BOWIE
POWER STATION

April 14, 2014

Mr. Wayne D. Bixler
Environmental Engineering Specialist
Air Permit Section, New Source Review
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007

Subject: Response to January 10, 2014 Arizona Department of Environmental Quality (ADEQ) Comments on the Bowie Power Station Class I Air Permit Application

Dear Mr. Bixler:

Enclosed please find the response to ADEQ's comments dated January 10, 2014 on the Bowie Power Station Class I Air Permit application. An electronic copy of the Response to Comments document and the updated modeling files are also being sent to you. With this submittal Southwestern Power Group respectfully requests that ADEQ schedule a public hearing in the town of Bowie as soon as possible.

Copies of the Response to Comments document and the modeling files are being provided to the individuals shown on the attached distribution list.

Should you have any questions, please feel free to call me at (602) 808-2004.

Sincerely,

Gary C

Gary Crane, Ph.D.
Manager, Environmental Affairs

Enclosures

BOWIE POWER STATION PROJECT
RESPONSE TO COMMENTS
DISTRIBUTION LIST

Addressed To	Hard Copies of Response to Comments Document	Electronic Copy of Response to Comments Document	Air Quality Modeling Files
Arizona Department of Environmental Quality			
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EPA			
Manny Aquitania U.S. Environmental Protection Agency, Region 9 Air Permits Office (AIR-3) 75 Hawthorne Street, San Francisco, CA 94105-3901 (415) 972-3977	1		
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Federal Land Managers			
Susanna M. Ehlers, Air Quality Specialist U.S. Forest Service, 333 Broadway SE Albuquerque, NM 87102 (505) 842-3840	1		1
John Notar National Parks Service, Air Resources Division 12795 W. Alameda Parkway Lakewood, CO 80228 (303) 969-2079 john_notar@nps.gov	1	X	1
Don Shepherd National Parks Service, Air Resources Division 12795 W. Alameda Parkway Lakewood, CO 80228 (303) 969-2075	Cover Letter Only		

RESPONSE TO COMMENTS

ADEQ Comments on BACT Analysis and Modeling Report Sections of Bowie Power Station Class I Air Permit Application
January 10, 2014

RESPONSE TO COMMENTS

ADEQ Comments on BACT Analysis and Modeling Report Sections of Bowie Power Station Class I Air Permit Application January 10, 2014

Comment

ADEQ finds the analysis and proposed BACT acceptable for all applicable pollutants and emission units with the exception of NO_x for the auxiliary boiler.

Bowie proposed as BACT for the auxiliary boiler NO_X an emission limit of 0.036 lb/MMBtu heat input (HHV), or an exhaust concentration of approximately 30 ppmv @ 3% O_2, using low-NO_X burners. The analysis acknowledges that lower limits are achievable using so-called ultra low-NO_X burners, but proposed that those more effective burners be rejected due to "extreme economic impacts." Specifically, Bowie's permit application (at p. 4-28 and in appendix D) claims the cost effectiveness of ultra low-NO_X burners would be approximately $117,000 per ton of emission reduction, based on information in the "Final Draft Staff Report for Rules 4306, 4307, and 4320," September 18, 2008, by the San Joaquin Valley Unified Air Pollution Control District.

The data relied upon by Bowie are not applicable to the BACT analysis for the proposed new auxiliary boiler. The cited San Joaquin rulemaking was for a Best Available Retrofit Control Technology rule applicable to existing units; the cited capital cost of approximately $114,000 represents the cost of replacing existing burners in an existing process heater, not the incremental cost of installing ultra low-NO_X burners in lieu of low-NO_X burners.

Incidentally, the recent PSD permits for Avenal Power in California and Kennecott in Utah include NO_X BACT limits of 9 ppmv @ 3% O_2 for comparable auxiliary boilers. Although this is not indicative of the site-specific economic, energy, or environmental impacts of improved NO_X controls on the proposed auxiliary boiler at the Bowie facility, it is relevant information.

Response

Specifications for a 50 million British thermal unit per hour (MMBtu/hr) heat input ultra low-NO_x boiler were obtained from Rentech Boiler Systems, Inc. (Rentech) (provided in Attachment A). This boiler will be installed as the auxiliary boiler at the Bowie facility.

It has been confirmed with Rentech that the decrease in oxides of nitrogen (NO_x) emissions can be accomplished without an increase in carbon monoxide (CO) or volatile organic compound (VOC) emissions.

Rentech has also confirmed that the same fuel use and stack parameters as the boiler not equipped with ultra low-NO_x burners can be achieved. This is done by adding heating surface to the ultra low-NO_x boiler economizer.

Emissions calculated for the auxiliary boiler and total project emissions have been adjusted to account for the use of the ultra low-NO_x auxiliary boiler. These emissions are provided in Attachment A.

Comment

Model Updates:

New versions of CALPUFF/CALMET and AERMOD have recently been released by EPA. Therefore, the modeling analyses (including the CALMET file creation) need to be updated using these latest model versions. Note that while the results are not expected to change significantly, EPA is certain to negatively comment if the latest regulatory versions of the models are not used.

Response

All modeling analyses have been updated using the most recent versions of CALPUFF/CALMET and AERMOD. Results are shown in the attached Modeling Addendum (Attachment B). As expected, changes to the results were insignificant.

Comment

Secondary $PM_{2.5}$ Analysis:

The $PM_{2.5}$ secondary analysis presents some modeling results from CALPUFF that are used to demonstrate the secondary $PM_{2.5}$ impact locations are located further away from the source than the primary $PM_{2.5}$ impacts, and do not overlay. This is a very good analysis, however information on the maximum (total of primary plus secondary) CALPUFF predicted concentrations should also be presented and discussed to fully evaluate and describe the potential secondary impacts.

Response

Figures showing the combination of directly emitted particulate matter less than 2.5 micrometers diameter ($PM_{2.5}$) and sulfate/nitrate are shown in the Modeling Addendum provided in Attachment B.

Comment

Class I Increment:

The analysis of PSD increment consumption at the nearby Class I areas, (Chiricahua Nat'l Monument and Chiricahua Wilderness Area) estimated results less than significant, and hence in accordance with the approved protocol, Bowie did not consult with ADEQ to expand the analysis to more distant Class I areas. At this time, ADEQ believes the absence of these more distant areas in the analysis is certain to generate negative comments from EPA. Therefore, given that Bowie will rerun CALPUFF using the current version, ADEQ will require receptors be included for all Class I areas within the 300 km CALPUFF domain. In the revised Class I analysis write-up, Bowie should also include information on the CALMET domain, including the map from the 2007 protocol.

Response

Class I modeling has been performed for all Class I areas within 300 kilometers of the Bowie Power Station site. An expanded writeup in the attached Modeling Addendum addresses the CALMET domain and includes an updated version of the map from the 2007 protocol. Results of the modeling are included in the attached Modeling Addendum.

Comment

In Stack Ratios:

On page E-43 of the modeling report Appendix E, the use of the CAPCOA in-stack NO_2/NO_x ratios is discussed. EPA has previously commented that additional information, from comparable stack testing and/or vendor supplied, would be useful as well as information about ratios in start-up/shut-down vs. normal operation. ADEQ strongly advises Bowie to include additional substantive information to support their selection of ISR(s). It is expected that EPA will comment negatively if the CAPCOA data is the sole source of reference.

Response

General Electric has been unwilling to provide in-stack nitrogen dioxide/oxides of nitrogen (NO_2/NO_x) ratios (ISRs) for the Bowie Power Station turbines and no vendor ratio information is available for the fire pump or auxiliary boiler. An Internet search was conducted for additional information regarding ISRs. In addition, the Web sites of the California Energy Commission (CEC; California), California Air Resources Board (CARB; California), San Joaquin Valley Unified Air Pollution Control District (SJUVAPCD; California), Bay Area Air Quality Management District (BAAQMD; California), South Coast Air Quality Management District (SCAQMD; California), and Texas Commission on Environmental Quality (TCEQ; Texas) were searched for ISR data and modeling guidance documents were reviewed. No new applicable data or guidance were found.

The US Environmental Protection Agency (EPA) has compiled two databases of ISR data from source testing. The NO2_ISR_database.xlsx file contains NO_2 ISR data that has been submitted via the formal collection process initiated by EPA's Office of Air Quality Planning and Standards (OAQPS). The NO2_ISR_alpha_database.xlsx file contains NO_2 ISR values collected by various regional, state, and local air permitting offices prior to the formal collection initiated by OAQPS. While this database contains a large number of entries, none fully satisfy the requirements for the formal collection effort.

Bowie Power Station Turbines

The Bowie Power Station will use two GE Frame 7FA Model 4 natural gas-fired combustion turbines using selective catalytic reduction (SCR) for NO_x control. The ISR used in the modeling analysis assumed the GE turbine default value of 0.091 for GE turbines from a California Air Pollution Control Offices Association (CAPCOA) guidance document titled "Modeling Compliance of the Federal 1-Hour NO2 NAAQS" (CAPCOA 2011) that includes recommended in-stack ratios in Appendix C. The NO2_ISR_database contains no data for natural gas-fired, GE turbines. The NO2_ISR_alpha_database, however, has 39 GE Frame 7FA with SCR source tests listed. All ratios listed were well below 0.091 (maximum 0.0101, average 0.0069), suggesting that a ratio of 0.091 is appropriate and conservative.

Bowie Power Station Auxiliary Boiler

The Bowie Power Station will include a natural gas-fired, 50 MMBtu/hr auxiliary boiler using ultra low-NO_x burners. The ISR used in the modeling analysis was the natural gas boiler default value of 0.1 from the CAPCOA data. The NO2_ISR_database has no natural gas-fired boilers listed. The NO2-ISR_alpha_databse has a number of natural gas boiler source tests; however, none use ultra low-NO_x burners and boiler size is uncertain in most cases. The average ISR from these tests was 0.0685 (range 0.0-0.1579). The CAPCOA ISR value for this source has been retained.

Bowie Power Station Diesel Fire Pump Engine

The Bowie Power Station will include a 260 horsepower (hp) diesel fire pump engine. The modeling analysis used an ISR value of 0.2, the CAPCOA default for diesel engines. The NO2_ISR_database contains several diesel engine source tests, all from engines larger than the Bowie Power Station's fire pump. The average ISR from these source tests for diesel engines that did not use NO_x control is 0.065 (range 0.022-0.22). The NO2_ISR_alpha_database also contains several diesel engine source tests. For diesel engines less than 500 hp with no NO_x control technology, the average ISR is 0.166 (range 0.0-0.5; note that the 0.5 ISR value results from a series of source tests that only recorded NO_2 and NO_x values as integer [whole number] parts per million values). Again, the CAPCOA value is appropriate based on this information.

Non-Bowie Sources

Cumulative modeling required the use of ISR values for surrounding sources, as discussed below.

Pistachio Corporation of Arizona

The Pistachio Corporation of Arizona facility has a variety of natural gas-fired equipment, including roasters, dryers, and silos. The EPA default ISR of 0.5 was used for the roaster and silos, while the maximum of the source test data for natural gas-fired dryers in the CAPCOA document was rounded up to an ISR of 0.12. Neither of the EPA ISR databases contain any data for these types of sources.

El Paso Natural Gas (EPNG) Willcox and Bowie Compressor Stations

Two compressor stations were included in the cumulative modeling. The sources were GE natural gas-fired turbines (two, GE M3142R-J turbines at the Willcox Compressor Station and one, GE M3122R turbine at the Bowie Compressor Station). The CAPCOA default ISR for GE turbines of 0.091 was used. As noted previously, the NO2_ISR_database has no entries for natural gas-fired GE turbines. The NO2-ISR_alpha_database contains ISR data for several hundred natural gas-fired GE turbines, including a variety of models and NO_x control technologies. All ISR values are less than the 0.091 ISR that was used in the modeling (average 0.0582, range 0.0-0.0825).

Apache Generating Station

The Apache Generating Station has a number of emission units that were included in the cumulative analysis. While several have the ability to use multiple fuels, the fuels with the highest NO_x emissions were modeled.

Steam unit 1 is a 75 megawatt (MW) natural gas-fired unit. The CAPCOA natural gas boiler default ISR of 0.1 was used for this unit. The NO2_ISR_database has no entries for natural gas boilers. The NO2-ISR_alpha_database has a number of natural gas boilers of uncertain size; the average ISR is 0.0685, range 0.0-0.1579.

Steam units 2 and 3 are 195 MW coal-fired units. The EPA default ISR of 0.5 was used for these units. The NO2_ISR_database contains source data for two source tests on smaller coal-fired boilers (around 96 MW). The resulting ISR values are 0.0054 and 0.0153, well below the 0.5 ISR used in the Bowie modeling. The NO2_ISR_alpha_database does not contain any data on coal-fired units.

The Apache Generating Station has three simple-cycle peaking turbines that are oil-fired, ranging from 10.4 to 64.9 MW. The NO2_ISR_database contains one source test for an oil-fired turbine, a GE Frame 7, with an ISR of 0.00355. No data for oil-fired turbines are included in the NO2_ISR_alpha_database. The EPA default ISR of 0.5 was used for these units.

A fourth simple-cycle turbine (44 MW) fires a combination of natural gas and diesel. No data for this combination of fuels was found in either database and the EPA default ISR of 0.5 was used for this unit.

The station also has a diesel startup engine (430 hp). The same analysis applies to this unit as delineated above for the Bowie Power Station 260 hp fire pump. An ISR of 0.2, the CAPCOA default for diesel engines, was used.

Comment

Cloud Cover:

On page 5-8 of the application, it is stated that "Cloud cover data from Safford were used in the meteorological data processing rather than on-site solar radiation data." Since the on-site solar radiation data is brought up, it would be useful to expand this to say why it wasn't used – RTP recalls that delta-T measurements were not made (or had some problems), so that the SRDT Bulk Richardson AERMET method could not be used.

Response

The on-site dataset did not include delta-T data.

Comment

Auxiliary Boiler:

The application specifies a limit in hours of operation for the auxiliary boiler at 450 hours/year. Using EPA's intermittent source policy, this emission unit does not necessarily need to be modeled for the 1-hr NO_x and SO_2 analyses, but does need to be included in $PM_{2.5}$ 24-hr analysis. In the remodeling using the updated version of AERMOD, Bowie has the option to drop the 1-hr NO_x and SO_2 analyses.

Response

The auxiliary boiler was dropped from the revised modeling for 1-hour NO_x and sulfur dioxide (SO_2) analyses.

Comment

Emissions:

The start-up/shut-down turbine flow rates and temperatures are higher than the minimum compliance load flow rates and temperatures, which is unexpected. What is the basis for the turbine SU/SD flows and temperatures?

Response

The turbines will be equipped with a fast start design developed by Kiewit Power Engineers Co. (Kiewit). Startup/shutdown (SU/SD) flows and temperatures associated with that design for the startup period were provided by Kiewit.

Comment

Misc Minor Comments:

Any references to ADEQ's Draft Revised Modeling Guidelines (August 2013) should be updated to the final September 23, 2013 version (for example, in the last paragraph of Section 5.4 of the application).

The second paragraph of Section 5.4.2 states "Local and regional emissions from upwind urban areas and rural sources can account for 50%-75% of total observed particulate matter concentrations." This passage generated some discussion amongst ADEQ staff as well as a comment from RTP. The review comments and discussion may be summarized as follows:

- Is this suggesting that 25%-50% are from non-anthropogenic sources ?
- This is a general statement, originally from Particulate Matter Science for Policy Makers: a NARSTO Assessment, and is not specific to the Chiricahua NM data. For clarification it is suggested Bowie preface the statement with *in general*, and include the (NARSTO 2004) citation immediately after the statement.

Response

Any further references to ADEQ's Draft Revised Modeling Guidelines (August 2013) will be updated to the September 23, 2013 version.

