

**AERMOD Modeling of SO<sub>2</sub> Impacts of the  
Luminant Martin Lake Coal Plant**

Final Report

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Prepared for

**Sierra Club**  
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## I. INTRODUCTION

This document presents the methodologies and results of an application of the AERMOD model to predict the air quality impacts of sulfur dioxide (SO<sub>2</sub>) emitted by the Martin Lake Steam Station. Martin Lake is a coal-fired power plant operated by Luminant near Henderson in Rusk County, Texas (Figure 1). It consists of three coal-fired boilers with a total electric generating capacity of 2,380 MW (gross). SO<sub>2</sub> impacts predicted by the AERMOD model will be compared against the 1-hour SO<sub>2</sub> ambient air quality standard (AAQS) of 75 ppb (or 196 ug/m<sup>3</sup>) which has been promulgated in June 2010 by the U.S. Environmental Protection Agency (EPA).



**Figure 1. Luminant Martin Lake Coal Plant**

## II. MODELING METHODOLOGIES

This section documents the methodologies and assumptions used in the generation of modeling inputs such as source emissions, stack parameters, receptors and meteorological data.

### A. Model Version

The version 11103 of the AERMOD model has been used in the modeling study. It is currently the latest version of the model that has been approved by the US Environmental Protection Agency (USEPA, 2011). It predicts the 1-hour SO<sub>2</sub> concentrations that can be compared against the 1-hour AAQS which is attained when the 3-year average of the 99<sup>th</sup>

percentile of the daily maximum 1-hour concentrations does not exceed 75 ppb (or 196 ug/m<sup>3</sup>) at each monitor within an area (USEPA, 2010a; 2010b).

**B. Source Emissions**

Coal-fired boilers at the plant are major sources of SO<sub>2</sub>. The Phase II Acid Rain Permit, as part of the plant Title V permit, shows a total of 98,870 tons per year (tpy). Emissions by boiler are as follows: 33, 220 tpy for Unit 1, 32,225 tpy for Unit 2 and 33,425 tpy for Unit 3. These emissions have been converted to grams per second (g/s) in Table 1 as required by the AERMOD model by assuming that the boilers operate continuously, i.e. 8760 hours per year. U.S. EPA's guidance on modeling 1-hour SO<sub>2</sub> impacts and the Modeling Guideline require using the maximum 1-hour emission rate. There are no 1-hour limits in the permit for the coal fired boilers. Therefore, the maximum theoretical emissions during a 1-hour period should be used. The emission rates used for this model are lower than the 1-hour maximum theoretical emissions and, hence, the modeled impacts are underestimated. The purpose of this modeling is to show that even when using emission rates lower than the 1-hour maximum, the facility causes violations of the NAAQS. Using the 1-hour maximum, as required by U.S. EPA and the Modeling Guidelines, should result in even higher modeled concentrations.

**C. Stack Parameters**

Stack parameters (stack height, diameter, temperature and exit velocity) for the boilers are shown in Table 1. They have been obtained from CENRAP point source data used in a previous photochemical modeling study (AMI, 2010).

**Table 1. Plant SO<sub>2</sub> Emissions & Stack Parameters**

| Stack   | SO <sub>2</sub> (g/s) | Height (m) | Diameter (m) | Temperature (K) | Velocity (m/s) |
|---------|-----------------------|------------|--------------|-----------------|----------------|
| Stack 1 | 955.6438              | 137.8      | 7.01         | 373             | 27.2           |
| Stack 2 | 927.0205              | 137.8      | 7.01         | 370             | 31.7           |
| Stack 3 | 961.5411              | 137.8      | 7.01         | 370             | 32.9           |

**D. Receptors**

The AERMOD modeling uses a grid of discrete receptors that are located within a radius of 50 km around the plant. The receptor grid has varying resolutions: 50 m on the plant boundaries, 100 m within the first 5 km, 250 m between 5 km and 10 km, 500 m between 10 km and 20 km, and 1000 m between 20 km and 50 km. Receptors located on-site have been removed from consideration and a total of 33,381 receptors have been used in the AERMOD modeling. The preprocessor AERMAP has been employed to obtain terrain elevations at these receptors using the NED data.

