or 0.02 lb/mmBtu

Ultra Central Gathering Facilities, and Other Stationary Engines and Heaters

Boulder Section 8	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Eight Tank Heaters (0.5 MMBtu/hr)	0.39	2.35E-03	0.03	5.49	355	7.76	0.15	24 hr/day 7 day/wk Nov-Apr	NOx = 100 lb/MMSCF; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
One Engine (690 hp)	0.80	2.98E-03	0.10	5.49	775	80.82	0.15	24 hr/day 7 day/wk 365 day/yr	0.5 g/bhp-hr NOx @ 100% engine load and horsepower - 690 bhp; Manufacturer specs and the permitted emissions limit; SO2 based on AP-42 Table 3.2-3 - 5.88 E-04 lb/MMBtu SO2; PM based on AP-42, or 0.02 lb/mmBtu

Warbonnet 15-26	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Sixteen Tank Heaters (0.5 MMBtu/hr)	0.78	4.71E-03	0.06	5.49	355	7.76	0.15	24 hr/day 7 day/wk Nov-Apr	NOx = 100 lb/MMSCF; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
Engine (E1) (566 bhp)	0.60	2.42E-03	0.08	5.49	751	64.10	0.15	24 hr/day 7 day/wk 365 day/yr	0.5 g/bhp-hr NOx @ 100% engine load and horsepower - 690 bhp; Manufacturer specs and the permitted emissions limit; SO2 based on AP-42 Table 3.2-3 - 5.88 E-04 lb/MMBtu SO2; PM based on AP-42, or 0.02 lb/mmBtu
Engine (E2) (690 bhp)	0.80	2.98E-03	0.10	5.49	775	80.80	0.15	24 hr/day 7 day/wk 365 day/yr	

Stud Horse Butte 14-21	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Engine (Cummins G855 - 188 bhp)	0.30	9.52E-04	0.03	2.44	920	0.00	0.10	24 hr/day 7 day/wk 365 day/yr	0.7 g/bhp-hr NOx @ 100% engine load and horsepower - 188 bhp; Manufacturer specs and the permitted emissions limit; SO2 based on AP-42 Table 3.2-3 - 5.88 E-04 lb/MMBtu SO2; PM based on AP-42, or 0.02 lb/mmBtu
Nine Tank Heaters (0.5 MMBtu/hr)	0.47	6.76E-02	0.04	5.49	355	7.76	0.15	24 hr/day 7 day/wk Nov-Apr	NOx = 100 lb/MMSCF; <0.3 MMBtu/hr 94 lb/MMSCF emission factor was used; SO2 based on 0.05 grains/scf sulfur content of the fuel gas (est.); PM(Total) = 7.6 lb/MMSCF based on AP-42 Table 1.4-2; 1,020 BTU/scf heating value.
One Glycol Reboiler Heater (0.125 MMBtu/hr)	0.01	7.35E-05	9.31E-04	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	
Three Line Heaters (0.5 MMBtu/hr)	0.15	8.82E-04	0.01	3.66	366	15.53	0.15	24 hr/day 7 day/wk 365 day/yr	
Glycol BTEX Combustor (no rating)	0.08	0.00E+00	0.01	9.15	533	6.47	0.30	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Based on 178 scf/hr vent gas derived from GLYCalc 4.0 and a heat rating of 1,061 Btu/scf

Ultra Well Pad Production Sources

Source Description	% of all heater emissions in 2011 inventory	2011 Heater Total NOx Emissions [1] (tpy)	2011 Operating Wells	Annual NOx Emissions per Well (tpy)	NOx Per Well Summer (lb/hr)	NOx Per Well Winter (lb/hr)	Total Summer NOx lb/hr: 995 wells	Total Winter NOx lb/hr: 995 wells	# of wells at end of 2015	Total Summer NOx lb/hr: 1328 wells	Total Winter NOx lb/hr: 1328 wells
Line Heaters	54.6%	61.4	995	0.062	0.01409	0.01409	14.02	14.02	1328	18.71	18.71
Seperator Heaters	21.6%	24.3	995	0.024	0.00557	0.00557	5.55	5.55	1328	7.40	7.40
Heater Treaters	3.1%	3.5	995	0.004	0.00080	0.00080	0.80	0.80	1328	1.07	1.07
Dehy Reboilers	20.6%	23.2	995	0.023	0.00533	0.00533	5.30	5.30	1328	7.07	7.07
Totals	**100%**	**112.4**		**0.113**	**0.02579**	**0.02579**	**25.66**	**25.66**		**34.25**	**34.25**

[1] The Total NOx from 2011 heaters emission inventory is 119.6 tpy NOx. The sum of heaters which only operated in the Jonah field was 7.2 tpy NOx, which are not part of this modeling effort. Therefore, 7.2 was subtracted from the total 119.6 tpy, leaving 112.4 tpy NOx which occured in the JDPA in 2011.

Ultra Well Pad Production Sources

Source Description	Total Summer SO2 lb/hr: 1328 wells	Total Winter SO2 lb/hr: 1328 wells	Total Summer PM lb/hr: 1328 wells	Total Winter PM lb/hr: 1328 wells	Operating Scenario for Modeling	Notes
Line Heaters	0.11	0.11	1.42	1.42	24 hr/day 7 day/wk 365 day/yr	
Seperator Heaters	0.04	0.04	0.56	0.56	24 hr/day 7 day/wk 365 day/yr	
Heater Treaters	0.01	0.01	0.08	0.08	24 hr/day 7 day/wk 365 day/yr	
Dehy Reboilers	0.04	0.04	0.54	0.54	24 hr/day 7 day/wk 365 day/yr	
Totals	**0.21**	**0.21**	**2.60**	**2.60**		**<= This is emission rate that will be modeled for this group, allocated across 1-square mile area sources for this Operator in CALPUFF, using area source release params from SEIS**