While the quoted passage is found verbatim on page 19 of *Particulate Matter Science for Policy Makers: a NARSTO Assessment* (NARSTO 2004), it is not very illuminating. It is part of a general discussion of particulate matter (PM) under the heading **Policy Question #2 – Where there is a PM problem, what is its composition and what factors contribute to elevated concentrations?**

The NARSTO document discusses the formation and ambient concentrations of PM, PM_{10}, and $PM_{2.5}$ in general and also examines the PM situation in certain specific areas of the United States and Canada in more detail. Unfortunately, southern Arizona is not one of the areas with sufficient information to form a conceptual model of PM formation and composition, so information in the NARSTO document that is relevant to the Bowie Power Station area is limited to the general discussions and observations.

Further discussion within the "synthesis" chapter as well as elsewhere in the NARSTO document provides the following expanded information:

- Generally, PM_{10} consists of 40%-60% $PM_{2.5}$, and the remainder is primarily locally generated, crustal/geological and biological material. In contrast, most of the observed $PM_{2.5}$ mass usually originates as precursor gases and, through various physiochemical processes, is transferred to the condensed phase as secondary particulate matter.
- Receptor based analysis indicates that greater than two-thirds of observed average $PM_{2.5}$ mass concentrations can be traced back to anthropogenic sources of primary PM and precursor gases.
- $PM_{2.5}$ comes from both local and regional sources. Local sources cause highly variable distribution of mass concentration and composition between urban and surrounding regional areas. Regional contributions to mass concentrations include interurban or long-range transport as well as non-anthropogenic background concentrations. Urban areas show mean $PM_{2.5}$ levels exceeding those at nearby rural areas.
- Regional contributions are an important addition to local emissions when ambient $PM_{2.5}$ concentrations are being interpreted in the majority of cases. Rural $PM_{2.5}$ levels surrounding urban areas can account for 50%-75% of urban $PM_{2.5}$ mass concentrations during peak periods. Rural levels are composed of aged emissions from upwind urban and rural areas as well as fresh emissions from local sources.
- The typically smaller spatial variations in $PM_{2.5}$ mass than PM_{10} mass are consistent with the well-known long residence time of fine PM, which permits transport over distances of 10 to 1,000 kilometers and tends to homogenize spatial variations in mass concentrations.

Attachment A
to
RESPONSE TO COMMENTS

ADEQ Comments on BACT Analysis and Modeling Report Sections of Bowie Power Station Class I Air Permit Application
January 10, 2014

Auxiliary Boiler Specifications
and
Revised Emissions

Emissions Data

Fuel Fired		Natural Gas
DESCRIPTION	UNITS	
System Performance		
Steam Flow (Gross)	Lb/hr	41,500
Steam Pressure	PSIG	150
System Efficiency (HHV)	%	83.7
Stack Gas Temperature	ºF	300
Stack Gas Flow	Lbs/hr	44,110
Stack Gas Flow	ACFM	14,731
Stack Diameter	in	30”
Stack Exit Velocit	Ft/sec	50
Furnace Volume	Ft^3	1013
Total Heat Input (HHV)	MMBtu/Hr	50.0
Fuel Higher Heating Value	Btu/SCF	1033
	Btu/lb	22,925
Emissions		
NOx	Lbs/MMBtu	0.011
	PPM	9
	Lbs/hr	0.54
CO	Lbs/MMBtu	0.037
	PPM	50
	Lbs/hr	1.85
PM/PM-10	Lbs/MMBtu	0.007
	Lbs/hr	0.35
VOC	Lbs/MMBtu	0.004
	Lbs/hr	0.20

Notes:

1. Feedwater temperature to boiler is 228°F.
2. Ambient temperature is 80°F.
3. Emissions guarantees are from 25% to 100% MCR only.

Rentech Boiler Systems, Inc.
Abilene Office: 5025 E. Business 20 • Abilene, TX 79601 • Phone: 325-672-3400 • Fax: 325-672-9996
Lincoln Office: 145 North 46th Street • Lincoln, NE 68503 • Phone: 402-474-4242 • Fax: 402-474-4243

BOWIE POWER STATION
AUXILIARY BOILER DATA AND EMISSIONS

Stack Parameters

Stack Height	13.7	meters	
	44.9	feet	
Stack Temperature	300	^oF	From Rentech Data sheet
	422.04	K	
Stack Exit Velocity	50.00	feet/second	From Rentech Data sheet
	15.24	meters/second	
Stack Diameter	30	inches	From Rentech Data sheet
	2.5	feet	
	0.76	meters	

Operating Data

Heat Input Rating	50	MMBtu/hr
Operating Hours	450	hrs/yr
Natural Gas Heat Content	1,035	Btu/scf
Natural Gas Sulfur Content	0.75	grains/100 scf
	7,500	grains/10^6 scf
Fuel Consumption Rate	0.048	mmscf/hr
Annual Fuel Usage	21.75	mmscf/yr

Criteria Pollutant Emission Estimation

Pollutant	Emission Factor (lb/mmscf)	Adjusted Emission Factor (lb/mmscf)	Emission Factor (lb/mmBtu)	Reference	Hourly Emissions (lb/hour)	Annual Emissions (tpy)
NO_x			0.011	Rentech Data Sheet	0.55	0.12
CO			0.037	Rentech Data Sheet	1.85	0.42
VOC			0.004	Rentech Data Sheet	0.20	0.05
SO_x	0.6	2.25		AP-42, Table 1.4-2, 7/98	0.11	0.02
PM			0.007	Rentech Data Sheet	0.35	0.08
PM_{10}			0.007	Rentech Data Sheet	0.35	0.08

BOWIE POWER STATION
AUXILIARY BOILER DATA AND EMISSIONS

Hazardous Air Pollutant Emission Estimation

Pollutant	Emission Factor (lb/mmscf)	Emission Factor Reference	Hourly Emissions (lb/hour)	Annual Emissions (tpy)
Arsenic	2.0E-04	AP-42, Table 1.4-4, 7/98	9.67E-06	2.17E-06
Benzene	2.1E-03	AP-42, Table 1.4-3, 7/98	1.01E-04	2.28E-05
Cadmium	1.1E-03	AP-42, Table 1.4-4, 7/98	5.32E-05	1.20E-05
Chromium	1.4E-03	AP-42, Table 1.4-4, 7/98	6.77E-05	1.52E-05
Cobalt	8.4E-05	AP-42, Table 1.4-4, 7/98	4.06E-06	9.13E-07
Dichlorobenzene	1.2E-03	AP-42, Table 1.4-3, 7/98	5.80E-05	1.30E-05
Formaldehyde	7.5E-02	AP-42, Table 1.4-3, 7/98	3.62E-03	8.16E-04
Hexane	1.8E+00	AP-42, Table 1.4-3, 7/98	8.70E-02	1.96E-02
Lead	0.0005	AP-42, Table 1.4-2, 7/98	2.42E-05	5.44E-06
Manganese	3.8E-04	AP-42, Table 1.4-4, 7/98	1.84E-05	4.13E-06
Mercury	2.6E-04	AP-42, Table 1.4-4, 7/98	1.26E-05	2.83E-06
Naphthalene	6.1E-04	AP-42, Table 1.4-3, 7/98	2.95E-05	6.63E-06
Nickel	2.1E-03	AP-42, Table 1.4-4, 7/98	1.01E-04	2.28E-05
POM	5.2E-05		2.50E-06	5.63E-07
Toluene	3.4E-03	AP-42, Table 1.4-3, 7/98	1.64E-04	3.70E-05

POM		
2-Methylnaphthalene	2.4E-05	AP-42, Table 1.4-3, 7/98
Fluoranthene	3.0E-06	AP-42, Table 1.4-3, 7/98
Fluorene	2.8E-06	AP-42, Table 1.4-3, 7/98
Phenanathrene	1.7E-05	AP-42, Table 1.4-3, 7/98
Pyrene	5.0E-06	AP-42, Table 1.4-3, 7/98
Total POM	**5.2E-05**	

BOWIE POWER STATION
AUXILIARY BOILER DATA AND EMISSIONS

$$\text{feet} = \text{meters} \times 3.281 \ \frac{\text{feet}}{\text{meters}}$$

$$K = \left[\frac{5}{9}\,(^{\circ}F-32)\right] + 273.15$$

$$\frac{\text{meters}}{\text{second}} = \frac{\text{feet}}{\text{second}} \times \frac{\text{meters}}{3.281\ \text{feet}}$$

$$\text{feet} = \text{inches} \times \frac{\text{feet}}{12\ \text{inches}}$$

$$\text{meters} = \text{inches} \times \frac{\text{feet}}{12\ \text{inches}} \times \frac{\text{meters}}{3.281\ \text{feet}}$$

$$\frac{\text{grains}}{10^6\ \text{scf}} = \frac{\text{grains}}{100\ \text{scf}} \times \frac{1{,}000{,}000\ \text{scf}}{10^6\ \text{scf}}$$

$$\frac{\text{mmscf}}{\text{hour}} = \frac{\text{mmBtu}}{\text{hour}} \times \frac{1{,}000{,}000\ \text{Btu}}{\text{mmBtu}} \times \frac{\text{scf}}{\text{Btu}} \times \frac{\text{mmscf}}{1{,}000{,}000\ \text{scf}}$$

$$\frac{\text{mmscf}}{\text{year}} = \frac{\text{mmscf}}{\text{hour}} \times \frac{\text{hours}}{\text{year}}$$

Adjust AP-42, SO2 emission factor for heat and sulfur content of Bowie natural gas:

$$\text{Adjusted Emission Factor}\ \frac{\text{lb}}{\text{mmscf}} = \frac{\text{lb}}{\text{mmscf}} \times \frac{\text{Bowie Sulfur Content grains/scf}}{\text{AP-42 Sulfur Content 2,000 grains/scf}}$$

lb/hour emissions:

$$\frac{\text{lb}}{\text{hour}} = \frac{\text{lb}}{\text{mmBtu}} \times \frac{\text{mmBtu}}{\text{hour}}$$

$$\frac{\text{lb}}{\text{hour}} = \frac{\text{lb}}{\text{mmscf}} \times \frac{\text{mmscf}}{\text{hour}}$$

$$\frac{\text{tons}}{\text{year}} = \frac{\text{lb}}{\text{mmBtu}} \times \frac{\text{mmBtu}}{\text{hour}} \times \frac{\text{hours}}{\text{year}} \times \frac{\text{tons}}{2000\ \text{lb}}$$

$$\frac{\text{tons}}{\text{year}} = \frac{\text{lb}}{\text{mmscf}} \times \frac{\text{mmscf}}{\text{year}} \times \frac{\text{tons}}{2000\ \text{lb}}$$

BOWIE POWER STATION - MODEL 4
ANNUAL PROJECT CRITERIA POLLUTANT EMISSIONS

Equipment

Turbines and Duct Burners	2
Auxiliary Boilers	1
Emergency Fire Pumps	1
Cooling Towers	1
Evaporation Pond	1
Circuit Breakers	5

Annual Criteria Pollutant Emissions - Per Piece of Equipment

	Emissions (tons/year)											
	NO_x	**CO**	**VOC**	**SO_2**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**SF_6**	**CO_2e**
Per Turbine and Duct Burner Pair	69.47	80.54	14.97	15.00	31.27	31.27	31.27	875,542.25	16.51	1.65	---	876,400.69
Per Auxiliary Boiler	0.12	0.42	0.05	0.02	0.08	0.08	0.08	1,315.23	0.02	0.002	---	1,316.52
Per Emergency Fire Pump	0.06	0.04	0.004	0.00016	0.003	0.003	0.003	14.97	0.0006	0.0001	---	15.02
Per Cooling Tower	---	---	0.64	---	5.67	3.83	1.82	---	---	---	---	---
Evaporation Ponds	---	---	2.15E-04	---	---	---	---	---	---	---	---	---
Circuit Breakers	---	---	---	---	---	---	---	---	---	---	0.0002	4.30

Annual Criteria Pollutant Emissions - Per Equipment Type

	Total Project Emissions (tons/year)											
Emission Source	**NO_x**	**CO**	**VOC**	**SO_2**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**SF_6**	**CO_2e**
Turbine and Duct Burner Total	138.93	161.08	29.94	30.00	62.54	62.54	62.54	1,751,084.50	33.02	3.30	---	1,752,801.38
Auxiliary Boiler Total	0.12	0.42	0.05	0.02	0.08	0.08	0.08	1315.23	0.02	0.002	---	1,316.52
Fire Pump Total	0.06	0.04	0.004	0.00	0.003	0.003	0.003	14.969	0.001	0.0001	---	15.02
Cooling Tower Total	---	---	0.64	---	5.67	3.83	1.82	---	---	---	---	---
Evaporation Pond Total	---	---	2.15E-04	---	---	---	---	---	---	---	---	---
Circuit Breakers	---	---	---	---	---	---	---	---	---	---	0.0009	21.51
Project Total	**139.12**	**161.54**	**30.64**	**30.03**	**68.29**	**66.45**	**64.45**	**1,752,414.70**	**33.04**	**3.30**	**0.0009**	**1,754,154.43**

TONS PER YEAR FOR EACH PIECE OF EQUIPMENT AT MAXIMUM OPERATION

For turbines and duct burners:
Ton/year values are from the spreadsheet titled "Combined Turbine and Duct Burner Annual Emissions"

For auxiliary boiler:
Ton/year values are from the spreadsheet titled "Auxiliary Boiler Data and Emissions".

For emergency fire pump:
Ton/year values are from the spreadsheet titled "Emergency Fire Pump Data and Emissions".

For cooling tower:
Tons/year value comes from the spreadsheest titled "Cooling Tower PM/PM_{10}/$PM_{2.5}$ Emissions" and "Cooling Tower HAP Emissions"

For evaporation pond:
Tons/year value comes from the spreadsheet titled "Evaporation Pond Chloroform Emissions".

CO_2, CH_4, N_2O, SF_6, and CO_2e:
Tons/year values are from the spreadsheet titled "Annual Greenhouse Gas Emissions"

Total Project Emissions tons = tons Each Piece of Equipment x # of Pieces of Equipment

For turbines, duct burners, auxiliary boiler, and emergency fire pump assume PM_{10} = $PM_{2.5}$

BOWIE POWER STATION - MODEL 4
ANNUAL CRITERIA POLLUTANT EMISSIONS SUMMARY - UNCONTROLLED

Annual Criteria Pollutant Emissions

	Emissions (tons/year)											
	NO_x	CO	VOC	SO_2	PM	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	SF_6	CO_2e
Per Turbine and Duct Burner Pair	299.6	248.6	22.6	15.0	31.3	31.3	31.3	875,542.25	16.51	1.65	---	876,400.69
Per Auxiliary Boiler	0.12	0.42	0.05	0.02	0.08	0.08	0.08	1,315.23	0.02	0.002	---	1,316.52
Per Emergency Fire Pump	0.06	0.04	0.004	0.00	0.003	0.003	0.003	14.97	0.0006	0.0001	---	15.02
Per Cooling Tower	---	---	0.64	---	5.67	3.83	1.82	---	---	---	---	---
Evaporation Ponds	---	---	2.15E-04	---	---	---	---	---	---	---	---	---
Per Circuit Breaker	---	---	---	---	---	---	---	---	---	---	0.0002	4.30

TONS PER YEAR FOR EACH PIECE OF EQUIPMENT AT MAXIMUM OPERATION
For turbines and duct burners
Ton/year are from the spreadsheet titled "Combined Turbine and Duct Burner Annual Emissions".

For auxiliary boiler:
Ton/year values are from the spreadsheet titled "Aux Boiler Data and Emissions".

For emergency fire pump:
Ton/year values are from the spreadsheet titled "Emergency Fire Pump Data and Emissions".

For cooling tower:
Tons/year value comes from the spreadsheets titled "Cooling Tower PM/PM_{10}/$PM_{2.5}$ Emissions" and Cooling Tower HAP Emissions"

For evaporation ponds:
Tons/year value comes from the spreadsheet titled "Evaporation Pond Chloroform Emissions".