### E. Meteorological Data

The AERMOD modeling uses a 5-year meteorological dataset that has been processed and recommended by TCEQ. It is comprised of surface observations at Shreveport (Station No. 13957) and upper-air data from the Longview site (Station No. 03951). Meteorological data processed by TCEQ for the years 1989 through 1993 have been used in the AERMOD modeling. It should be noted that these TCEQ-recommended data may not be the best available data, since more accurate wind data can be derived from 1-minute measurements at ASOS stations in recent years. The pre-processed data from TCEQ was used here to be consistent with TCEQ practices, even though the TCEQ practices are, themselves, inconsistent with best modeling practices.

### F. Background Concentrations

For comparing against the SO<sub>2</sub> 1-hour NAAQS, background concentrations at a monitoring station are added to the concentrations predicted by the AERMOD model. Maximum 1-hour SO<sub>2</sub> measurements in Dallas, Longview and Waco for 2006-2008 are shown in Table 2. The Longview measurements are the highest and exceed the NAAQS since Longview is the closest monitor to the Luminant plants and, hence, they are not suitable as background. The Waco measurements are much lower than those in Dallas; they are more representative as background since Waco is a much smaller city and less polluted than Dallas, and there is less chance for a “double counting” for an existing source such as the Luminant plant. Thus, a background of 21 ug/m<sup>3</sup> is used in comparing modeled SO<sub>2</sub> impacts against the NAAQS.

**Table 2. Maximum Ambient 1-Hour SO<sub>2</sub> Concentrations in Dallas, Longview and Waco**

| Year | 1-Hour SO <sub>2</sub> in Dallas | 1-Hour SO <sub>2</sub> in Longview | 1-Hour SO <sub>2</sub> in Waco |
|------|----------------------------------|------------------------------------|--------------------------------|
| 2008 | 23 ppb (60 ug/m <sup>3</sup> )   | 96 ppb (251 ug/m <sup>3</sup> )    | 8 ppb (21 ug/m <sup>3</sup> )  |
| 2007 | 14 ppb (45 ug/m <sup>3</sup> )   | 168 ppb (440 ug/m <sup>3</sup> )   | 8 ppb (21 ug/m <sup>3</sup> )  |
| 2006 | 16 ppb (42 ug/m <sup>3</sup> )   | 111 ppb (291 ug/m <sup>3</sup> )   | Not available                  |

Source: US EPA AirData

<http://iaspub.epa.gov/airsdata/adaqs.monvals?geotype=st&geocode=TX&geoinfo=st~TX~Texas&pol=SO2&year=2008&fld=monid&fld=siteid&fld=address&fld=city&fld=county&fld=stabbr&fld=regnrpp=25>

### III. MODELING RESULTS

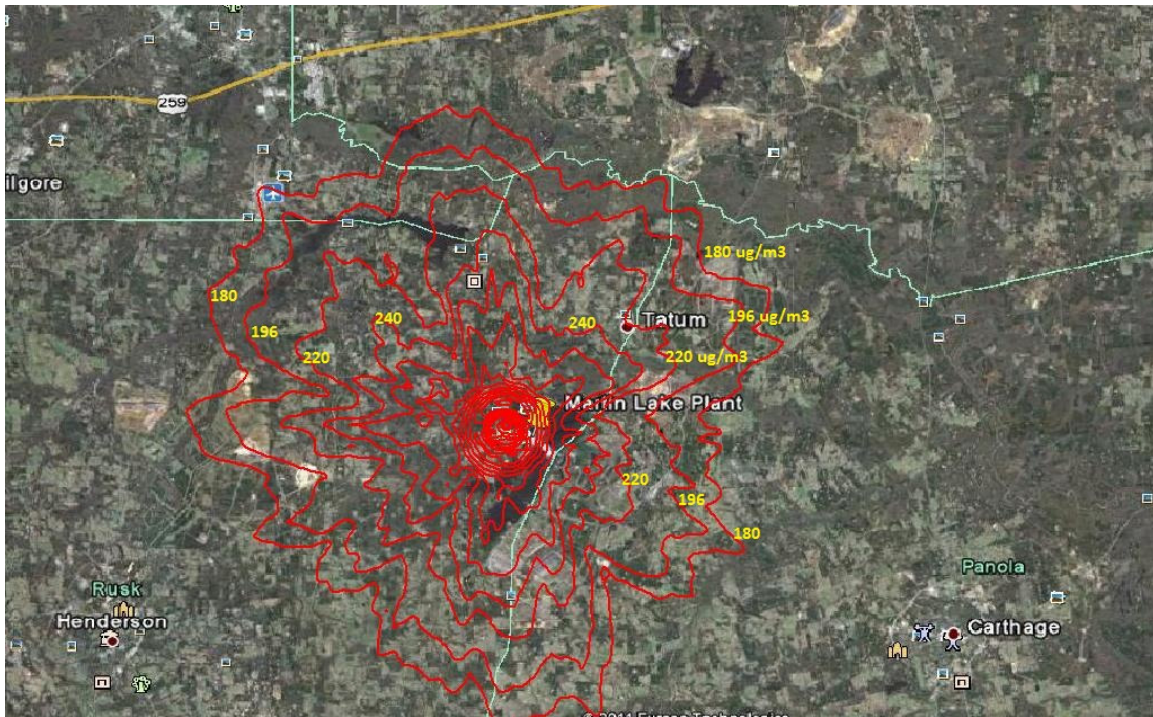
In June 2010, US EPA has announced a new 1-hour AAQS which is attained when the 3-year average of the 99<sup>th</sup> percentile of the daily maximum 1-hour concentrations does not exceed 75 ppb (or 196 ug/m<sup>3</sup>) at each monitor within an area. Subsequently, US EPA has issued in August 2010 a modeling guidance for using the AERMOD model with 5-year of meteorological data (USEPA, 2010b). According to the US EPA, the 4<sup>th</sup> highest maximum daily 1-hour concentrations averaged over five years should be used in the NAAQS comparison.