Ultra Well Pad Production Controls

Source Description	2011 Total NOx Emissions [1] (tpy)	2011 Operating Wells	Annual NOx Emissions per Well (tpy)	NOx Per Well Summer (lb/hr)	NOx Per Well Winter (lb/hr)	Total Summer NOx lb/hr: 995 wells	Total Winter NOx lb/hr: 995 wells	# of wells at end of 2015	Total Summer NOx lb/hr: 1328 wells	Total Winter NOx lb/hr: 1328 wells
Dehy Controls (BTEX Combustors)	45.2	995	0.045	0.01038	0.01038	10.33	10.33	1328	13.78	13.78
Pneumatic Controls	9.8	995	0.010	0.00000	0.00451	0.00	4.49	1328	0.00	5.99
Tank Combustors (VOC Combustors)	0.1	995	0.000	0.00002	0.00002	0.02	0.02	1328	0.02	0.02
Totals			**0.055**	**0.01039**	**0.01490**	**10.34**	**14.83**		**13.80**	**19.79**

[1] NOx from Dehy and Pneumatic controls were taken directly from the 2011 emission inventory. NOx from tank combustors only include those well pads not connected to the CGFs and only well pads which operated in the JDPA (2.086 tpy NOx occurred in the Jonah field in 2011).

Ultra Well Pad Production Controls

Source Description	Total Summer SO2 lb/hr: 1328 wells	Total Winter SO2 lb/hr: 1328 wells	Total Summer PM lb/hr: 1328 wells	Total Winter PM lb/hr: 1328 wells	Operating Scenario for Modeling	Notes
Dehy Controls (BTEX Combustors)	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	
Pneumatic Controls	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk Nov-Apr	
Tank Combustors (VOC Combustors)	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	
Totals	**0.00**	**0.00**	**0.00**	**0.00**		**<= This is emission rate that will be modeled for this group, allocated across 1-square mile area sources for this Operator in CALPUFF, using area source release params from SEIS**

Ultra Drill Rigs

Drill Rig Engines	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
3 Diesel-Fired, Tier 2 Engines with SCR	0.577	1.50E-02	0.261	6.10	667	10.35	0.51	24 hr/day 7 day/wk 365 day/yr	Eight (8) Rigs in 2015; see sample calcs below

Drill Rig Boiler	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
1 Diese-Fired Boiler, no controls	0.429	3.24E-03	0.043	4.57	755	4.04	0.61	24 hr/day 7 day/wk Nov-Apr	Eight (8) Rigs in 2015; see sample calcs below

Calculation Methodology:

The NOx emission factor is based on actual performance test results from 1st and 2nd quarter 2012 testing (0.176 g/hp-hr per engine). The EF was converted to lb/hr using the average 2011 fuel use/well drilled (see example NOx equation below). The boiler NOx, SO2, and PM EFs are based on AP-42, Table 1.3-1 for distillate oil-fired boilers, 2011 boiler fuel use, and the anticipated number of wells to be drilled during the Nov-Apr modeling timeframe (see example NOx boiler calculation below).

NOx Example Calculation - Drill Rig Engines Only

$$\frac{24{,}127.26\ \text{gal}}{\text{well}} \cdot \frac{208\ \text{wells}}{8\ \text{rigs}} = 627{,}308.76\ \frac{\text{gal}}{\text{yr-rig}}$$

$$\frac{0.176\ \text{gram NOx}}{\text{hp-hr}} \cdot \frac{\text{hp-hr}}{6682\ \text{Btu}} \cdot \frac{138{,}152\ \text{Btu}}{\text{gal}} \cdot \frac{627{,}308.76\ \text{gal}}{\text{yr-rig}} \cdot \frac{\text{lb}}{453.6\ \text{gram}} \cdot \frac{\text{yr}}{8760\ \text{hrs}} = 0.577\ \frac{\text{lb}}{\text{hr-rig}}$$

NOx Example Calculation - Boiler Only

$$\frac{1{,}383{,}420\ \text{gal}}{\text{yr}} \cdot \frac{138152\ \text{Btu}}{\text{gal}} \cdot \frac{\text{MMBtu}}{10^6\ \text{Btu}} \cdot \frac{0.145\ \text{lb NOx}}{\text{MMBtu}} \cdot \frac{1}{191\ \text{wells}} = 144.86\ \frac{\text{Avg lbs NOx}}{\text{well}}$$

$$= \frac{144.86\ \text{Avg lb NOx}}{\text{well}} \cdot \frac{103\ \text{wells}}{\text{yr 2015}} \cdot \frac{1}{8\ \text{boilers}} \cdot \frac{\text{yr 2015}}{4344\ \text{hrs}} = 0.429\ \frac{\text{lb}}{\text{hr-boiler}}$$

Ultra Completions

Total Completions	Emissions (lb/hr)				
Equipment	**NOx**	**SO2**	**PM**	**Operating Scenario for Modeling**	**Notes**
Total Completion Emissions	63.94	0.15	1.89	24 hr/day 7 day/wk 365 day/yr	208 completions in 2015 with EF of 1.346 tons NOx/completion = 280 tpy

Ultra Construction Mobile

Construction Mobile	Emissions (lb/hr)			Operating Scenario for Modeling	Notes
Equipment	NOx	SO2	PM		
Total Construction Mobile Emissions	3.48	0.03	0.15	7 day/wk 6am-6pm May-Oct	Four (4) pads forecasted to be built [1]

[1] 208 wells are projected to be drilled in 2015. Many of which will be drilled on existing well pads.
Ultra anticipates only four additional well pads will need to be constructed to meet the additional wells.