CO_2, CH_4, N_2O, SF_6, and CO_2e:
Tons/year values are from the spreadsheet titled "Annual Greenhouse Gas Emissions"

For turbines, duct burners, auxiliary boiler, and emergency fire pump assume $PM_{10} = PM_{2.5}$

BOWIE POWER STATION - MODEL 4
ONE-HOUR CRITERIA POLLUTANT EMISSION SUMMARY

Maximum One-Hour Emissions

	Emissions (pounds/hour)											
Emission Basis	**Normal Operation**							**Startup Operation**				
	NOx	**CO**	**VOC**	**SO_2**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**NOx**	**CO**	**VOC**	**SO_2**	**PM_{10}/$PM_{2.5}$**
Per Turbine and Duct Burner Pair	15.60	9.50	4.10	4.10	8.50	8.50	8.50	101.32	262.28	17.56	3.60	6.50
Per Aux. Boiler	0.55	1.85	0.20	0.11	0.35	0.35	0.35					
Per Fire Pump	1.26	0.81	0.07	0.003	0.07	0.07	0.07					
Per Cooling Tower	---	---	0.15	---	1.29	0.87	0.42					
Evaporation Ponds	---	---	4.92E-05	---	---	---	---					

For turbines and Duct Burners:
Normal operation values are from the spreadsheet titled "Combined Turbine and Duct Burner Hourly Emission Rates"
Startup values for NOx, CO, and VOC are maximum values from the spreadsheet titled "Turbine Startup Emissions"
Startup values for SO2 and PM_{10}/$PM_{2.5}$ are maximum turbine only (no duct firing) emissions from the spreadshee "Turbine Hourly CriteriaEmission"

For auxiliary boiler:
Ton/year values are from the spreadsheet titled "Auxiliary Boiler Data and Emissions".

For emergency fire pump:
Ton/year values are from the spreadsheet titled "Emergency Fire Pump Data and Emissions".

For cooling tower:
Tons/year value comes from the spreadsheets titled "Cooling Tower PM/PM_{10}/$PM_{2.5}$ Emissions" and "Cooling Tower HAP Emissions"

For evaporation pond:
Tons/year value comes from the spreadsheet titled "Evaporation Pond Chloroform Emissions".

Total Project Emissions tons = tons Each Piece of Equipment x # of Pieces of Equipment

For turbines, duct burners, auxiliary boiler, and emergency fire pump assume $PM_{10} = PM_{2.5}$

ATTACHMENT B

ADDENDUM TO
MODELING REPORT
FOR THE
BOWIE POWER STATION

Prepared for:

Arizona Department of Environmental Quality

April 2014

ATTACHMENT B

ADDENDUM TO
MODELING REPORT
FOR THE
BOWIE POWER STATION

Prepared by:
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April 2014

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LIST OF ACRONYMS

%	Percent
$\mu g/m^3$	Micrograms per cubic meter
AAAQS	Arizona Ambient Air Quality Standards
ADEQ	Arizona Department of Environmental Quality
AERMET	AERMOD Meteorological Preprocessor
AERMOD	AMS/EPA Regulatory Model
AMS	American Meteorological Society
AQRV	Air quality related value
CAPCOA	California Air Pollution Control Officers Association
CO	Carbon monoxide
DAT	Deposition Analysis Thresholds
EPA	United States Environmental Protection Agency
EPNG	El Paso Natural Gas
FLM	Federal Land Manager
GE	General Electric
HAP	Hazardous air pollutant
hp	Horsepower
HRSG	Heat recovery steam generator
Kg/ha/yr	Kilogram per hectare per year
km	Kilometers
LCC	Lambert conformal coordinates
mi	Mile
MM	Mesocale modeled
MMBtu/hr	Million British thermal units per hour
MRPO	Midwest regional Planning Organization
MW	Megawatt
NA	Not applicable
NAAQS	National Ambient Air Quality Standards
NM	National Monument
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
$PM_{2.5}$	Particulate matter less than 2.5 micrometers
PM_{10}	Particulate matter less than 10 micrometers

LIST OF ACRONYMS (CONTINUED)

ppb	Parts per billion
ppm	Parts per million
PSD	Prevention of Significant Deterioration
PVMRM	Plume Volume Molar Ratio Method
SCR	Selective catalytic reduction
SIL	Significant impact level
SO_2	Sulfur dioxide
SWPG	SouthWestern Power Group II, LLC
USDA	United States Department of Agriculture
VOC	Volatile organic compound
WA	Wilderness Area
WRAP	Western Regional Air Partnership

1.0 INTRODUCTION

SouthWestern Power Group II, LLC (SWPG), plans to build a 1,000 megawatt (MW; 1,050 with duct firing) natural gas-fired, combined-cycle power plant. The facility, called the Bowie Power Station, will be built in phases. Phase one will be 525 MW and was addressed in a Class I Prevention of Significant Deterioration (PSD)/Title V permit application submitted to the Arizona Department of Environmental Quality (ADEQ) in September 2013. The plant will be owned and operated by Bowie Power Station, LLC (Bowie). Bowie Power Station, LLC is wholly owned by SWPG.

The project will include the following emission units:

- Two combined-cycle, natural gas-fired, General Electric (GE) Frame 7FA combustion turbines;
- Two heat recovery steam generators (HRSGs), each equipped with a 420 million British thermal unit per hour [MMBtu/hr] heat input) duct burner;
- Nine-cell cooling tower;
- Evaporation pond (not modeled);
- Natural gas-fired auxiliary boiler (50 MMBtu/hr heat input); and
- Diesel-fired emergency fire pump (260 horsepower).

The project plans to use GE Frame 7FA, Model 4 (7FA.04) combustion turbines with a "fast start" configuration.

Oxides of nitrogen (NO_x) emissions from the turbines and duct burners will be controlled using selective catalytic reduction (SCR) systems. Carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) emissions from the turbines and duct burners will be controlled using oxidation catalysts.

The plant will be located approximately 2 miles (mi) north of the unincorporated community of Bowie in Cochise County in southeastern Arizona, approximately 80 mi east of Tucson. The area is attainment for all pollutants.

This Addendum to the originally submitted modeling report addresses items included in January 2014 comments from ADEQ.

2.0 CLASS II AREA ANALYSES

Air quality impacts in the Class II areas surrounding the Bowie Power Station were revised as requested by ADEQ using the most recent version of the AMS/EPA Regulatory Model (AERMOD; 12350), which was released after the permit application was submitted.. Due to problems with the 13350 version of the AERMOD meteorological processor (AERMET), the meteorological data were not reprocessed using the version released in December 2013; instead, the meteorological data that were previously processed with AERMET version 12345 were again employed in the revised modeling.

2.1 AERMOD Impact Analysis

Table 1 summarizes the air quality standards and thresholds to which the project is subject.

Table 1. Air Quality Significance Levels, Standards, and Increments

Averaging Period/ Pollutant	Class II Modeling Significant Impact Level (μg/m³)	Class II PSD Increment (μg/m³)	Class I Modeling Significant Impact Level (μg/m³)	Class I PSD Increment (μg/m³)	Limiting National or Arizona Ambient Air Quality Standard (μg/m³)
1-hour NO_2	7.5	NA	NA	NA	188.7[a] (100 ppb)
Annual NO_2	1	25	0.1	2.5	100
1-hour SO_2	8	NA	NA	NA	196.4[b] (75 ppb)
3-hour SO_2	25	512[c]	1.0	25[c]	1,300[c]
24-hour SO_2	5	91[c]	0.2	5[c]	365[c,d]
Annual SO_2	1	20	0.1	2	80[d]
24-hour PM_{10}	5	30[e]	0.3	8[e]	150[e]
Annual PM_{10}	1	17	0.2	4	50[f]
24-hour $PM_{2.5}$	1.2	9[c]	0.07	2[c,]	35[g]
Annual $PM_{2.5}$	0.3	4	0.06	1	12[h]
1-hour CO	2,000	NA	NA	NA	40,000[c]
8-hour CO	500	NA	NA	NA	10,000[c]

Note: Lead and ozone standards not shown. Project will not emit significant amounts of lead; ozone is more appropriately modeled in regional analyses.

[a] The 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations must not exceed the standard.

[b] The 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations must not exceed the standard.

[c] Not to be exceeded more than once per year.

[d] National standard will be revoked following a transition period.

[e] Not to be exceeded more than once per year on average over three years.

[f] National standard revoked effective December 17, 2006; annual Arizona Ambient Air Quality Standard (AAAQS) is still listed at R18-2-201(A)(1)(a).

[g] The 3-year average of the 98th percentile of 24-hour concentrations must not exceed the standard.

[h] Revised standard promulgated December 14, 2012. The 3-year average of the weighted annual mean must not exceed the standard.

Notes:

μg/m³	=	Micrograms per cubic meter
CO	=	Carbon monoxide
NA	=	Not applicable
NO_2	=	Nitrogen dioxide
PM_{10}	=	Particulate matter less than 10 micrometers
$PM_{2.5}$	=	Particulate matter less than 2.5 micrometers
ppb	=	Parts per billion
PSD	=	Prevention of Significant Deterioration
SO_2	=	Sulfur dioxide

In accordance with the US Environmental Protection Agency's (EPA's) guidance on modeling intermittent sources (EPA 2011), the fire pump and auxiliary boiler were not included in the 1-hour sulfur dioxide (SO_2) or nitrogen dioxide (NO_2) modeling but were included in modeling all other pollutants and averaging periods.

The best available control technology (BACT) proposed in the September 2013 permit application was based on using low-NO_X burners. The auxiliary boiler specifications have been changed to the use of ultra low-NO_X burners. As a result, NO_x emissions from the auxiliary boiler have decreased from those modeled in the original application. The emissions used for modeling all sources and scenarios are shown in Appendix A to this Addendum.

For the combustion turbines, exit temperature and exit velocity will vary slightly with whether or not the duct burners are operating, during startup and shutdown, with load, and with ambient temperature. Screening analyses conducted to determine the worst-case dispersion conditions that lead to the highest impacts for a given emission rate and operating scenario were revised using AERMOD version 13350. The load screening results showed only very minor changes from those resulting from AERMOD 12345 and did not change the conclusions regarding worst-case dispersion conditions; therefore, the same combinations of emissions and stack parameters were used in the revised modeling. Load screening files have been provided to ADEQ with this report.

2.2 In-Stack Ratios

The Plume Volume Molar Ratio Method (PVMRM) option in AERMOD was used to account for the after stack conversion of emitted NO_x to downwind NO_2. This option requires use of an in-stack ratio (ISR) for each source. The California Air Pollution Control Officers Association (CAPCOA) has produced a guidance document titled "Modeling Compliance of the Federal 1-Hour NO_2 NAAQS" (CAPCOA 2011) that includes recommended in-stack ratios in Appendix C to that report. The following recommended in-stack NO_2/NO_x ratios were used for the Bowie sources:

- The natural gas boiler default factor of 0.1 was used for the auxiliary boiler;
- The diesel internal combustion engine default factor of 0.2 was used for the fire pump; and
- The GE natural gas turbine recommended ratio of 0.091 was used for the turbines/HRSGs.

ADEQ requested additional information regarding the choice of in-stack ratios to use in the modeling. No vendor information is available regarding NO2/NOx ISRs for the Bowie Power Station turbines, fire pump, or auxiliary boiler. An Internet search was conducted for additional information regarding ISRs. In addition, the Web sites of the California Energy Commission (CEC; California), California Air Resources Board (CARB; California), San Joaquin Valley Unified Air Pollution Control District (SJUVAPCD; California), Bay Area Air Quality Management District (BAAQMD; California), South Coast Air Quality Management District (SCAQMD; California), and Texas Commission on Environmental Quality (TCEQ; Texas) were searched for ISR data and modeling guidance documents were reviewed. No new applicable data or guidance were found.

EPA has compiled two databases of ISR data from source testing. The NO2_ISR_database.xlsx file contains NO2 ISR data that has been submitted via the formal collection process initiated by EPA's Office of Air Quality Planning and Standards (OAQPS). The NO2_ISR_alpha_database.xlsx file contains NO_2 ISR values collected by various regional, state, and local air permitting offices prior to the formal collection initiated by OAQPS. While this database contains a large number of entries, none fully satisfy the requirements for the formal collection effort.

2.2.1 Bowie Power Station Turbines

The Bowie Power Station will use two GE Frame 7FA Model 4 natural gas-fired combustion turbines using SCR for NO_x control. The ISR used in the modeling analysis assumed the GE turbine default value of 0.091 for GE turbines from the Appendix C of the CAPCOA guidance document. The NO2_ISR_database contains no data for natural gas-fired, GE turbines. The NO2_ISR_alpha_database, however, has 39 GE Frame 7FA with SCR source tests listed. All ratios listed were well below 0.091 (maximum 0.0101, average 0.0069), suggesting that a ratio of 0.091 is appropriate and conservative.

2.2.2 Bowie Power Station Auxiliary Boiler

The Bowie Power Station will include a natural gas-fired, 50 MMBtu/hr auxiliary boiler using ultra-low NO_x burners. The ISR used in the modeling analysis was the natural gas boiler default value of 0.1 from the CAPCOA data. The NO2_ISR_database has no natural gas-fired boilers listed. The NO2-ISR_alpha_databse has a number of natural gas boiler source tests; however, none use ultra-low NO_x burners and boiler size is uncertain in most cases. The average ISR from these tests was 0.0685 (range 0.0-0.1579). The CAPCOA ISR value for this source was retained.

2.2.3 Bowie Power Station Diesel Fire Pump Engine

The Bowie Power Station will include a 260 horsepower (hp) diesel fire pump engine. The modeling analysis used an ISR value of 0.2, the CAPCOA default for diesel engines. The NO2_ISR_database contains several diesel engine source tests, all from engines larger than the Bowie Power Station's fire pump. The average ISR from these source tests for diesel engines that did not use NO_x control is 0.065 (range 0.022-0.22). The NO2_ISR_alpha_database also contains several diesel engine source tests. For diesel engines less than 500 hp with no NO_x control technology, the average ISR is 0.166 (range 0.0-0.5; note that the 0.5 ISR value results from a series of source tests that only recorded NO_2 and NO_x values as integer [whole number] parts per million values). Again, the CAPCOA value is appropriate based on this information.

2.3 Revised Preliminary Analysis Results

Table 2 presents the results of the preliminary analysis using AERMOD version 13350. All impacts shown are the maximum impacts (1st high impacts) over the receptor grid.

2.4 Full Impact Analysis

A full impact analysis was performed for 1-hour NO_2, the only pollutant and averaging period for which the preliminary analysis predicts an impact above the modeling significant impact level (SIL). The full impact analysis used the updated AERMOD version 13350. The receptors modeled were limited to those that showed a maximum impact above the 1-hour NO_x SIL in the preliminary (Bowie Power Station only) analysis.

ISR options for the additional sources modeled in the full impact analysis were examined.

2.4.1 Pistachio Corporation of Arizona

The Pistachio Corporation of Arizona facility has a variety of natural gas-fired equipment, including roasters, dryers, and silos. The EPA default ISR of 0.5 was used for the roaster and silos, while the maximum of the source test data for natural gas-fired dryers in the CAPCOA document was rounded up to an ISR of 0.12. Neither of the EPA ISR databases contain any data for these types of sources.