Five runs of the AERMOD model have been performed. SO<sub>2</sub> modeling results are summarized in Appendix A and presented in Table 3. According to the US EPA recommendations, modeled impacts in Table 3 have been averaged over five years of modeled meteorological data. The AERMOD model has predicted a maximum 1-hour concentration of 544.7 ug/m<sup>3</sup> and a 4<sup>th</sup> highest (99<sup>th</sup> percentile) concentration of 442.5 ug/m<sup>3</sup> from the plant emissions alone. Both these concentrations largely exceed (more than a factor of 2) the NAAQS of 196 ug/m<sup>3</sup>: 178% by the maximum 1-hour concentration and 126% by the 4<sup>th</sup> highest concentration. With the background of 21 ug/m<sup>3</sup>, the maximum total 1-hour concentration is 565.7 ug/m<sup>3</sup> which is 189% over the NAAQS, and the maximum total 4<sup>th</sup> highest concentration is 463.5 ug/m<sup>3</sup> which is 136% above the 1-hour NAAQS of 196 ug/m<sup>3</sup>. A plot of the contour of 196 ug/m<sup>3</sup> is shown in Figure 2. The area with concentrations exceeding 196 ug/m<sup>3</sup>, i.e. violating the 1-hr NAAQS, due to the plant emissions alone has a radius of about 10 miles around the plant. Located about 6 miles NE of the Martin Lake plant, Tatum lies on the contour line of 220 ug/m<sup>3</sup>.

**Table 3. Predicted 1-Hour SO<sub>2</sub> Impacts by the Luminant Martin Lake Plant (averaged over 5 years)**

| <b>Pollutant</b>                                 | <b>Project Conc. (ug/m<sup>3</sup>)</b> | <b>Background Conc. (ug/m<sup>3</sup>)</b> | <b>Total Conc. (ug/m<sup>3</sup>)</b> | <b>NAAQS (ug/m<sup>3</sup>)</b> | <b>NAAQS Exceed</b> | <b>Percent Over NAAQS</b> |
|--|---|--|---------------------------------------|---------------------------------|---------------------|---------------------------|
| 1-hour SO <sub>2</sub> (max)                     | 544.7                                   | 21   | 565.7                                 | 196                             | <b>YES</b>          | <b>189%</b>               |
| 1-hour SO <sub>2</sub> (4 <sup>th</sup> highest) | 442.5                                   | 21   | 463.5                                 | 196                             | <b>YES</b>          | <b>136%</b>               |





**Figure 2. Area with 4<sup>th</sup> Highest 5-yr Averaged SO<sub>2</sub> Concentrations Exceeding the 1-Hour NAAQS of 196 ug/m<sup>3</sup> by Plant Emissions Alone**

#### **IV. CONCLUSIONS**

Air quality impacts of SO<sub>2</sub> emissions from the Luminant Martin Lake facility have been analyzed with the AERMOD model. Using permitted emissions, five years of meteorological data and the latest US EPA modeling guidance, the AERMOD model has predicted large exceedances (more than a factor of 2) of the recent 1-hour NAAQS of 196 ug/m<sup>3</sup>. The plant alone has also been shown to cause a large area with a radius of about 10 miles where the concentrations exceed this NAAQS. Thus, SO<sub>2</sub> impacts from the Martin Lake coal plant are very adverse since its SO<sub>2</sub> emissions alone cause large exceedances of the 1-hour NAAQS and a large area of NAAQS violations. It should be noted that the predicted NAAQS exceedances are understated since annual-averaged emissions that are less than maximum hourly emissions have been used in the modeling.