Well Pad Construction Emission Calculation Details

		SC ARB Emission Factor[A]			Total Equipment EF		
Construction Equipment	Typical Number of Equipment Used	PM	NOx	SO2	PM	NOx	SO2
		(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Roller	1	0.0547	0.7749	0.0008	0.0547	0.7749	0.0008
Scraper	4	0.1256	2.9078	0.0027	0.5024	11.6312	0.0108
Blader	1	0.0753	1.4338	0.0015	0.0753	1.4338	0.0015
Dozer	1	0.1288	2.9891	0.1288	0.1288	2.9891	0.1288
Water Truck	1	0.0875	2.3885	0.0027	0.0875	2.3885	0.0027
				Total lb/hr	0.8487	19.2175	0.1446
10	**Average Construction Activity hours/day**						
10	**Average days of construction to complete**			**lb/day:**	8.487	192.175	1.446
4	**Pads Constructed in 2015**			**lb/well pad:**	84.87	1921.75	14.46
				lb/year 2015:	339.48	7687	57.84
				lb/hr (Year 2015):	0.15	3.48	0.03

Sample Calculation:

19.2	NOx lb	10 hrs	10 days	4 Pads	Year 2015	=	3.48	NOx lb
	hr	day	Pad Const.	Year 2015	2208 hours			hr

Note A

These are horsepower-based off-road emission factors for 2010 developed for the SCAQMD by CARB from its Off-road Model. The off-road emission factors were derived based on the equipment category (tractor, dozer, scraper, etc.), and average equipment age and horsepower rating within horsepower ranges for the year.

Construction Equipment Emissions Factors by Equipment Catgeory and Horsepower Range, for 2010 [Note A]

Equipment Type	Emission Factor (lb/hr)				
	NOx	CO	ROG	SOx	PM
Crawler Tractors Composite Emission Factors	1.3854	0.6409	0.1861	0.0013	0.0854
Excavators Composite Emission Factors	1.1502	0.5581	0.1483	0.0013	0.0638
Graders Composite Emission Factors	1.4338	0.6314	0.1723	0.0015	0.0753
Off-Highway Tractors Composite Emission Factors	1.9897	0.8385	0.2368	0.0017	0.0974
Off-Highway Trucks Composite Emission Factors	2.3885	0.7429	0.2480	0.0027	0.0875
Rollers Composite Emission Factors	0.7749	0.4212	0.1176	0.0008	0.0547
Rubber Tired Dozers Composite Emission Factors	2.9891	1.4127	0.3379	0.0025	0.1288
Rubber Tired Loaders Composite Emission Factors	1.1537	0.5078	0.1440	0.0012	0.0651
Scrapers Composite Emission Factors	2.9078	1.2424	0.3202	0.0027	0.1256
Tractors/Loaders/Backhoes Composite Emission Factors	0.6747	0.3930	0.1021	0.0008	0.0521

Note A

These are horsepower-based off-road emission factors for 2007 developed for the SCAQMD by CARB from its Off-road Model. The off-road emission factors were derived based on the equipment category (tractor, dozer, scraper, etc.), and average equipment age and horsepower rating within horsepower ranges for the year. The emission factors can be downloaded from http://www.aqmd.gov/ceqa/handbook/offroad/offroad.html

SWEPI

SWEPI Central Gathering Facilities and Other Stationary Engines

Facility Listing

Facility	Electric?
North CGF	Yes
Central CGF	No
South CGF	No
Big Piney Water Injection Facility	No
Section 14/South Mesa	No

North CGF	Emissions (lb/hr)			Stack Parameters						
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes	
78.1 MMBtu/hr Combustion Control (Enclosed Flare)	0.87	0.00	0.00	9.14	644	0.30	1.07	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Hourly Emission Rate (Lbs/Hr) = (Emission Factor, lb/MMBtu) * (Flare Heat Input, MMBtu/hr) Flare heat input = natural gas heating value (1559 Btu/mcf) * combustor throughput (calculated by throughput of facility and 35% VRU downtime in 2011, 3960mcf/hr) + pilot gas heating value (40scf/hr *1020Btu/scf)	SO2 and PM are insignificant
Two 1.4 MMBtu/hr Stabilization Heaters	0.27	0.00	0.00	4.57	644	0.31	0.46	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMFt3, SO2 - 0.6lb/MMFt3, PM = 7.6lb/MMFt3	lb/hr = EF (lb/MMft3)*FHV/020*Burner Rating (Mmbtu/hr) * 1/1020 * 1MMft3/1,000000ft3*1,000,000Btu/Mmbtu
Two 0.5 MMBtu/hr Glycol Heaters	0.18	0.00	0.00	4.57	644	0.31	0.46	24 hr/day 7 day/wk Nov-Apr	NOx = 100 lb/MMFt3, SO2 - 0.6lb/MMFt3, PM = 7.6lb/MMFt3	lb/hr = EF (lb/MMft3)*FHV/020*Burner Rating (Mmbtu/hr) * 1/1020 * 1MMft3/1,000000ft3*1,000,000Btu/Mmbtu
Emergency Flare (pilot gas only)	0.04	0.00	0.00	9.14	1273	20.00	0.25	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Hourly Emission Rate (Lbs/Hr) = (Emission Factor, lb/MMBtu) * (Flare Heat Input, MMBtu/hr) Flare heat input = natural gas heating value (1020Btu/mcf) * pilot gas throughput (300mcf/hr)	SO2 and PM are insignificant