Table 2. Results of Preliminary Class II Analysis

Averaging Period/ Pollutant	Maximum Predicted Impact ($\mu g/m^3$)	Class II Modeling Significance Level ($\mu g/m^3$)	Significant Monitoring Level ($\mu g/m^3$)
1-hour NO_2	84.34	7.5	NA
Annual NO_2	0.27	1	14
1-hour SO_2	5.23	8	NA
3-hour SO_2	1.75	25	NA
24-hour SO_2	0.35	5	NA
Annual SO_2	0.06	1	NA
24-hour PM_{10}	1.81	5	10
Annual PM_{10}	0.26	1	NA
24-hour $PM_{2.5}$	1.07	1.2	NA
Annual $PM_{2.5}$	0.16	0.3	NA
1-hour CO	439.4	2,000	NA
8-hour CO	85.10	500	575

Notes:

$\mu g/m^3$ = Micrograms per cubic meter
CO = Carbon monoxide
NA = Not applicable
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter less than 10 micrometers
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers

2.4.2 El Paso Natural Gas (EPNG) Willcox and Bowie Compressor Stations

Two compressor stations were included in the cumulative modeling. The sources were GE natural gas-fired turbines (two, GE M3142R-J turbines at the Willcox Compressor Station and one, GE M3122R turbine at the Bowie Compressor Station). The CAPCOA default ISR for GE turbines of 0.091 was used. As noted previously, the NO2_ISR_database has no entries for natural gas-fired GE turbines. The NO2-ISR_alpha_database contains ISR data for several hundred natural gas-fired GE turbines, including a variety of models and NO_x control technologies. All ISR values are less than the 0.091 ISR that was used in the modeling (average 0.0582, range 0.0-0.0825).

2.4.3 Apache Generating Station

The Apache Generating Station has a number of emission units that were included in the cumulative analysis. While several have the ability to use multiple fuels, the fuels with the highest NOx emissions were modeled.

Steam unit 1 is a 75 MW natural gas-fired unit. The CAPCOA natural gas boiler default ISR of 0.1 was used for this unit. The NO2_ISR_database has no entries for natural gas boilers. The NO2-ISR_alpha_database has a number of natural gas boilers of uncertain size; the average ISR is 0.0685, range 0.0-0.1579.

Steam units 2 and 3 are 195 MW coal-fired units. The EPA default ISR of 0.5 was used for these units. The NO2_ISR_database contains source data for two source tests on smaller coal-fired boilers (around 96 MW). The resulting ISR values are 0.0054 and 0.0153, well below the 0.5 ISR used in the Bowie modeling. The NO2_ISR_alpha_database does not contain any data on coal-fired units.

The Apache Generating Station has three simple-cycle peaking turbines that are oil-fired, ranging from 10.4 to 64.9 MW. The NO2_ISR_database contains one source test for an oil-fired turbine, a GE

Frame 7, with an ISR of 0.00355. No data for oil-fired turbines are included in the NO2_ISR_alpha_ database. The EPA default ISR of 0.5 was used for these units.

A fourth simple-cycle turbine (44 MW) fires a combination of natural gas and diesel. No data for this combination of fuels was found in either database and the EPA default ISR of 0.5 was used for this unit.

The station also has a diesel startup engine (430 hp). The same analysis applies to this unit as delineated above for the Bowie Power Station 260 hp fire pump. An ISR of 0.2, the CAPCOA default for diesel engines, was used.

2.5 Full Impact Analysis Results

The 98th percentile (high, 8th high) of the daily maximum 1-hour values from the Bowie project plus other nearby sources was modeled. Background NO_2 concentrations that vary by season and hour of the day (see Table 3) were added to the combined impact within the model. The total maximum 98th percentile (high, 8th high) of the daily maximum concentrations, including background, has been compared with the 1-hour NO_2 standard.

Table 3. Background Concentrations for 1-Hour NO_2 Analysis

Hour of the Day	Winter (ppm)	Spring (ppm)	Summer (ppm)	Fall (ppm)
1	0.0190	0.0163	0.0130	0.0183
2	0.0177	0.0143	0.0133	0.0150
3	0.0180	0.0147	0.0130	0.0153
4	0.0173	0.0150	0.0130	0.0160
5	0.0177	0.0177	0.0140	0.0167
6	0.0167	0.0197	0.0140	0.0177
7	0.0177	0.0200	0.0130	0.0183
8	0.0183	0.0177	0.0097	0.0180
9	0.0183	0.0127	0.0067	0.0163
10	0.0163	0.0060	0.0040	0.0120
11	0.0120	0.0030	0.0033	0.0050
12	0.0063	0.0017	0.0030	0.0033
13	0.0043	0.0013	0.0027	0.0023
14	0.0033	0.0013	0.0023	0.0023
15	0.0030	0.0010	0.0023	0.0020
16	0.0027	0.0010	0.0027	0.0020
17	0.0040	0.0013	0.0023	0.0030
18	0.0093	0.0020	0.0027	0.0090
19	0.0183	0.0057	0.0040	0.0193
20	0.0253	0.0117	0.0077	0.0263
21	0.0247	0.0203	0.0147	0.0267
22	0.0247	0.0220	0.0157	0.0250
23	0.0233	0.0243	0.0173	0.0223
24	0.0200	0.0173	0.0190	0.0200

Notes:
NO_2 = Nitrogen dioxide
ppm = Parts per million

The results indicate that the 1-hour NO_2 NAAQS would potentially be exceeded at one receptor and for up to two hours per year. The largest contributor to the potential exceedance is the Apache Generating Station.

Bowie's contribution to impacts above 90% of the NAAQS was determined using the "MAXDCONT" option in AERMOD. There were no impacts with a total concentration (including background) that exceeded 90% of the 1-hour NAAQS where Bowie's contribution was greater than 3% of the total impact; therefore, no refined grids were developed.

The maximum 1-hour NO_2 concentration predicted by the model, including background, was 192.32 $\mu g/m^3$ (the 1-hour NO_2 NAAQS is 188.7 $\mu g/m^3$). A total of two hours were predicted to exceed the NAAQS and the largest contribution to any of the potential exceedances by the Bowie Power Station was 0.00149 $\mu g/m^3$, well below the SIL of 7.5 $\mu g/m^3$. The Bowie Power Station will not cause or contribute to any exceedance of the 1-hour NO_2 NAAQS.

2.6 Increment Analysis

The preliminary analysis did not show any pollutants/averaging periods that exceeded a SIL for which Class II increments have been defined. Therefore, no increment consumption analysis was performed.

3.0 CLASS I AREA ANALYSES

At the request of ADEQ, Class I areas within 300 kilometers (km) of the Bowie Power Station, shown in Table 4, were included in the revised Class I area analyses where possible. The Petrified Forest National Park is beyond the MM5 data used in the analyses, however, and therefore this Class I area could not be included, as explained further in Section 3.1.1. The analyses were also updated using recently released updates to the CALPUFF (version 5.8.4, level 130731) and CALMET models (version 5.8.4, level 130731). CALPOST (version 6.221, level 080724) has not been updated since the September 2013 permit application.

3.1 Class I Analysis Methods

For NO_2, particulate matter less than 10 micrometers (PM_{10}), and particulate matter less than 2.5 micrometers ($PM_{2.5}$), impacts from the project were estimated within the Class I areas listed in Table 3 for comparison with Class I significance levels (there are no CO increments or Air Quality Related Values [AQRVs], and SO_2 emissions from the Bowie Power Station are below PSD significant emission rates). Project impacts on visibility and acid deposition were also assessed at these locations. Impacts on applicable AQRVs, deposition, and increments were calculated at Federal Land Manager (FLM)-provided Class I area receptor locations, converted to the appropriate grid locations.

An analysis of the proposed source's effect on Class I increments and AQRVs in the Class I areas beyond 50 km from the Bowie Power Station was made using CALPUFF. Although the nearest boundary of the Chiricahua Wilderness Area (WA) is approximately 47 km from the project site, the farthest edge is approximately 77 km. CALPUFF was applied for the Bowie project to estimate impacts at the Chiricahua WA, including for receptors within 50 km of the Bowie project site.

Given that Chiricahua National Monument (NM) lies completely within 50 km of the project site, however, only AERMOD was used to predict impacts for comparison with the NO_2, PM_{10}, and $PM_{2.5}$ Class I significance levels at this Class I area. Deposition impacts at this Class I area were assessed with CALPUFF because AERMOD lacks the required chemical processing capabilities for this type of impact analysis.

Table 4. Class I Areas within 300 Kilometers of Bowie Power Station

Areas	Approximate Distance from Project Site (kilometers)	Federal Land Manager
Chiricahua National Monument Arizona	38	National Park Service
Chiricahua Wilderness Area, Arizona	47	USDA Forest Service
Galiuro Wilderness Area, Arizona	73	USDA Forest Service
Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona	99	National Park Service
Gila Wilderness Area. New Mexico	116	USDA Forest Service
Superstation Wilderness Area, Arizona	185	USDA Forest Service
Sierra Ancha Wilderness Area, Arizona	201	USDA Forest Service
Pine Mountain Wilderness Area, Arizona	256	USDA Forest Service
Petrified Forest National Park	275	National Park Service
Bosque del Apache National Wildlife Refuge	280	US Fish and Wildlife Service

Notes:
USDA = US Department of Agriculture

VISCREEN was used to assess visibility impacts in the Chiricahua NM and Fort Bowie National Historic Site, a Class II area located approximately 23 km to the south-southeast of the proposed project location, for the September 2013 permit application. Because there have been no version changes in VISCREEN since the permit application and the only emissions changes in the project are a decrease in NO_x emissions from the auxiliary boiler, these analyses have not been revised.

3.1.1 CALMET

The CALPUFF model relies on meteorological and geophysical inputs to provide land use, terrain, and wind and temperature field parameters. These inputs are provided by the CALMET program, which processes the varying geophysical parameters and surface and upper air measurements into CALPUFF-ready formats.

There are several steps needed to provide this CALPUFF-ready format and include developing terrain and land use information (geo.dat), compilation of surface meteorological parameters (surf.dat), upper air data (ua.dat), and surface measured precipitation data (precip.dat). Augmenting the upper air data is a set of diagnostic wind, temperature, and other parameter fields available from mesocale modeled (MM) domains such as MM5.

The CALMET processor was initially run in 2007 in accordance with a protocol submitted to the ADEQ for a previous Bowie project. The initial modeling domain was less extensive than currently requested as the domain consisted of a 75 by 60, 4-km gridded domain which extended outward to include the nearest Class I areas. ADEQ has requested that additional Class I areas out to 300 km distance from the project location be included in the updated analysis. Therefore the base grid was modified to include all but Petrified Forest National Park as the park receptors were beyond the MM5 data originally used. Given the distance and intervening terrain between the Bowie project site and the Petrified Forest National Park and the inclusion of other Class I areas at similar distances from the project, impacts at the other distant Class I areas should suffice as reasonable surrogates for impacts at the Petrified Forest National Park.

The input files (MM5, surface and upper air meteorological and precipitation data) used in support of the 2007 CALMET processing were also used for the current assessment. The MM5 data sets used in the 2007 CALMET processing were based on the 2001 EPA 36 km MM5 data set, the 2002 Western Regional Air Partnership (WRAP) 12 km MM5 data set, and the 2003 Midwest Regional Planning Organization (MRPO) 36 km MM5 data set. CALMET was run for each month for the two years with 36-km MM data but for every two weeks for the single year (2002) with 12-km MM data.

These data sets were used in an approved manner as input to CALMET along with four surface meteorological stations (DUG, SAD, SUC, and TUS), one upper air station (TUS), and 11 precipitation stations. The updated Lambert Conformal Coordinate (LCC) projected domain consisted of 127 NX grid cells and 92 NY grid cells spaced 4 km apart, in accordance with recent EPA guidance. The domain is shown in Figure 1, which also shows the location of Bowie Power Station (red star), the location of nearby Class 1 areas included in the analysis (green), the location of the meteorological stations (orange), the location of the precipitation stations (blue), and the surrounding terrain (shaded relief). As seen in the figure, the Bowie Power Station site is located near several of the Class I areas and available meteorological data are located on four sides of the project site. Not shown in the figure are the varying 36- and 12-km MM5 locations that are extracted in accordance with the CALMET grid dimensions from overlying data.

In reprocessing the meteorological and terrain and land use data in the most recent EPA-approved version of CALMET, the default values listed in the recent CALMET guidance (Tyler Fox, August 31, 2009 Memorandum: "Clarification on EPA- FLM Recommended Settings for CALMET"; EPA 2009) were used. The CALMET data were reprocessed for 2001-2003 using the current regulatory version of the model (version 5.8.4, level 130731) in accordance with the revised guidance using the switch settings as recommended in the EPA memorandum. All CALMET input files are being provided with this Addendum, including the meteorological data files (surf, precip, ua) and geophysical files (geo). The CALMET output file was used in CALPUFF along with the same grid settings.

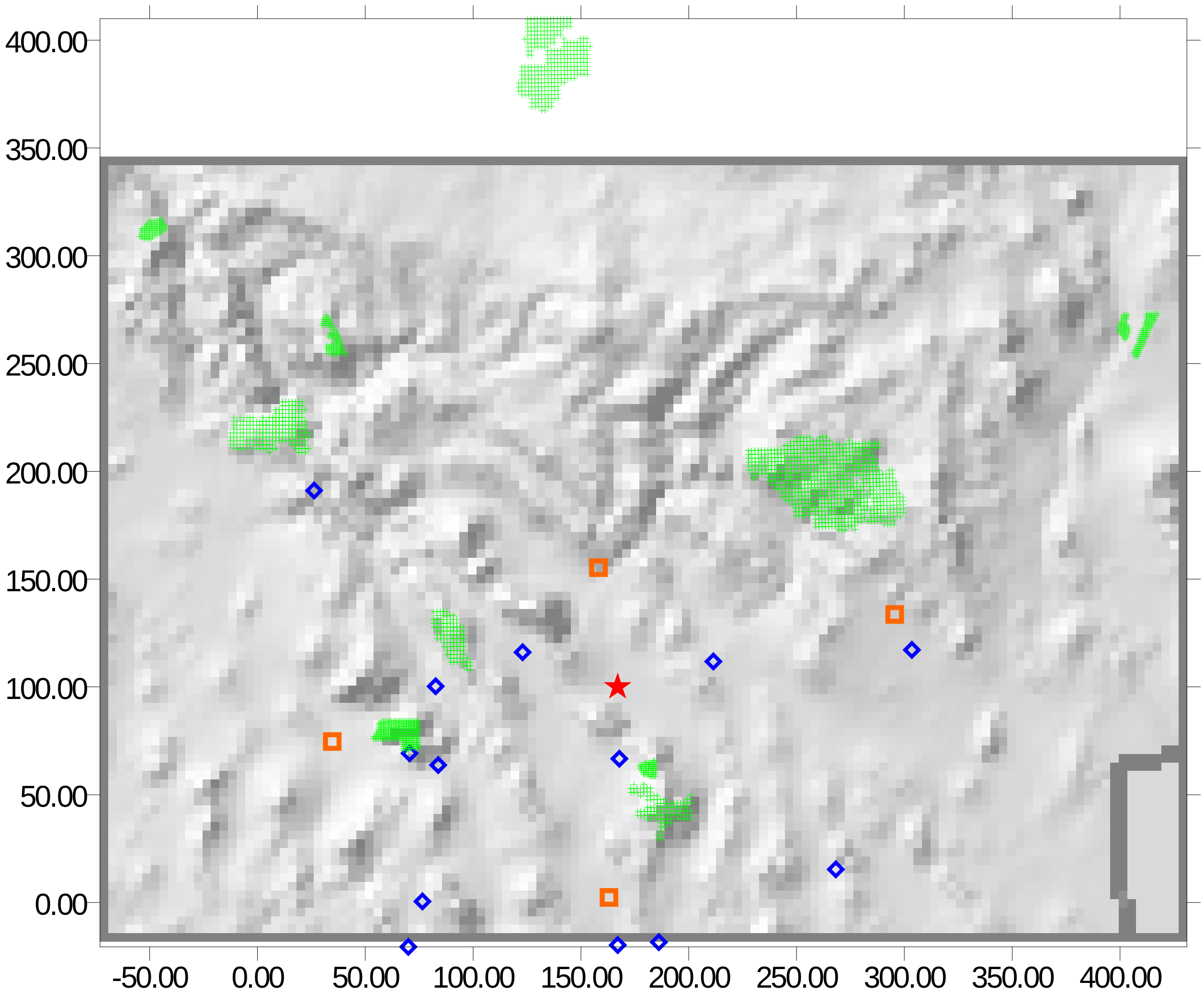
3.1.2 Emissions and Stack Parameters

To determine compliance with Class I significance levels (increments), the Bowie Power Station sources was modeled using the emission scenarios and stack parameters described in the September 2013 permit application, with the exception of NO_x emissions from the auxiliary boiler. Auxiliary boiler NO_x emissions were reduced from the September 2013 permit application by the use of ultra-low NO_x burners (see Appendix A).