#### **V. REFERENCES**

AMI, 2010. Photochemical Modeling of Ozone, PM<sub>2.5</sub> and Visibility Impacts in Arkansas from Texas Existing and Planned Coal-Fired Power Plants. Report prepared for Sierra Club by AMI Environmental, September 2010.

U.S. EPA, 2011. Addendum to User's Guide of the AMS/EPA Regulatory Model AERMOD version 11103, March 2011. Available at:  
[http://www.epa.gov/ttn/scram/models/aermod/aermod\\_userguide.zip](http://www.epa.gov/ttn/scram/models/aermod/aermod_userguide.zip)

U.S. EPA, 2010a. *Guidance Concerning the Implementation of the 1-hour SO<sub>2</sub> NAAQS for the Prevention of Significant Deterioration Program*. Memorandum issued on August 23, 2010 from Stephen D. Page, Director of OAQPS. Available at  
<http://www.epa.gov/region07/air/nsr/nsrmemos/appwso2.pdf>

U.S. EPA, 2010b. *Applicability of Appendix W Modeling Guidance for the 1-hour SO<sub>2</sub> NAAQS*. Memorandum issued on August 23, 2010 from Tyler Fox, Leader of Air Quality Modeling Group, OAQPS. Available at  
<http://www.epa.gov/region07/air/nsr/nsrmemos/appwso2.pdf>

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## **Appendix A**

### **Summary of AERMOD Modeling Results**

\*\*\* AERMOD - VERSION 11103 \*\*\* \*\*\* Martin Lake - 1993 SO2 runs (AMI) \*\*\*  
05/28/11

\*\*\* 04:15:09

\*\*MODELOPTs: RegDFAULT CONC  
MULTYR

PAGE 4  
ELEV

\*\*\* THE SUMMARY OF MAXIMUM 1ST-HIGHEST MAX DAILY 1-HR RESULTS AVERAGED  
OVER 5 YEARS \*\*\*

\*\* CONC OF SO2 IN MICROGRAMS/M\*\*3 \*\*

NETWORK  
GROUP ID AVERAGE CONC RECEPTOR (XR, YR, ZELEV, ZHILL, ZFLAG) OF TYPE  
GRID-ID

-----  
ALL 1ST HIGHEST VALUE IS 544.66935 AT ( 349000.00, 3570300.00, 106.64, 106.64, 0.00) DC  
2ND HIGHEST VALUE IS 544.40763 AT ( 349000.00, 3570200.00, 109.76, 109.76, 0.00) DC  
3RD HIGHEST VALUE IS 544.07522 AT ( 348900.00, 3570200.00, 109.30, 109.30, 0.00) DC  
4TH HIGHEST VALUE IS 543.92996 AT ( 348900.00, 3570300.00, 108.61, 134.45, 0.00) DC  
5TH HIGHEST VALUE IS 543.80517 AT ( 349100.00, 3570300.00, 110.37, 110.37, 0.00) DC  
6TH HIGHEST VALUE IS 543.80517 AT ( 349100.00, 3570300.00, 110.37, 110.37, 0.00) DC  
7TH HIGHEST VALUE IS 543.80517 AT ( 349100.00, 3570300.00, 110.37, 110.37, 0.00) DC  
8TH HIGHEST VALUE IS 543.80517 AT ( 349100.00, 3570300.00, 110.37, 110.37, 0.00) DC  
9TH HIGHEST VALUE IS 543.35347 AT ( 349100.00, 3570200.00, 113.52, 113.52, 0.00) DC  
10TH HIGHEST VALUE IS 543.08167 AT ( 348850.00, 3570300.00, 111.53, 134.77, 0.00) DC

\*\*\* AERMOD - VERSION 11103 \*\*\* \*\*\* Martin Lake - 1993 SO2 runs (AMI)  
05/28/11

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\*\*\* 04:15:09

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\*\*MODELOPTs: RegDFAULT CONC  
MULTYR