SWEPI Central Gathering Facilities and Other Stationary Engines

Central CGF	Emissions (lb/hr)			Stack Parameters						
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes	
Two Generators (there are four on-site, 3 are full use, 1 is emergency but only two run at a time)	0.70	4.00E-03	0.08	3.05	672	10.1	0.15	24 hr/day 7 day/wk 365 day/yr	477hp with historical actual hours demonstrating only 2 engines operating full time for a year, average of 2012 reference method testing for 3 full use engines (.35g/hp-hr * 2engines). These engines were installed in Feb 2012 and are different from those reported in 2011 inventory. Emissions are lower than reported in 2011 inventory.	SO2 EF = 5.88x10-4 lb/MMBtu, PM EF = .04 g/hp-hr
Tank Controls	0.16	0.00	0.00	9.14	700	0.30	0.91	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Hourly Emission Rate (Lbs/Hr) = (Emission Factor, lb/MMBtu) * (Flare Heat Input, MMBtu/hr) Flare heat input = natural gas heating value (1559Btu/mcf) * combustor throughput (calculated by throughput of facility and 10% VRU downtime in 2011, 760mcf/hr) + pilot gas heating value	SO2 and PM are insignificant
Two 1.4 MMBtu/hr Stabilization Heaters	0.27	0.00	0.00	4.57	672	0.31	0.25	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMFt3, SO2 - 0.6lb/MMFt3, PM = 7.6lb/MMFt3	lb/hr = EF (lb/MMft3)*FHV/020*Burner Rating (Mmbtu/hr) * 1/1020 * 1MMft3/1,000000ft3*1,000,000Btu/Mmbtu
Two 1.5 MMBtu/hr Glycol Heaters	0.18	0.00	0.00	4.57	672	0.31	0.25	24 hr/day 7 day/wk Nov-Apr	NOx = 100 lb/MMFt3, SO2 - 0.6lb/MMFt3, PM = 7.6lb/MMFt3	lb/hr = EF (lb/MMft3)*FHV/020*Burner Rating (Mmbtu/hr) * 1/1020 * 1MMft3/1,000000ft3*1,000,000Btu/Mmbtu
Emergency Flare (pilot gas only)	0.04	0.00	0.00	9.14	1273	20.00	0.25	24 hr/day 7 day/wk 365 day/yr	Emission factors for NOx (0.14 lb/MMBtu) based on WDEQ Ch 6, Section 2 O&G Guidance (March 2010), pg 63 of 71. Hourly Emission Rate (Lbs/Hr) = (Emission Factor, lb/MMBtu) * (Flare Heat Input, MMBtu/hr) Flare heat input = natural gas heating value (1020Btu/mcf) * pilot gas throughput (300mcf/hr)	SO2 and PM are insignificant

SWEPI Central Gathering Facilities and Other Stationary Engines

South CGF	Emissions (lb/hr)			Stack Parameters						
Equipment (Facility not yet permitted or constructed. Engines assumed to be same as Central Facility with throughput the same as North Facility.)	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**	
Two Generators (there are four on-site but only two run at a time)	0.70	4.00E-03	0.08	3.05	672	10.1	0.15	24 hr/day 7 day/wk 365 day/yr	assumed same as CLGS	SO2 EF = 5.88x10-4 lb/MMBtu, PM EF = .04 g/hp-hr
78.1 MMBtu/hr Combustion Control (Enclosed Flare)	0.87	0.00	0.00	9.14	644	0.30	1.07	24 hr/day 7 day/wk 365 day/yr	assumed same as NLGS	SO2 and PM are insignificant
Two 1.4 MMBtu/hr Stabilization Heaters	0.27	0.00	0.00	4.57	644	0.31	0.46	24 hr/day 7 day/wk 365 day/yr	NOx = 100 lb/MMFt3, SO2 - 0.6lb/MMFt3, PM = 7.6lb/MMFt3	lb/hr = EF (lb/MMft3)*FHV/020*Burner Rating (Mmbtu/hr) * 1/1020 * 1MMft3/1,000000ft3*1,000,000Btu/Mmbtu
Two 0.5 MMBtu/hr Glycol Heaters	0.18	0.00	0.00	4.57	644	0.31	0.46	24 hr/day 7 day/wk Nov-Apr	NOx = 100 lb/MMFt3, SO2 - 0.6lb/MMFt3, PM = 7.6lb/MMFt3	lb/hr = EF (lb/MMft3)*FHV/020*Burner Rating (Mmbtu/hr) * 1/1020 * 1MMft3/1,000000ft3*1,000,000Btu/Mmbtu
Emergency Flare (pilot gas only)	0.04	0.00	0.00	9.14	1273	20.00	0.25	24 hr/day 7 day/wk 365 day/yr	assumed same as NLGS	SO2 and PM are insignificant

Big Piney Water Injection Facility	Emissions (lb/hr)			Stack Parameters					
Equipment	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**
Two Diesel-Fired Engines (Deutz and Cummins)	0.16	0.03	0.01	7.62	755	20.00	0.30	24 hr/day 7 day/wk 365 day/yr	Deutz 199 hp NOx = 4.9g/hp-hr SO2=1g/hp-hr, PM=0.15g/hp-hr (2011 - 584 hours), cummins 535hp NOx = 7.9g/hp-hr, SO2 =0.6g/hp-hr, PM=0.4g/hp-hr (2010 - 22 hours) to account for low run-times the lb/hr rates were multiplied by (greatest yearly actual hours from last 2 years/8760)

Section 14/South Mesa	Emissions (lb/hr)			Stack Parameters						
Equipment	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**	
Four Waukesha NG-Fired Engines	0.67	0.00	0.22	8.84	700	20.42	0.46	24 hr/day 7 day/wk 365 day/yr	combined g/hp-hr rate for all 4 engines (840 hp) from 2011 (0.82 g/hp-hr NOx) multiplied by 2011 operating hours (actual hours/total hours in year = 0.443), NOx = 0.21g/hp-hr. same methodology for SO2 and PM	SO2 EF = 5.88x10-4 lb/MMBtu, PM EF = .07 g/hp-hr

SWEPI Well Pad Production Sources

Source Description	% of all heater emissions in 2011 inventory	2011 Heater Total NOx Emissions [1] (tpy)	2011 Full Year Equivalent Wells	Annual NOx Emissions per Well (tpy)	NOx Per Well Summer (lb/hr)	NOx Per Well Winter (lb/hr)	Total Summer NOx lb/hr: 484 wells	Total Winter NOx lb/hr: 484 wells	# of wells at end of 2015	Total Summer NOx lb/hr: 739 wells	Total Winter NOx lb/hr: 739 wells
Production Heaters	59%	21.5	484	0.044	0.01013	0.01013	4.90	4.90	739	7.49	7.49
Dehy Reboilers	16%	5.8	484	0.012	0.00275	0.00275	1.33	1.33	739	2.03	2.03
Winter Heaters	25%	9.1	484	0.019	0.00000	0.00859	0.00	4.16	739	0.00	6.35
Totals	**100%**	**36.41**		**0.075**	**0.01**	**0.02**	**6.23**	**10.39**		**9.52**	**15.87**

[1] Total NOx from 2011 heaters emissions Annual WDEQ EI. Pg 2-8 in EI report.