3.2 Class I Significant Impact Analysis Results

Maximum impacts predicted in each Class I area for each pollutant and averaging period were compared to the Class I significance levels. The results are shown in Table 5.

Because no maximum Class I impact exceeded a SIL, no Class I increment consumption analysis was performed. Because no maximum impact exceeded 90% of any SIL value, no refined receptor grids were developed.



Green = Class I areas

Red = Bowie Power Station

Orange = Meteorological stations

Blue = Precipitation measurements

Figure 1. CALPUFF Modeling Domain

Table 5. Results of Class I Significant Impact Analysis

Averaging Period/ Pollutant	Annual NO_2 ($\mu g/m^3$)	24-hour PM_{10} ($\mu g/m^3$)	Annual PM_{10} ($\mu g/m^3$)	24-hour $PM_{2.5}$ ($\mu g/m^3$)	Annual $PM_{2.5}$ ($\mu g/m^3$)
Class I Significant Impact Level ($\mu g/m^3$)	0.1	0.3	0.2	0.07	0.06
Chiricahua National Monument Arizona[a]	0.002	0.013	0.001	0.012	0.001
Chiricahua Wilderness Area, Arizona[b]	0.009	0.122	0.005	0.016	0.006
Galiuro Wilderness Area, Arizona[b]	0.005	0.037	0.003	0.003	0.0002
Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona[b]	0.0006	0.016	0.0004	0.0006	0.00002
Gila Wilderness Area. New Mexico[b]	0.0006	0.014	0.0004	0.0009	0.00003
Superstation Wilderness Area, Arizona[b]	0.0004	0.013	0.0006	0.0003	0.00001
Sierra Ancha Wilderness Area, Arizona[b]	0.0001	0.006	0.0002	0.0002	0.00001
Pine Mountain Wilderness Area, Arizona[b]	0.00002	0.003	0.00008	0.00007	0.000001
Bosque del Apache National Wildlife Refuge[b]	0.00006	0.002	0.0001	0.0001	0.000003

[a] Maximum impacts for 1-year of site-specific meteorological data determined with AERMOD
[b] Maximum impacts for 2001-2003 as determined with CALPUFF/CALPOST

Notes:

$\mu g/m^3$ = Micrograms per cubic meter
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter less than 10 micrometers
$PM_{2.5}$ = Particulate matter less than 2.5 micrometer

3.3 Nitrogen Deposition

The CALPUFF model was used to estimate nitrogen deposition within the respective Class I areas (to accommodate the atmospheric chemistry, CALPUFF was used to assess deposition within Chiricahua NM as well). CALPOST was used to calculate annual aggregate species values to compare to deposition analysis thresholds. Deposition values were compared to the NPS Deposition Analysis Thresholds (DATs) for the western United States of 0.005 kilograms per hectare per year (kg/ha/yr). The results of the analysis are shown in Table 6.

Table 6. Deposition Impacts

Deposition	Total Nitrogen 2001 (kg/ha/yr)	Total Nitrogen 2002 (kg/ha/yr)	Total Nitrogen 2003 (kg/ha/yr)	Deposition Analysis Threshold (kg/ha/yr)
Chiricahua National Monument Arizona[a]	0.0011	0.0010	0.0016	0.005
Chiricahua Wilderness Area, Arizona[b]	0.0015	0.0014	0.0021	0.005
Galiuro Wilderness Area, Arizona[b]	0.0013	0.0011	000013	0.005
Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona[b]	0.0002	0.0002	0.0002	0.005
Gila Wilderness Area. New Mexico[b]	0.0002	0.0002	0.0001	0.005
Superstation Wilderness Area, Arizona[b]	0.0001	0.0001	0.0002	0.005
Sierra Ancha Wilderness Area, Arizona[b]	0.00009	0.0002	0.0001	0.005
Pine Mountain Wilderness Area, Arizona[b]	0.00002	0.00003	0.00005	0.005
Bosque del Apache National Wildlife Refuge[b]	0.00003	0.00003	0.00002	0.005

Notes:
kg/ha/yr = Kilogram per hectare per year

3.4 Visibility Impacts beyond 50 Kilometers

The results of the visibility assessment using the CALPUFF modeling system are shown in Tables 7 and 8. No “bright line” standards have been defined that determine whether a change in light extinction is acceptable or unacceptable. Decisions regarding the importance of a predicted effect are made on a case-by-case basis by the FLM responsible for a given Class I area. FLM policy has generally considered impacts below 5% to be insignificant, while impacts above 10% may be considered unacceptable. All results are below 10% change in light extinction, while there were two days between 5% and 10% over the three years modeled at Chiricahua Wilderness Area. All results at all other Class I areas were below 5% change in light extinction.

Table 7. Visibility Analysis Maximum Change

Change in Light Extinction	Maximum % Change 2001	Maximum % Change 2002	Maximum % Change 2003
Chiricahua Wilderness Area, Arizona	3.13	4.03	7.17
Galiuro Wilderness Area, Arizona	2.82	2.46	2.55
Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona	0.73	1.31	1.33
Gila Wilderness Area. New Mexico	0.59	0.98	0.54
Superstation Wilderness Area, Arizona	0.72	0.64	0.87
Sierra Ancha Wilderness Area, Arizona	0.48	0.59	0.52
Pine Mountain Wilderness Area, Arizona	0.25	0.12	0.21
Bosque del Apache National Wildlife Refuge	0.20	0.20	0.24

Note:
% = Percent

Table 8. Visibility Analysis Results

Change in Light Extinction	Days >5%/10% Change 2001	Days >5%/10% Change 2002	Days >5%/10% Change 2003
Chiricahua Wilderness Area, Arizona	0/0	0/0	2/0
Galiuro Wilderness Area, Arizona	0/0	0/0	0/0
Saguaro National Park East Unit/ Saguaro Wilderness Area, Arizona	0/0	0/0	0/0
Gila Wilderness Area. New Mexico	0/0	0/0	0/0
Superstation Wilderness Area, Arizona	0/0	0/0	0/0
Sierra Ancha Wilderness Area, Arizona	0/0	0/0	0/0
Pine Mountain Wilderness Area, Arizona	0/0	0/0	0/0
Bosque del Apache National Wildlife Refuge	0/0	0/0	0/0

Note:
% = Percent

4.0 ADDITIONAL SECONDARY $PM_{2.5}$ ANALYSIS

Due to the potentially large contributions of secondary $PM_{2.5}$ to total ambient $PM_{2.5}$ concentrations, EPA has provided draft guidance that includes analyses of both primary and secondary $PM_{2.5}$ from proposed new major sources, such as the Bowie Power Station (EPA 2013). AERMOD was used to analyze primary $PM_{2.5}$ emissions, while potential secondary $PM_{2.5}$ from emissions of precursors (NO_x, SO_2) from the project was assessed using CALPUFF. The September 2013 permit application contained an analysis and discussion of the results.

At the request of ADEQ, additional information has been developed using the results of the updated AERMOD primary $PM_{2.5}$ analysis and the updated CALPUFF secondary $PM_{2.5}$ (sulfate, nitrate) analysis. The analysis was developed to evaluate whether secondary $PM_{2.5}$ contributions from sulfate and nitrate formation, in conjunction with primary $PM_{2.5}$ impacts, might cause or contribute to a PSD increment exceedance or, with background concentrations of $PM_{2.5}$, a NAAQS/AAAQS exceedance.

Examination of the maximum direct impacts of $PM_{2.5}$ emitted by the Bowie Power Station shows that the highest annual and 24-hour impacts would occur close to the facility (<1 km from the turbine stacks). In contrast, maximum sulfate and nitrate concentrations, on both a short-term and annual basis, would occur further downwind.

A CALPUFF receptor grid was developed that matched the Class II area receptor grid used for AERMOD so that primary and secondary impacts could be compared on a receptor by receptor basis. Both AERMOD and CALPUFF analyses were divided up into a number of separate runs representing different time periods to accommodate turbine emissions and stack parameters that varied with ambient temperature and CALPUFF limitations. The overall time period modeled in CALPUFF was selected to match the one-year of meteorological data used for the AERMOD analyses (4/25/2001 through 4/29/2002). The annual analyses were run in two parts (approximately eight months in 2001 and four months in 2002), with period averages calculated for each run. Two scenarios were modeled for the 24-hour analysis (see Appendix A) and each scenario was divided into six runs varying from one to three months.

Primary $PM_{2.5}$, sulfate, and nitrate were then added on a receptor by receptor basis for each of the temporal periods analyzed. Maximum sulfate and nitrate concentrations were added to the high, second high primary $PM_{2.5}$ impacts at each receptor for the 24-hour periods. For comparison with annual limits, a weighted average of the period averages from the two portions of the meteorological year modeled were generated for sulfate, nitrate, and primary $PM_{2.5}$ at each receptor and added together.

The maximum combined results for each scenario are shown in Table 9. Maximum estimated combined impacts are well below the PSD increment and NAAQS/AAAQS standard limitations. Figures 2 through 10 show isopleths of the primary and secondary maximum impacts as well as the combined isopleths.

Table 9. Results of Secondary $PM_{2.5}$ Analysis

Averaging Period/ Pollutant	Maximum Primary + Secondary $PM_{2.5}$ ($\mu g/m^3$)	Class II PSD Increment ($\mu g/m^3$)	$PM_{2.5}$ Background ($\mu g/m^3$)	Combined Impact with Background ($\mu g/m^3$)	Limiting National/Arizona Ambient Air Quality Standard ($\mu g/m^3$)
Annual $PM_{2.5}$	0.16	4	3.5[a]	3.66	12[b]
24-hour $PM_{2.5}$, Scenario 1 (with duct firing)	1.08	9[c]	9[d]	10.08	35[e]
24-hour $PM_{2.5}$, Scenario 2 (minimum compliance load)	1.05	9[c]	9[d]	10.05	35[e]

[a] Average 2009-2011 Chiricahua National Monument
[b] Average of 2009-2011 98th percentile values Chiricahua National Monument
[c] Not to be exceeded more than once per year
[d] The 3-year average of the weighted annual mean must not exceed the standard.
[e] The 3-year average of the 98th percentile of 24-hour concentrations must not exceed the standard.
Notes:
$\mu g/m^3$ = Micrograms per cubic meter
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers

5.0 SOILS AND VEGETATION ANALYSIS

The PSD regulations codified at 40 CFR 52.21(o) require the applicant to conduct an analysis of the impact that would occur to soils and vegetation of significant commercial or recreational value as a result of the project. The September 2013 permit application contained an analysis of impacts to soils and vegetation. Because the revised maximum concentrations of project pollutants in the Class II areas surrounding the Bowie Power Station did not change due to revised AERMOD (version 13350) modeling, the September 2013 analyses were not revised.

6.0 REFERENCES

CAPCOA, 2011. *Modeling Compliance of the Federal 1-Hour NO_2 NAAQS*. October 27, 2011.

EPA, 2009. Memorandum from Tyler Fox (EPA) to Regional Modeling Contacts regarding “Clarification on EPA-FLM Recommended Settings for CALMET.” August 31, 2009.

EPA, 2011. Memorandum from Tyler Fox (EPA) to Regional Modeling Contacts regarding “Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-Hour NO_2 National Ambient Air Quality Standard.” March 1, 2011.

EPA, 2013. *Draft Guidance for $PM_{2.5}$ Permit Modeling*, EPA 454/D-13/001. March 2013. Available online at www.epa.gov/scram001/guidance/guide/Draft_Guidance_for_PM25_Permit_Modeling.pdf.

NARSTO, 2004. *Particulate Matter Science for Policy Makers: A NARSTO Assessment*. Cambridge University Press, Cambridge, UK.