ELEV

\*\*\* THE SUMMARY OF MAXIMUM 2ND-HIGHEST MAX DAILY 1-HR RESULTS AVERAGED  
OVER 5 YEARS \*\*\*

\*\* CONC OF SO2 IN MICROGRAMS/M\*\*3

\*\*

GROUP ID                      AVERAGE CONC                      NETWORK  
GRID-ID    RECEPTOR (XR, YR, ZELEV, ZHILL, ZFLAG) OF TYPE

-----  
ALL 1ST HIGHEST VALUE IS 452.72731 AT ( 352000.00, 3571700.00, 93.24, 93.24, 0.00) DC  
2ND HIGHEST VALUE IS 452.08342 AT ( 352100.00, 3571700.00, 94.34, 94.34, 0.00) DC  
3RD HIGHEST VALUE IS 451.49987 AT ( 352000.00, 3571600.00, 93.24, 93.24, 0.00) DC  
4TH HIGHEST VALUE IS 448.87098 AT ( 352100.00, 3571600.00, 93.24, 93.24, 0.00) DC  
5TH HIGHEST VALUE IS 447.74698 AT ( 352000.00, 3571800.00, 93.24, 93.24, 0.00) DC  
6TH HIGHEST VALUE IS 445.75721 AT ( 352200.00, 3571700.00, 94.45, 94.45, 0.00) DC  
7TH HIGHEST VALUE IS 445.71810 AT ( 352100.00, 3571800.00, 93.96, 93.96, 0.00) DC  
8TH HIGHEST VALUE IS 445.71810 AT ( 352100.00, 3571800.00, 93.96, 93.96, 0.00) DC  
9TH HIGHEST VALUE IS 445.71810 AT ( 352100.00, 3571800.00, 93.96, 93.96, 0.00) DC  
10TH HIGHEST VALUE IS 445.48663 AT ( 351700.00, 3571600.00, 93.24, 93.24, 0.00) DC

\*\*\* AERMOD - VERSION 11103 \*\*\* \*\*\* Martin Lake - 1993 SO2 runs (AMI) \*\*\*  
 05/28/11

\*\*\* 04:15:09  
 PAGE 6  
 ELEV

\*\*MODELOPTs: RegDFAULT CONC  
 MULTYR

\*\*\* THE SUMMARY OF MAXIMUM 4TH-HIGHEST MAX DAILY 1-HR RESULTS AVERAGED  
 OVER 5 YEARS \*\*\*

\*\* CONC OF SO2 IN MICROGRAMS/M\*\*3 \*\*

GROUP ID AVERAGE CONC NETWORK  
 RECEPTOR (XR, YR, ZELEV, ZHILL, ZFLAG) OF TYPE  
 GRID-ID

-----  
 ALL 1ST HIGHEST VALUE IS 442.52318 AT ( 352000.00, 3571700.00, 93.24, 93.24, 0.00) DC  
 2ND HIGHEST VALUE IS 441.27352 AT ( 352000.00, 3571600.00, 93.24, 93.24, 0.00) DC  
 3RD HIGHEST VALUE IS 439.57203 AT ( 352100.00, 3571700.00, 94.34, 94.34, 0.00) DC  
 4TH HIGHEST VALUE IS 439.18890 AT ( 352200.00, 3571700.00, 94.45, 94.45, 0.00) DC  
 5TH HIGHEST VALUE IS 437.19365 AT ( 352000.00, 3571800.00, 93.24, 93.24, 0.00) DC  
 6TH HIGHEST VALUE IS 436.30430 AT ( 351900.00, 3571700.00, 93.24, 93.24, 0.00) DC  
 7TH HIGHEST VALUE IS 436.27488 AT ( 352100.00, 3571800.00, 93.96, 93.96, 0.00) DC  
 8TH HIGHEST VALUE IS 436.27488 AT ( 352100.00, 3571800.00, 93.96, 93.96, 0.00) DC  
 9TH HIGHEST VALUE IS 436.27488 AT ( 352100.00, 3571800.00, 93.96, 93.96, 0.00) DC  
 10TH HIGHEST VALUE IS 435.91821 AT ( 351700.00, 3571700.00, 93.24, 93.24, 0.00) DC

\*\*\* RECEPTOR TYPES: GC = GRIDCART  
 GP = GRIDPOLR  
 DC = DISCCART  
 DP = DISCPOLR