SWEPI Well Pad Production Sources

Source Description	Total Summer SO2 lb/hr: 739 wells	Total Winter SO2 lb/hr: 739 wells	Total Summer PM lb/hr: 739 wells	Total Winter PM lb/hr: 739 wells	Operating Scenario for Modeling	Notes
Production Heaters	0.04	0.04	0.57	0.57	24 hr/day 7 day/wk 365 day/yr	
Dehy Reboilers	0.01	0.01	0.15	0.15	24 hr/day 7 day/wk 365 day/yr	
Winter Heaters	0.00	0.04	0.00	0.48	24 hr/day 7 day/wk Nov-Apr	
Totals	**0.06**	**0.10**	**0.72**	**1.21**		**<= This is emission rate that will be modeled for this group, allocated across 1-square mile area sources for this Operator in CALPUFF, using area source release params from SEIS**

SWEPI Well Pad Production Controls

Source Description	2011 Total NOx Emissions [1] (tpy)	2011 Full Year Equivalent Wells	Annual NOx Emissions per Well (tpy)	NOx Per Well Summer lb/hr	NOx Per Well Winter lb/hr	Total Summer NOx lb/hr: 484 wells	Total Winter NOx lb/hr: 484 wells	# of wells at end of 2015	Total Summer NOx lb/hr: 739 wells	Total Winter NOx lb/hr: 739 wells
Dehy Controls (BTEX Combustors)	17.84	484	0.037	0.00842	0.00842	4.07	4.07	739	6.22	6.22
Pneumatic Controls	3	484	0.006	0.00000	0.00283	0.00	1.37	739	0.00	2.09
Tank Combustors (VOC Combustors)	3.87	484	0.008	0.00183	0.00183	0.88	0.88	739	1.35	1.35
Totals			**0.051**	**0.01024**	**0.01307**	**4.96**	**6.33**		**7.57**	**9.66**

[1] NOx from dehy and tanks taken directly from 2011 annual WDEQ EI. NOx from tanks only include emissions from wellpads.
NOx from wellpads is only from locations not connected to LGS facilities. Facilities connected to the LGS account for control of flashing, standing, working, and breathing losses in the combustion NOx, included for each CGF facility emissions. Pneumatic controllers NOx emissions were modified from 2011 inventory to exclude emissions from locations that have been modified in 2011 and 2012 to use exhaust as fuel instead of VOC combustion. Emissions from combusting pump exhaust as fuel would be accounted for in the production sources (heaters). pg 2-16 in EI report.

SWEPI Well Pad Production Controls

Source Description	Total Summer SO2 lb/hr: 739 wells	Total Winter SO2 lb/hr: 739 wells	Total Summer PM lb/hr: 739 wells	Total Winter PM lb/hr: 739 wells	Operating Scenario for Modeling	Notes
Dehy Controls (BTEX Combustors)	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	SO2 and PM insignificant
Pneumatic Controls	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk Nov-Apr	SO2 and PM insignificant
Tank Combustors (VOC Combustors)	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	SO2 and PM insignificant
Totals	**0.00**	**0.00**	**0.00**	**0.00**		**<= This is emission rate that will be modeled for this group, allocated across 1-square mile area sources for this Operator in CALPUFF, using area source release params from SEIS**

SWEPI Drill Rigs

Single Drill Rig Engines	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
3 Diesel-Fired, Tier 2 Engines with SCR	1.00	0.018	0.18	5.68	667	18.40	0.38	24 hr/day 7 day/wk 365 day/yr	Data available on 2011 drill rig emission inventory: 15ppmw sulfur content SO2=6lbs/well drilled, PM= 0.05 g/hp-hr, Cat 3512B HP stack parameter and emissions data from manf spec sheet @1200 RPM

.

Single Drill Rig Boiler	nissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
1 Diesel-Fired Boiler, no controls	0.37	0.13	0.04	4.57	755	5.82	0.51	24 hr/day 7 day/wk Nov-Apr	

Engine Example Calculation:

EF (controlled) = **0.25 g/hp-hr -** taken as average from multiple stack tests for drill rig engines
Fuel Usage = **28,241 gallons** - taken as average from all wells drilled in 2010
BSFC = **5798 btu/hp-hr** - taken from stack tests
Well Emissions Factor = **0.2 Tons/well** - based on equation below

0.25 g/hp-hr * 1 lb/453.59 g * 28,241gallons fuel/yr * 137,041 btu/gallon diesel * hp-hr/5,798 Btu * 1 Ton/2,000 lbs = 0.2 Tons/well/yr

2015 emissions = 0.2 Tons/well * 96 wells drilled
= **17.7 Tons/yr, or 4.01 lb/hr**
(total of 4 rigs)

SWEPI Completions

Total Completions	Emissions (lb/hr)			Operating Scenario for Modeling	Notes
Equipment	NOx	SO2	PM		
Total Completion Emissions	23.15	0.07	0.66	24 hr/day 7 day/wk 365 day/yr	96 completions in 2015 with EF of 1.056 tons NOx/completion = 101 tpy

SWEPI Construction Mobile

Construction Mobile	Emissions (lb/hr)				
Equipment	NOx	SO2	PM	Operating Scenario for Modeling	Notes
Total Construction Mobile Emissions	3.11	0.04	0.13	7 day/wk 6am-6pm May-Oct	

QEP

QEP Stationary Engines

Facility Listing

Facility	Electric?
Mesa 8-30 SWD Facility	No

Mesa 8-30 SWD Facility	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
One Natural Gas-Fired Engine (Rating of 546 hp)	0.6	0.003	0.09	4.88	700	26.88	0.23	24 hr/day 7 day/wk 365 day/yr	Emission factors: NOx=0.5 g/hp-hr; SO2=5.88E-04 lb/MMBtu; PM=1.94E-02 lb/MMBtu.