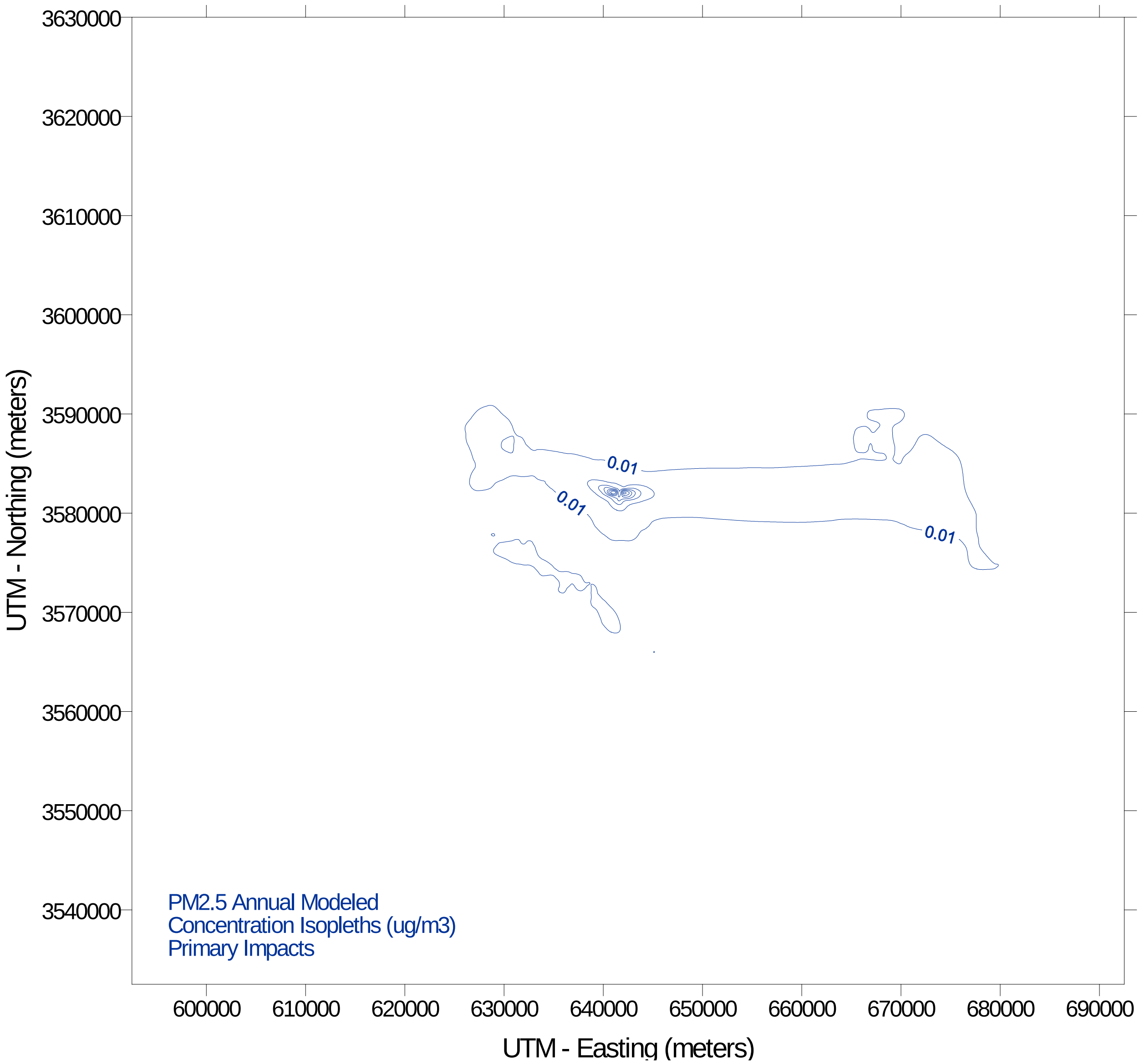


Figure 2. Annual Primary $PM_{2.5}$

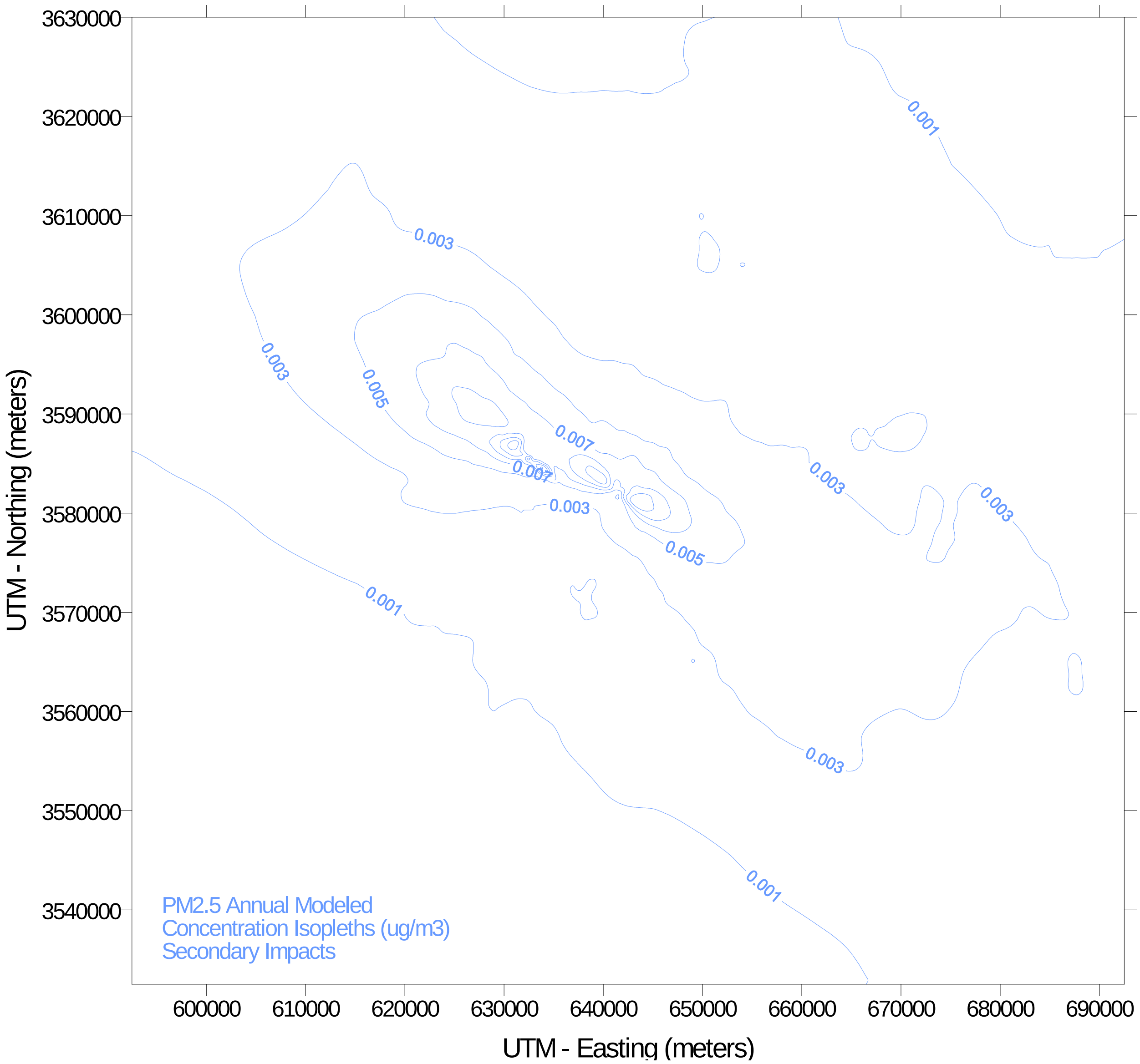


Figure 3. Annual Secondary $PM_{2.5}$

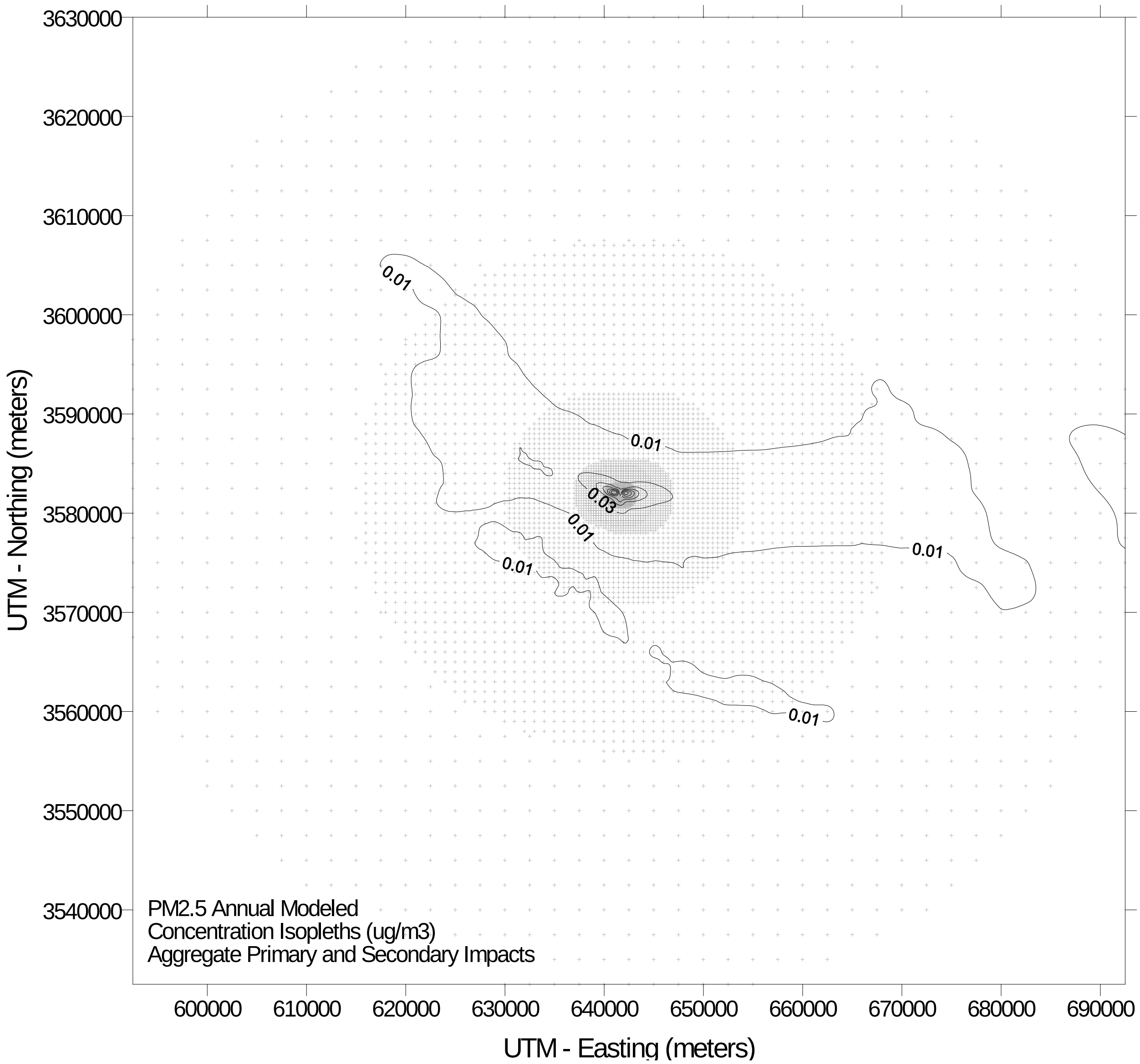


Figure 4. Annual Primary + Secondary $PM_{2.5}$

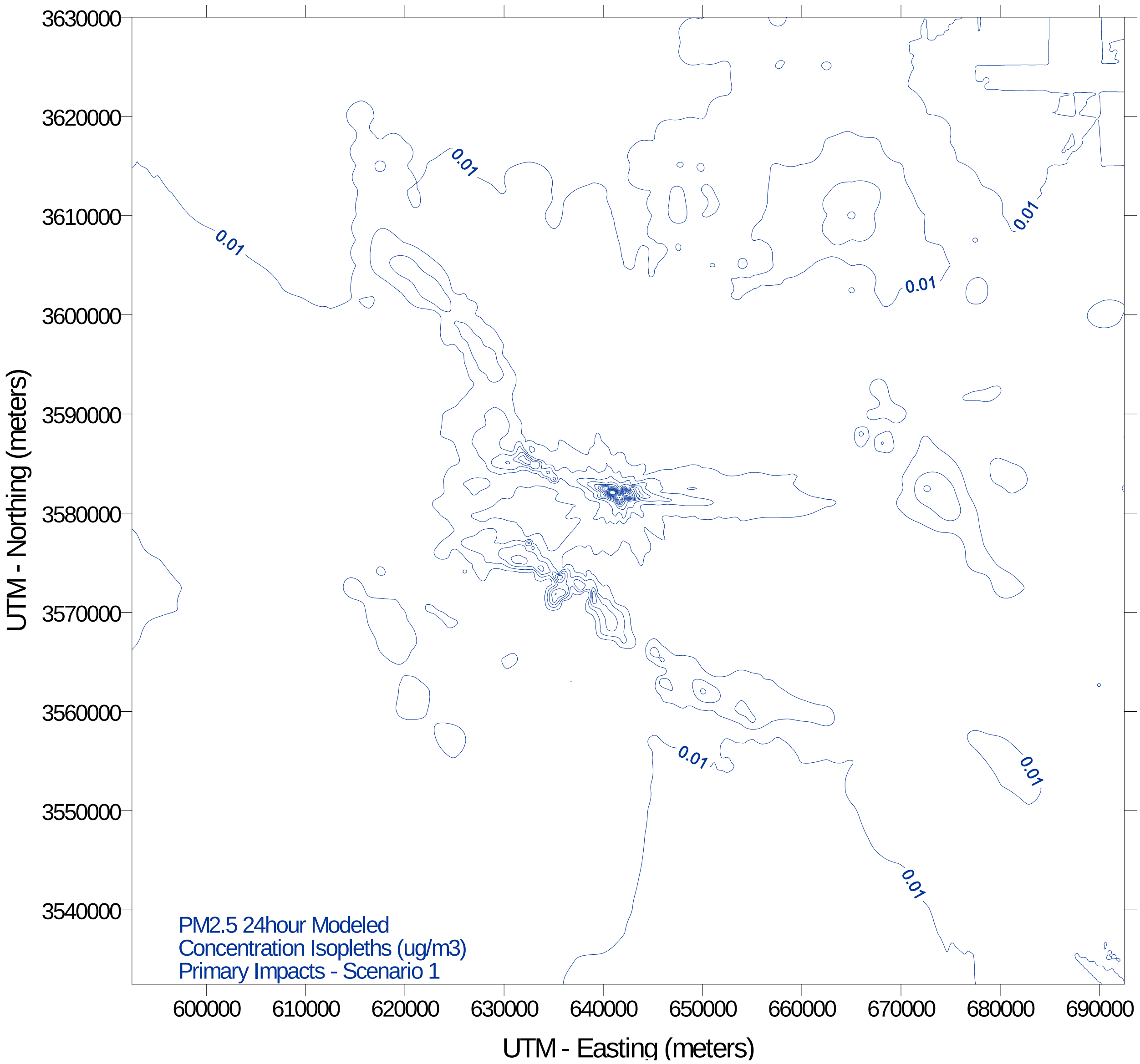


Figure 5. Scenario 1: 24-Hour Primary $PM_{2.5}$

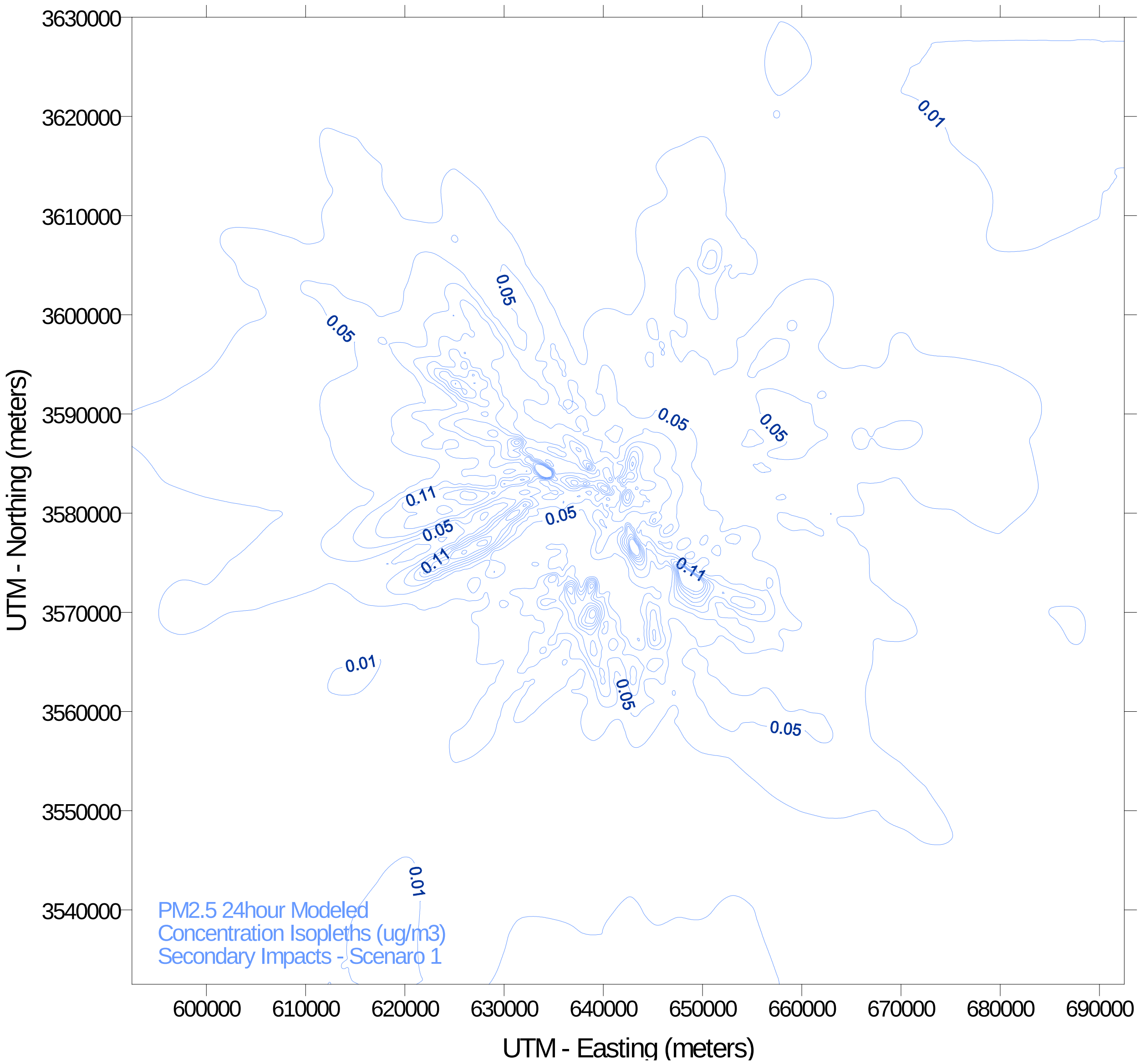


Figure 6. Scenario 1: 24-Hour Secondary $PM_{2.5}$

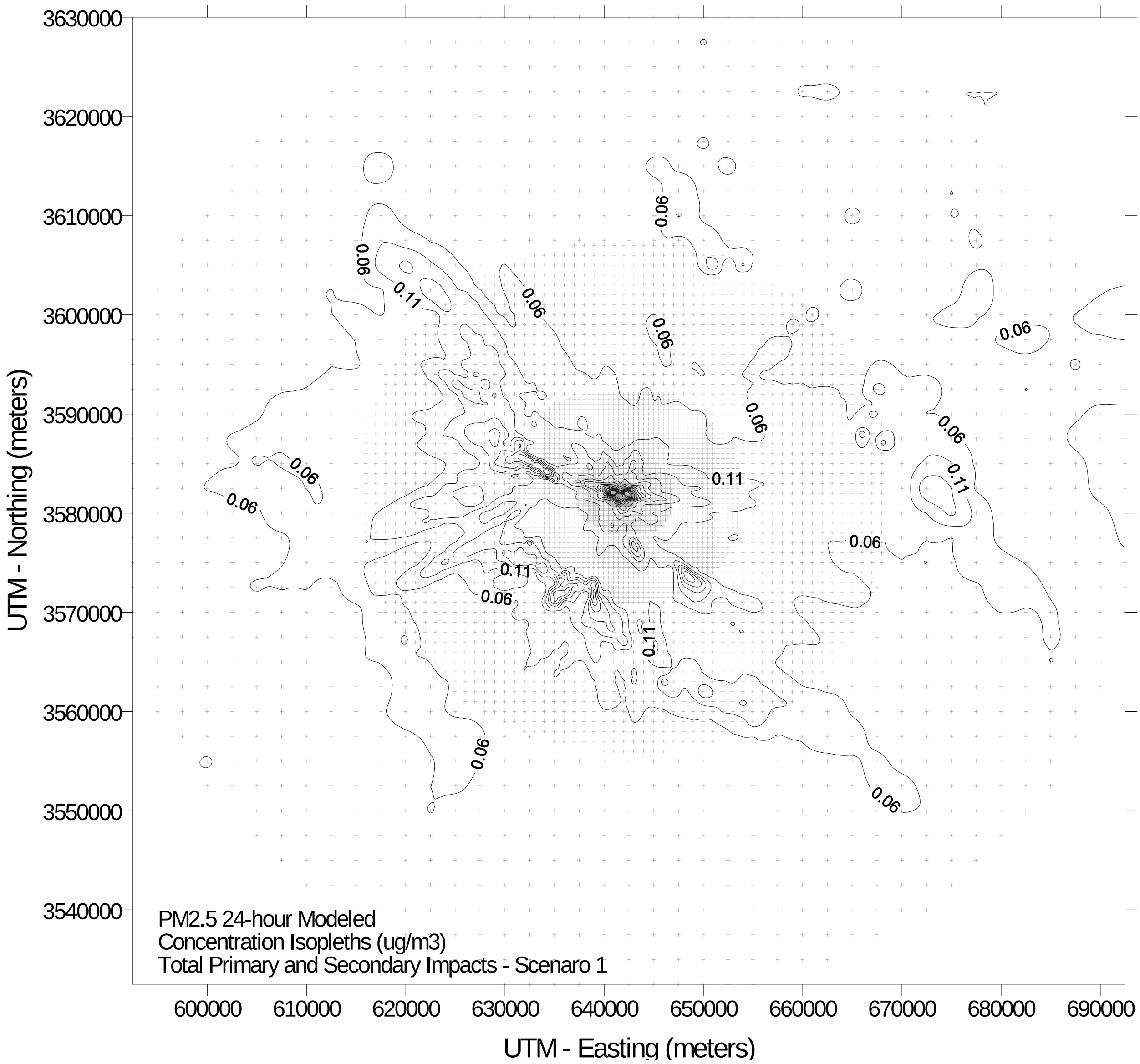


Figure 7. Scenario 1: 24-Hour Primary + Secondary $PM_{2.5}$

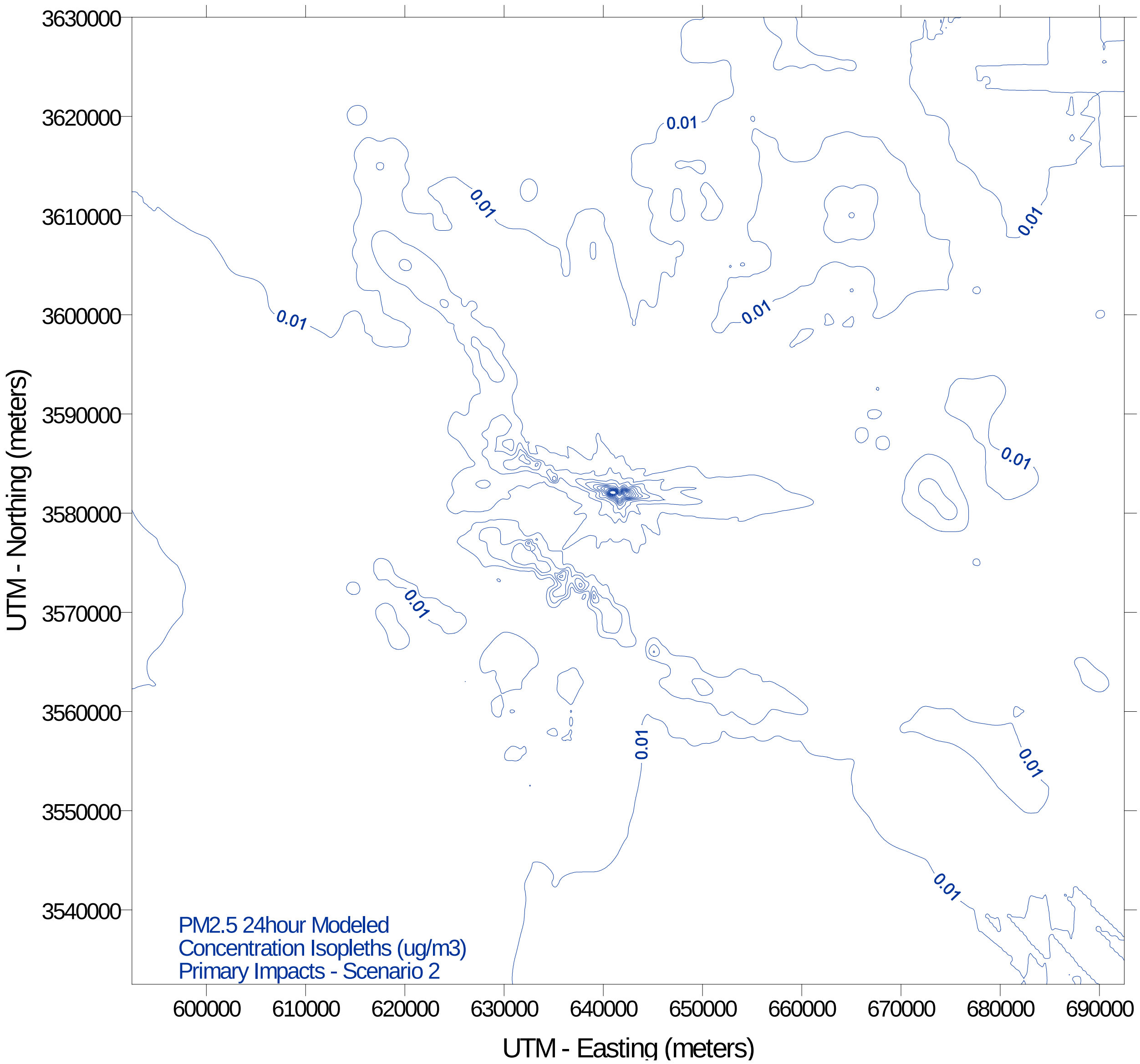


Figure 8. Scenario 2: 24-Hour Primary $PM_{2.5}$

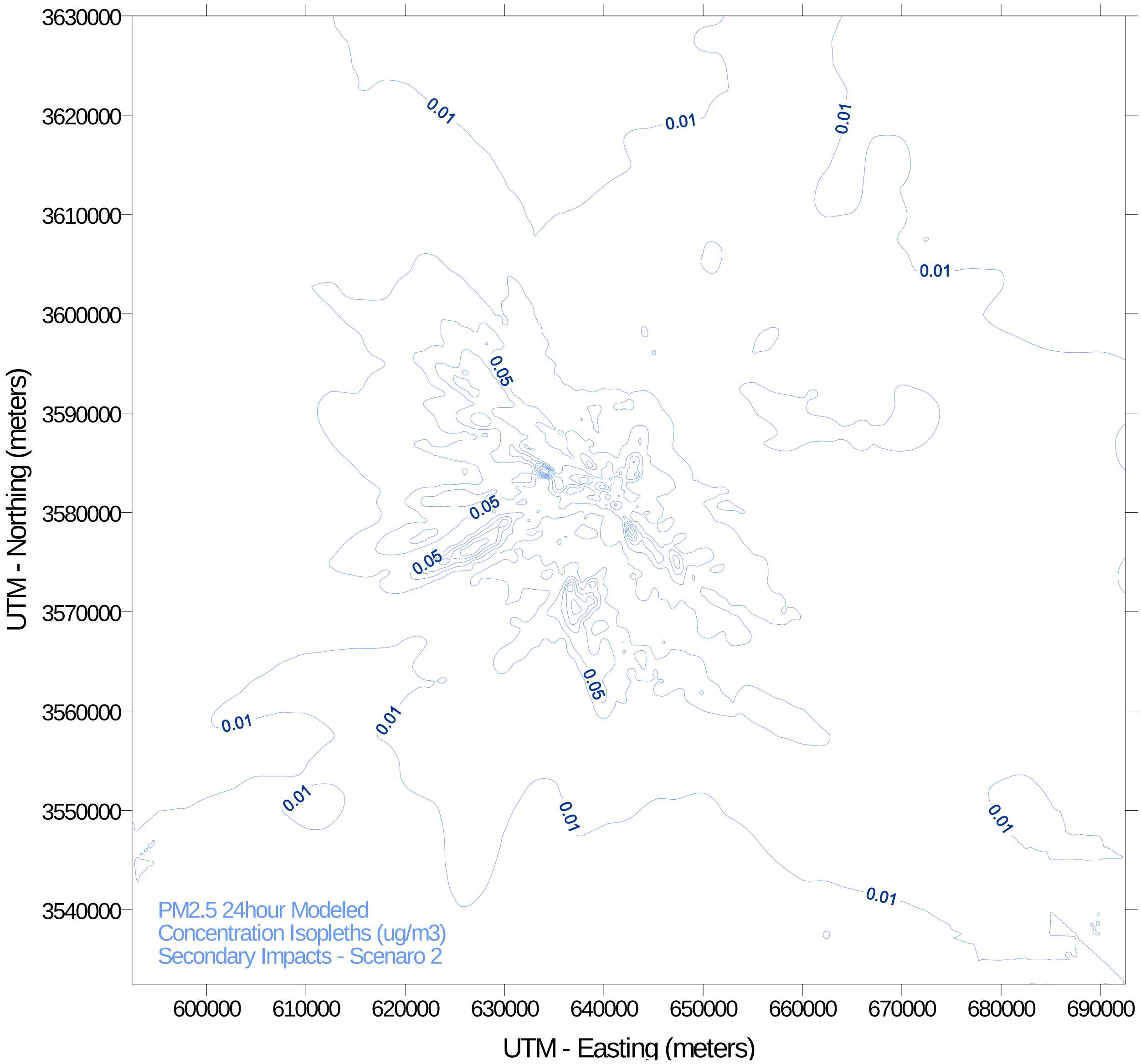


Figure 9. Scenario 2: Secondary $PM_{2.5}$

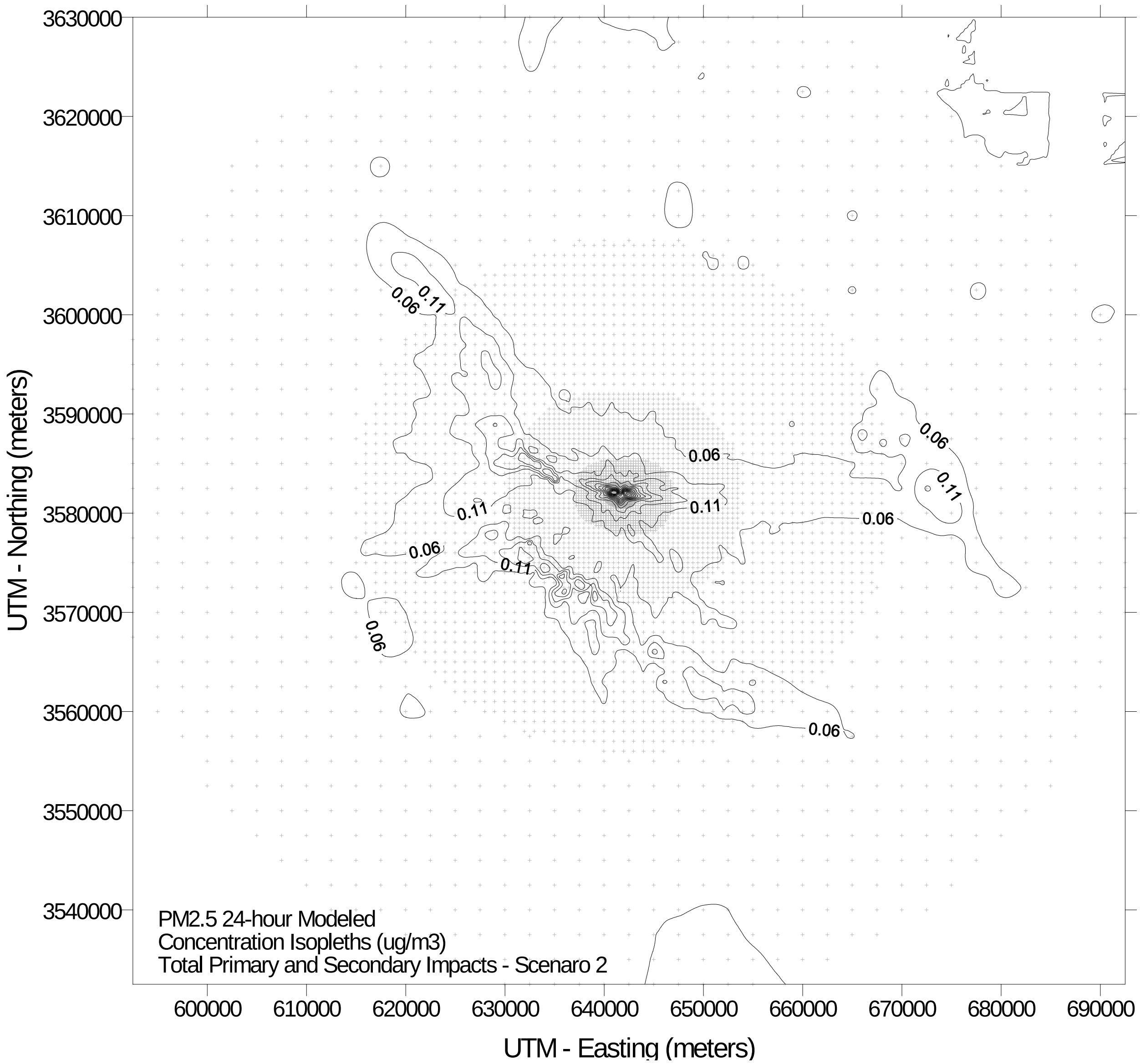


Figure 10. Scenario 2: Primary + Secondary $PM_{2.5}$

APPENDIX: MODELING DATA SUMMARY

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
NO_x	1-hour	NAAQS Vegetation and Soils Impacts	Turbines and Duct Burners	101.32	1.28E+01	54.86	354.76	17.04	5.49	Hot Start - 10^{o}F ambient used for months with average minimum temperature below freezing (December, January)	Startup Stack Parameters - 10^{o}F ambient used for months with average minimum temperature below freezing (December, January)
				87.08	1.10E+01		356.04	15.94		Hot Start - 59^{o}F ambient used for months where 10^{o}F or 102^{o}F not used (February, March, April, May, October, November)	Startup Stack Parameters - 59^{o}F ambient used for months where 10^{o}F or 102^{o}F not used (February, March, April, May, October, November)
				92.82	1.17E+01		359.04	15.12		Hot Start - 102^{o}F ambient used for months with average maximum high over 90^{o}F (June, July, August, September)	Startup Stack Parameters - 102^{o}F ambient used for months with average maximum high over 90^{o}F (June, July, August, September)
			~~Auxiliary Boiler~~	~~0.55~~	~~6.93E-02~~	~~13.70~~	~~422.04~~	~~15.24~~	~~0.76~~	~~Normal Operation~~	
	24-hour (Scenario 1) (Operating Scenario for Emissions and Stack Parameter Scenario match SO_2 and $PM_{2.5}$ scenario 1)	Secondary $PM_{2.5}$ Impacts	Turbines and Duct Burners	15.60	1.97E+00	54.86	352.71	21.33	5.49	Normal Operation - 10^{o}F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)	Normal Operation - 10^{o}F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)
				14.70	1.85E+00		352.87	19.81		Normal Operation - 59^{o}F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - 59^{o}F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				14.00	1.76E+00		353.76	18.90		Normal Operation - 102^{o}F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - 102^{o}F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.28	3.46E-02	13.70	422.04	15.24	0.76	Operation for 12 hours	
			Emergency Fire Pump	0.21	2.65E-02	10.67	809.26	65.23	0.13	Operation for 4 hours	
	24-hour (Scenario 2) (Operating Scenario for Emissions and Stack Parameter Scenario match SO2 and PM2.5 scenario 2)	Secondary $PM_{2.5}$ Impacts	Turbines and Duct Burners	9.10	1.15E+00	54.86	356.09	15.24	5.49	Normal Operation - Minimum Compliance Load 10^{o}F ambient used for months with average minimum temperature below freezing (December, January)	Normal Operation - Minimum Compliance Load 10^{o}F ambient used for months with average minimum temperature below freezing (December, January)
				7.40	9.32E-01		355.32	13.11		Normal Operation - Minimum Compliance Load 59^{o}F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - Minimum Compliance Load 59^{o}F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				7.40	9.32E-01		358.21	13.72		Normal Operation - Minimum Compliance Load 102^{o}F ambient used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.28	3.46E-02	13.70	422.04	15.24	0.76	Operation for 12 hours	
			Emergency Fire Pump	0.21	2.65E-02	10.67	809.26	65.23	0.13	Operation for 4 hours	

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
NO_x (continued)	Annual	NAAQS/AAAQS, Class I & II Increments, NO_x Deposition, Vegetation and Soils Impacts	Turbines and Duct Burners	15.86	2.00E+00	54.86	355.23	18.10	5.49	Annual average	Weighted average stack parameters 59°F ambient
			Auxiliary Boiler	0.03	3.56E-03	13.70	422.04	15.24	0.76	Annual average	
			Emergency Fire Pump	0.01	1.81E-03	10.67	809.26	65.23	0.13	Annual average	
CO	1-hour and 8-hour	NAAQS/AAAQS, Vegetation and Soils Impacts	Turbines and Duct Burners	262.28	3.30E+01	54.86	355.32	13.11	5.49	Conservatively use Hot Start 10°F	Worst-case Stack Parameters - 59°F ambient, minimum compliance load
			Auxiliary Boiler	1.85	2.33E-01	13.70	422.04	15.24	0.76	Conservatively assume Normal Operation for all 8 hours	
			Emergency Fire Pump	0.81	1.02E-01	10.67	809.26	65.23	0.13	Conservatively assume Normal Operation for all 8 hours	
SO_2	1-hour and 3-hour (Scenario 1)	NAAQS/AAAQS	Turbines and Duct Burners	4.10	5.17E-01	54.86	352.71	21.33	5.49	Normal Operation - 100% load with duct firing, 10°F ambient used for months with average minimum temperature below freezing (December, January)	Normal Operation - 100% load with duct firing, 10°F ambient used for months with average minimum temperature below freezing (December, January)
				3.80	4.79E-01		352.87	19.81		Normal Operation - 100% load with duct firing, 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November)	Normal Operation - 100% load with duct firing, 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November)
				3.60	4.54E-01		353.76	18.90		Normal Operation - 100% load with duct firing, 102°F ambient used for months with average maximum high over 90°F (June, July, August, September)	Normal Operation - 100% load with duct firing, 102°F ambient used for months with average maximum high over 90°F (June, July, August, September)
			Auxiliary Boiler	0.11	1.37E-02	13.70	422.04	15.24	0.76	Normal Operation	
			Emergency Fire Pump - 3-hour only	0.003	3.98E-04	10.67	809.26	65.23	0.13	Normal Operation	
	1-hour and 3-hour (Scenario 2)	NAAQS/AAAQS	Turbines and Duct Burners	3.60	4.54E-01	54.86	354.76	17.04	5.49	Startup - 10°F ambient used for months with average minimum temperature below freezing (December, January)	Startup Stack Parameters - 10°F, used for months with average minimum temperature below freezing (December, January)
				3.40	4.28E-01		356.04	15.94		Startup - 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November)	Startup Stack Parameters - 59°F used for months where 10°F or 102°F not used (February, March, April, May, October, November)
				3.20	4.03E-01		359.04	15.12		Startup - 102°F ambient used for months with average maximum high over 90°F (June, July, August, September)	Startup Stack Parameters - 102°F used for months with average maximum high over 90°F (June, July, August, September)
			Auxiliary Boiler	0.11	1.37E-02	13.70	422.04	15.24	0.76	Normal Operation	
			Emergency Fire Pump - 3-hour only	0.003	3.98E-04	10.67	809.26	65.23	0.13	Normal Operation	

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
SO_2 (continued)	1-hour and 3-hour (Scenario 3)	NAAQS/AAAQS	Turbines and Duct Burners	2.60	3.28E-01	54.86	356.09	15.24	5.49	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)
				2.10	2.65E-01		355.32	13.11		Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				2.10	2.65E-01		358.21	13.72		Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.11	1.37E-02	13.70	422.04	15.24	0.76	Normal Operation	
			Emergency Fire Pump - 3-hour only	0.003	3.98E-04	10.67	809.26	65.23	0.13	Normal Operation	
	24-hour (Scenario 1)	NAAQS/AAAQS	Turbines and Duct Burners	4.10	5.17E-01	54.86	352.71	21.33	5.49	Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)	Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)
				3.80	4.79E-01		352.87	19.81		Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				3.60	4.54E-01		353.76	18.90		Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.05	6.85E-03	13.70	422.04	15.24	0.76	Operation for 12 hours	
			Emergency Fire Pump	0.0005	6.63E-05	10.67	809.26	65.23	0.13	Operation for 4 hours	

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
SO2 (continued)	24-hour (Scenario 2)	NAAQS/AAAQS	Turbines and Duct Burners	2.60	3.28E-01	54.86	356.09	15.24	5.49	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)
				2.10	2.65E-01		355.32	13.11		Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				2.10	2.65E-01		358.21	13.72		Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.05	6.85E-03	13.70	422.04	15.24	0.76	Operation for 12 hours	
			Emergency Fire Pump	0.0005	6.63E-05	10.67	809.26	65.23	0.13	Operation for 4 hours	
	Annual	NAAQS/AAAQS	Turbines and Duct Burners	3.42	4.32E-01	54.86	355.23	18.10	5.49	Annual Average	Weighted average stack parameters 59°F
			Auxiliary Boiler	0.006	7.04E-04	13.70	422.04	15.24	0.76	Annual Average	
			Emergency Fire Pump	0.00004	4.54E-06	10.67	809.26	65.23	0.13	Annual Average	

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
PM_{10}	24-hour (Scenario 1)	NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts	Turbines and Duct Burners	8.50	1.07E+00	54.86	352.71	21.33	5.49	Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)	Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)
				8.50	1.07E+00		352.87	19.81		Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				8.50	1.07E+00		353.76	18.90		Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.18	2.20E-02	13.70	422.04	15.24	0.76	Operation for 12 hours	
			Emergency Fire Pump	0.01	1.42E-03	10.67	809.26	65.23	0.13	Operation for 4 hours	
			Cooling Tower[a]	0.10	1.22E-02	14.00	294.26	8.59	10.00	Operation for 24 hours	

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
PM_{10} (continued)	24-hour (Scenario 2)	NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts	Turbines and Duct Burners	6.50	8.19E-01	54.86	356.09	15.24	5.49	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)
				6.50	8.19E-01		355.32	13.11		Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				6.50	8.19E-01		358.21	13.72		Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.18	2.20E-02	13.70	422.04	15.24	0.76	Operation for 12 hours	
			Emergency Fire Pump	0.01	1.42E-03	10.67	809.26	65.23	0.13	Operation for 4 hours	
			Cooling Tower[a]	0.10	1.22E-02	14.00	294.26	8.59	10.00	Operation for 24 hours	
	Annual	NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts	Turbines and Duct Burners	7.14	9.00E-01	54.86	355.23	18.10	5.49	Annual average	Weighted average stack parameters 59°F
			Auxiliary Boiler	0.02	2.27E-03	13.70	422.04	15.24	0.76	Annual average	
			Emergency Fire Pump	0.0008	9.73E-05	10.67	809.26	65.23	0.13	Annual average	
			Cooling Tower[a]	0.10	1.22E-02	14.00	294.26	8.59	10.00	Annual average	

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
$PM_{2.5}$	24-hour (Scenario 1)	NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts	Turbines and Duct Burners	8.50	1.07E+00	54.86	352.71	21.33	5.49	Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)	Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January)