QEP Well Pad Production Sources

Source Description	% of all heater emissions in 2011 inventory	2011 Heater Total NOx Emissions [1] (tpy)	2011 Full Year Equivalent Wells	Annual NOx Emissions per Well (tpy)	NOx Per Well Summer (lb/hr)	NOx Per Well Winter (lb/hr)	Total Summer NOx lb/hr: 578.125 wells	Total Winter NOx lb/hr: 578.125 wells	2015 Full Year Equiv Wells	Total Summer NOx lb/hr: 1156 wells	Total Winter NOx lb/hr: 1156 wells
Production Heaters	88%	32.7	578.125	0.057	0.01291	0.01291	7.46	7.46	1156	14.92	14.92
Dehy Reboilers	9%	3.3	578.125	0.006	0.00128	0.00128	0.74	0.74	1156	1.48	1.48
Winter Heaters	3%	1.1	578.125	0.002	0.00000	0.00089	0.00	0.52	1156	0.00	1.03
Totals	**100%**	**37.07**		**0.06**	**0.01**	**0.02**	**8.21**	**8.72**		**16.41**	**17.44**

[1] 2011 total heater emissions are from QEP's 2011 Annual Inventory submitted to the WDEQ.

Additional Notes:

Wells at end of 2010 = 530. 135 wells completed during 2011 were assumed to produce 5.5 months. Equivalent wells = (5.5/12)(135) + 530

Wells at end of 2014 = 1069. 190 wells completed during 2015 are assumed to produce 5.5 months. Equivalent wells = (5.5/12)(190) +1069

SO2 and PM scaling factors are based on AP-42 EF.

QEP Well Pad Production Sources

Source Description	Total Summer SO2 lb/hr: 1156 wells	Total Winter SO2 lb/hr: 1156 wells	Total Summer PM lb/hr: 1156 wells	Total Winter PM lb/hr: 1156 wells	Operating Scenario for Modeling	Notes
Production Heaters	0.09	0.09	1.13	1.13	24 hr/day 7 day/wk 365 day/yr	
Dehy Reboilers	0.01	0.01	0.11	0.11	24 hr/day 7 day/wk 365 day/yr	
Winter Heaters	0.00	0.01	0.00	0.08	24 hr/day 7 day/wk Nov-Apr	
Totals	**0.10**	**0.10**	**1.25**	**1.33**		**<= This is emission rate that will be modeled for this group, allocated across 1-square mile area sources for this Operator in CALPUFF, using area source release params from SEIS**

QEP Well Pad Production Controls

Source Description	2011 Total NOx Emissions [1] (tpy)	2011 Full Year Equivalent Wells	Annual NOx Emissions per Well (tpy)	NOx Per Well Summer (lb/hr)	NOx Per Well Winter (lb/hr)	Total Summer NOx lb/hr: 578.125 wells	Total Winter NOx lb/hr: 578.125 wells	# of wells at end of 2015	Total Summer NOx lb/hr: 1156 wells	Total Winter NOx lb/hr: 1156 wells
Dehy Controls (BTEX Combustors)	32.06	578.125	0.055	0.01266	0.01266	7.32	7.32	1156	14.64	14.64
Pneumatic Pumps	20.29	578.125	0.035	0.00000	0.01603	0.00	9.26	635	0.00	10.18
Tank Combustors (VOC Combustors): Sidewinder 3-15D [2]	0.019	1	0.019	0.00434	0.00434	0.004	0.004	1	0.004	0.004
Tank Combustors (VOC Combustors): Mesa 8-30 SWD [2]	0.209	1	0.209	0.04772	0.04772	0.05	0.05	1	0.05	0.05
Totals			**0.319**	**0.065**	**0.081**	**7.37**	**16.64**		**14.69**	**24.86**

Additional Notes:

[1] Dehydration unit and pneumatic controls NOx emissions from 2011 Annual Inventory submitted to WDEQ.

[2] As stated in Section 2.3.3 of the report, 2015 emissions from tank combustors at Sidewinder 3-15D and Mesa 8-30 SWD are assumed to be equal to 2011 emissions.

Assumed that vent streams from pneumatic pumps installed 2012 - 2015 are routed to heater burners.

Emissions of SO2 and PM are insignificant.

QEP Well Pad Production Controls

Source Description	Total Summer SO2 lb/hr: 1156 wells	Total Winter SO2 lb/hr: 1156 wells	Total Summer PM lb/hr: 1156 wells	Total Winter PM lb/hr: 1156 wells	Operating Scenario for Modeling	Notes
Dehy Controls (BTEX Combustors)	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	
Pneumatic Pumps	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk Nov-Apr	
Tank Combustors (VOC Combustors): Sidewinder 3-15D [2]	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	
Tank Combustors (VOC Combustors): Mesa 8-30 SWD [2]	0.00	0.00	0.00	0.00	24 hr/day 7 day/wk 365 day/yr	
Totals	**0.00**	**0.00**	**0.00**	**0.00**		**<= This is emission rate that will be modeled for this group, allocated across 1-square mile area sources for this Operator in CALPUFF, using area source release params from SEIS**

QEP Drill Rigs

Drill Rig Engines	Emissions (lb/hr)			Stack Parameters					
Equipment	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**
3 Diesel-Fired, Tier 2 Engines with SCR	1.32	0.02	0.58	6.86	671	10.30	0.51	24 hr/day 7 day/wk 365 day/yr	

Drill Rig Boiler	Emissions (lb/hr)			Stack Parameters					
Equipment	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**
1 Natural Gas-Fired Boiler, no controls	0.52	0.003	0.04	3.35	783	20.06	0.41	24 hr/day 7 day/wk Nov-Apr	

NOTES:
Drill rig emissions are based on fuel consumption as shown in the calculations below (see Section 2.4 in the report).
Engine emissions:
194 wells to be drilled in 2015
2011 engine fuel use = 29906 gal/well
NOx emission factor (controlled) = 0.34 g/hp-hr
BSFC = 6453 btu/hp-hr
NOx emissions = (476 lb/well)(194 wells)/8 rigs = 11543 lbs/rig
SO2 emissions based on 15 ppmw sulfur content
SO2 emissions = (6.3 lb/well)(194 wells)/8 rigs = 153 lbs/rig
PM emission factor = 0.15 g/hp-hr (EPA Non-road Diesel Engine Emissions Standard)
PM emissions = (210 lb/well)(194 wells)/8 rigs = 5093 lbs/rig
Emissions are based on fuel consumption and emissions test data. Rating, load factor of engines, and hours are not required for calculation.
However, the fuel consumption factor is based on 100% load for Caterpillar 3512DITA engines rated at 1476 hp. Note that drilling occurs continuously 8760 hours per year.
Therefore, total annual emissions were divided by 8760 hours to produce an hourly rate. See Section 2.4.3 of report.