				8.50	1.07E+00		352.87	19.81		Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				8.50	1.07E+00		353.76	18.90		Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.18	2.20E-02	13.70	422.04	15.24	0.76	Assume Normal Operation for 12 hours	
			Emergency Fire Pump	0.01	1.42E-03	10.67	809.26	65.23	0.13	4 hours of operation	
			Cooling Tower[a]	0.05	5.83E-03	14.00	294.26	8.59	10.00	Normal Operation	

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
$PM_{2.5}$ (continued)	24-hour (Scenario 2)	NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts	Turbines and Duct Burners	6.50	8.19E-01	54.86	356.09	15.24	5.49	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)	Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January)
				6.50	8.19E-01		355.32	13.11		Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)	Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November)
				6.50	8.19E-01		358.21	13.72		Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September)	Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September)
			Auxiliary Boiler	0.18	2.20E-02	13.70	422.04	15.24	0.76	Assume Normal Operation for 12 hours	
			Emergency Fire Pump	0.01	1.42E-03	10.67	809.26	65.23	0.13	4 hours of operation	
			Cooling Tower[a]	0.05	5.83E-03	14.00	294.26	8.59	10.00	Normal Operation	
	Annual	NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts	Turbines and Duct Burners	7.14	9.00E-01	54.86	355.23	18.10	5.49	Annual average	Weighted average stack parameters at 59°F ambient
			Auxiliary Boiler	0.02	2.27E-03	13.70	422.04	15.24	0.76	Annual average	
			Emergency Fire Pump	0.0008	9.73E-05	10.67	809.26	65.23	0.13	Annual average	
			Cooling Tower[a]	0.046	5.83E-03	14.00	294.26	8.59	10.00	Annual average	

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario
NO_x	24-hour	Visibility Impacts	Turbines and Duct Burners	22.00	2.77E+00	54.86	355.36	13.28	5.49	Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 10°F ambient	Weighted average stack parameters at minimum compliance load 59°F ambient
			Auxiliary Boiler	0.28	3.46E-02	13.70	422.04	15.24	0.76	Assume Normal Operation for 12 hours	
			Emergency Fire Pump	0.21	2.65E-02	10.67	809.26	65.23	0.13	4 hours of operation	
SO_2			Turbines and Duct Burners	4.06	5.11E-01	54.86	355.36	13.28	5.49	Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 10°F ambient	Weighted average stack parameters at minimum compliance load 59°F ambient
			Auxiliary Boiler	0.05	6.85E-03	13.70	422.04	15.24	0.76	Assume Normal Operation for 12 hours	
			Emergency Fire Pump	0.0005	6.63E-05	10.67	809.26	65.23	0.13	4 hours of operation	
$PM_{10}/PM_{2.5}$			Turbines and Duct Burners	8.33	1.05E+00	54.86	355.36	13.28	5.49	Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, emissions assumed to be the same at all temperatures	Weighted average stack parameters at minimum compliance load 59°F ambient
			Auxiliary Boiler	0.18	2.20E-02	13.70	422.04	15.24	0.76	Assume Normal Operation for 12 hours	
			Emergency Fire Pump	0.01	1.42E-03	10.67	809.26	65.23	0.13	4 hours of operation	
			Cooling Tower[a]	0.10	1.22E-02	14.00	294.26	8.59	10.00	Normal Operation	

[a]There are 9 cooling tower cells. Data shown are for each cell individually.

BOWIE POWER STATION
MODELING DATA SUMMARY

Base Elevation	1139.00	meters

Pollutant	Averaging Periods	Modeling Scenario(s)	Emission Unit	Emission Rate (lb/hour)	Emission Rate (g/sec)	Stack Height (m)	Stack Exit Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)	Operating Scenario for Emissions	Stack Parameter Scenario

Maximum Turbine Short-term Emission Rates:
NO_x - Maximum emission rate occurs during hot starts. Hot start emission rates are much higher than normal operation emission rates.
CO - Maximum emission rate occurs during hot starts
$PM_{10}/PM_{2.5}$ - Maximum emission rate occurs at 100% turbine load plus duct firing,. Startup emission are assumed to equal normal operation emissions without duct firing, maximum emission rate occurs at 100% turbine load.
SO_2 - Maximum emission rate occurs at 100% turbine load plus duct firing,. Startup emission are assumed to equal normal operation emissions without duct firing, maximum emission rate occurs at 100% turbine load

Worst-Case Turbine Stack Parameters from Screening Modeling occur at:
59ºF ambient temperature, minimum compliance load case

Short-term Emission Rates for turbines are from spreadsheets titled "Turbine and Duct Burner Hourly Emissions" and "Turbine Startup Emissions"

Short-term Emission rates for non-turbine emission units are from "One Hour Emission Criteria Pollutant Emission Summary"

24-hour Average Emission Rate for auxiliary boiler and fire pump SO_2 and $PM_{10}/PM_{2.5}$

$$\frac{\text{lb}}{\text{hour}} = \frac{\text{lb}}{\text{hour}} \times \frac{\text{hours of operation}}{\text{24 hours}}$$

24-hour Emission Rates for visibility impacts are from "24-Hour Modeling Scenario Emissions"

Annual Average Emission Rates are from "Annual Project Criteria Pollutant Emissions"

Annual Averages Emissions $\frac{\text{lb}}{\text{hour}} = \frac{\text{tons}}{\text{year}} \times \frac{\text{year}}{\text{8760 hours}} \times \frac{\text{2000 lb}}{\text{ton}}$

Cooling Tower Emissions are divided by 9 to apportion the emissions among the 9 cooling tower cells

$$\frac{\text{grams}}{\text{second}} = \frac{\text{lb}}{\text{hour}} \times \frac{\text{453.59 grams}}{\text{lb}} \times \frac{\text{hour}}{\text{3600 seconds}}$$

Short-term stack parameters are from the spreadsheet titled "Turbine Stack Parameters"

Annual stack parameters are from the spreadsheet titled "Turbine and Duct Burner Annual Weighted Average Stack Parameters"