Boiler emissions:
2011 fuel use = 881.68 mscf/well *Total annual 2011 fuel use was divided by the number of wells to derive rate. The calculated hourly rate is based on 4380 hours/year (winter ops only).*
Emissions are based on AP-42 factors
Heat content = 1080 Btu/scf
NOx emissions = (93.3 lb/well)(194 wells)/8 rigs = 2263 lbs/rig
SO2 emissions = (0.56 lb/well)(194 wells)/8 rigs = 13.6 lbs/rig
PM emissions = (7.1 lb/well)(194 wells)/8 rigs = 172 lbs/rig
Drilling occurs continuously 8760 hours/year, while the boilers only operate in winter. The hourly rate is based on 4380 hrs/year. Therefore the number of hours to drill a well is not required.

QEP Completions

Total Completions	Emissions (lb/hr)			Operating Scenario for Modeling	Notes
Equipment	NOx	SO2	PM		
Total Completion Emissions	37.18	0.04	1.21	24 hr/day 7 day/wk 365 day/yr	

Emission factors from 2011 EI:
NOx = 0.857 tons/completion
SO2 = 0.0008 tons/completion
PM = 0.028 tons/completion

190 completions in 2015

QEP Construction Mobile

Construction Mobile	Emissions (lb/hr)				
Equipment	**NOx**	**SO2**	**PM**	**Operating Scenario for Modeling**	**Notes**
Well Pad Construction Mobile Emissions	9.10	0.09	0.41	6am-6pm 7 day/wk May-Oct	See Non-RoadEmissions Example sheet.
Conductor Holes	0.65	2.1E-04	0.02	6am-6pm 7 day/wk May-Oct	
Surface Holes	9.10	2.9E-03	0.28	24 hr/day 7 day/wk May-Oct	

Notes
No new pads constructed in 2015. All construction is expansion of existing pads.
Total disturbed area in 2015 = 125 acres.
NOx emission factor = 13.4 lb/hr
PM emission factor = 0.6 lb/hr
SO2 emission factor = 0.14 lb/hr
Construction duration = 1 day/acre
Average daily construction activity = 12 hours/day
Total annual emissions/(184 days*12 hr/day) = rate (lb/hr)
Construction occurs May - October
As described in Section 2.8.3 of the report, QEP expects to drill 25 well pods at three existing well pads. Based on Pinedale Antilcline experience, 5 acres of disturbance per well pod is reasonable.

Conductor Holes
Fuel use = 36 gal/event. 194 events. *Based on 2011 fuel use*
NOx = 7.46 lb/event * 194 events = 1446 lbs
SO2 = 0.0023 lb/event * 194 events = 0.45 lbs
PM = 0.23 lb/event * 194 events = 45 lbs

Surface Holes
Fuel use = 1000 gal/event *Based on 2011 fuel use*
NOx = 207.1 lb/event * 194 events = 40179 lbs
SO2 = 0.065 lb/event * 194 events = 12.6 lbs
PM = 6.47 lb/event * 194 events = 1256 lbs

Emission factors for conductor and surface holes - Tier II diesel engines
NOx - 4.8 g/hp-hr
SO2 - 0.0015 g/hp-hr
PM - 0.15 g/hp-hr
BSFC = 7000 Btu/hp-hr
Heat content = 137,000 Btu/gal

Calculations and Computations

Well Pad Construction Emissions

		SC ARB Emission Factor			Total Equipment EF		
Construction Equipment	**Typical Number of Equipment Used**	**PM**	**NOx**	**SO2**	**PM**	**NOx**	**SO2**
		(lb/hr)	**(lb/hr)**	**(lb/hr)**	**(lb/hr)**	**(lb/hr)**	**(lb/hr)**
Roller	1	0.0547	0.7749	0.0008	0.0547	0.7749	0.0008
Scraper	2	0.1256	2.9078	0.0027	0.2512	5.8156	0.0054
Blader	1	0.0753	1.4338	0.0015	0.0753	1.4338	0.0015
Dozer	1	0.1288	2.9891	0.1288	0.1288	2.9891	0.1288
Water Truck	1	0.0875	2.3885	0.0027	0.0875	2.3885	0.0027
Loader	1	0.0521	0.6747	0.0000	0.0521	0.6747	0.0000
Dump Truck	1	0.0875	2.3885	0.0008	0.0875	2.3885	0.0008
Backhoe	1	0.0521	0.6747	0.0008	0.0521	0.6747	0.0008
				Total lb/hr	0.5975	13.4019	0.1392

12	**Average Construction Activity hours/day**			
5	**Average days of construction to complete one well pod**	**lb/day:**	7.17	160.8228	1.6704
25	**Pods Constructed in 2015**	**lb/well pad:**	35.85	804.114	8.352
		lb/year 2015:	896.25	20102.85	208.8
		lb/hr (Year 2015):	0.41	9.10	0.09

Sample Calculation:

13.4019	NOx lb	12 hrs	5 days	25 Pods	Year 2015	=	9.10	NOx lb
	hr	day	Pod Const.	Year 2015	2208 hours			hr

QEPFS

QEPFS Central Gathering Facilities and Other Stationary Engines

Facility Listing

Facility	Electric?
Mesa 14-16	No
Mesa 15-16	No
Stewart Point 16-18	Yes
Pinedale Anticline Disposal Facility	No

Mesa 14-16	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
QEPFS had provided lump sum emissions in 2011 for engines, flares, and heaters	2.49	0.00	0.16	9.14	772	47.36	0.25	24 hr/day 7 day/wk 365 day/yr	NOx emissions source: Table 1 from permit MD-1425 SO_2 emissions are negligible due to </= 1 ppm H_2S in fuel gas. PM from engine: (0.00991condensible+0.0095filterable)lb PM/MMBtu based on AP-42 Table 3.2-3; 830 hp; 8080 btu/hp-hr BSFC. PM from heaters: 7.6 lb PM/MMSCF based on AP-42 Table 1.4-2; 20.6 MMSCF per year total fuel consumption. Assume all emissions come from the engine.

Mesa 15-6	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
QEPFS had provided lump sum emissions in 2011 for engines, flares, and heaters	2.58	0.00	0.16	9.14	772	47.36	0.25	24 hr/day 7 day/wk 365 day/yr	NOx emissions source: Table 1 from permit MD-1424 SO_2 emissions are negligible due to </= 1 ppm H_2S in fuel gas. PM from engine: (0.00991condensible+0.0095filterable)lb PM/MMBtu based on AP-42 Table 3.2-3; 830 hp; 8080 btu/hp-hr BSFC. PM from heaters: 7.6 lb PM/MMSCF based on AP-42 Table 1.4-2; 32.6 MMSCF per year total fuel consumption. Assume all emissions come from the engine.

Stewart Point 16-18	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
Lump sum emissions for flare, and heater	0.24	0.00	0.01	5.64	706	0.27	0.51	24 hr/day 7 day/wk 365 day/yr	NOx emissions source: application for permit CT-4062 SO_2 emissions are negligible due to </= 1 ppm H_2S in fuel gas. PM from heaters: 7.6 lb PM/MMSCF based on AP-42 Table 1.4-2; 16.2 MMSCF per year total fuel consumption. Assume all emissions come from the heater.

Pinedale Anticline Disposal Facility	Emissions (lb/hr)			Stack Parameters					
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)	Operating Scenario for Modeling	Notes
One 0.25 MMBtu/hr heater and one 0.35 MMBtu/hr heater	0.06	0.00	0.01	5.64	706	0.27	0.51	24 hr/day 7 day/wk 365 day/yr	Assume all emissions come from a heater. Emissions based on the 2011 annual emissions inventory.

QEPFS Compressor Stations

Pinedale Complex	Emissions (lb/hr)			Stack Parameters				Operating Scenario for Modeling	Notes
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)		
Caterpillar G3608SITA	2.88	0.00	0.00	15.2	743	46.76	0.46	24 hr/day 7 day/wk 365 day/yr	Emissions source: Permit MD-11378 (Corrected) and application for same. Emissions from these sources occur throughout the year (i.e. they are not seasonal). Therefore, the ton per year emission rates were divided by 8760 hours per year to calculate the lb/hr emission rates for the modeling inventory. Emissions from engines E-3, E-4, E-5, and E-6, which share a total operating hours limit, were divided evenly amongst the four engines. NOx emissions from venting and blowdowns are accounted for as flare emissions. Venting and blowdown emissions as a result of upset conditions are not included in the inventory.
Caterpillar G3608SITA	2.88	0.00	0.00	15.2	743	46.76	0.46		
Caterpillar G3616SITA	3.81	0.00	0.00	15.2	742	92.98	0.46		
Caterpillar G3616SITA	3.81	0.00	0.00	15.2	742	92.98	0.46		
Caterpillar G3616SITA	3.81	0.00	0.00	15.2	742	93.07	0.46		
Caterpillar G3616SITA	3.81	0.00	0.00	15.2	742	93.07	0.46		
Heater 1	0.02	0.00	0.00	7.62	811	10.02	0.05		
Heater 2	0.02	0.00	0.00	7.62	811	10.02	0.05		
Heater 3	0.84	0.00	0.07	1.98	509	4.38	0.41		
Heater 4	0.18	0.00	0.02	5.64	811	0.27	0.51		
Heater 5	0.05	0.00	0.00	8.84	811	20.03	0.05		
Heater 6	0.05	0.00	0.00	8.84	811	20.03	0.05		
Flare 1	0.09	0.00	0.00	10.7	811	17.05	0.05		
Solar Tital 130	7.03	0.00	0.80	21	756	17.96	2.44		

QEPFS Gas Processing Plants

Black's Fork (Expansion)	Emissions (lb/hr)			Stack Parameters				Operating Scenario for Modeling	Notes
Equipment	NOx	SO2	PM	Stack Ht (m)	Exh Temp (K)	Exh Vel (m/s)	Stack Diam (m)		
Titan 130 Turbine	8.7	0	0.74	11.43	499.4	48.02	1.219	24 hr/day 7 day/wk 365 day/yr	NOx: Air Quality Permit MD-11019A SO2: AP-42 = 0.94*(%sulfur)*MMBtu=0
Titan 130 Turbine	8.7	0	0.74	11.43	499.4	48.02	1.219		
Titan 130 Turbine	8.7	0	0.74	11.43	499.4	48.02	1.219		
Titan 130 Turbine	8.7	0	0.74	11.43	499.4	48.02	1.219		
Flare	0.3	0	0	18.29	1273	20	0.592		

Notes:

Titan 130 Turbine horsepower is 15,088hp, and brake-specific fuel consumption is 7,463 Btu/hp-hr.

Enterprise

Enterprise Compressor Stations

Paradise	Emissions (lb/hr)			Stack Parameters					
Facility Total	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**
Facility Total	55.70	0.00	1.96	14.8	726.5	28.65	0.71	24 hr/day 7 day/wk 365 day/yr	NOx from permit MD 11562; PM from 2009 annual EI; SO2 assumed to be negligible.

Falcon	Emissions (lb/hr)			Stack Parameters					
Facility Total	**NOx**	**SO2**	**PM**	**Stack Ht (m)**	**Exh Temp (K)**	**Exh Vel (m/s)**	**Stack Diam (m)**	**Operating Scenario for Modeling**	**Notes**
Facility Total	43.60	0.00	1.54	14.8	726.5	28.65	0.71	24 hr/day 7 day/wk 365 day/yr	NOx from permit MD 11561; PM from 2009 annual EI; SO2 assumed to be negligible.

Anschutz, Yates, and Newfield (See 2011 WDEQ Annual Inventories)