Attachment F

Information Submitted for the Limestone Generating Station and the W A Parish Electric Generating Station

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Information Submitted for the Limestone Generating Station and the W A Parish Electric Generating Station

Part 1:

Submittal Letter from NRG to the TCEQ

NRG Texas Power LLC
1000 Main
Houston, Tx 77002

July 24, 2015

Via Email

David Brymer
Director, Air Quality Division
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

Re: NRG Texas Power LLC
Demonstrations of 1-Hour SO2 NAAQS Attainment Status
Limestone and W.A. Parish Power Plants

Dear Mr. Brymer:

NRG Texas Power LLC ("NRG") respectfully offers the attached air quality demonstrations for the Limestone and W.A. Parish facilities regarding EPA's proposed actions on the 1-hour SO2 National Ambient Air Quality Standard (NAAQS) in Texas.

NRG is a subsidiary of NRG Energy, Inc., a Fortune 250 Company and one of the country's largest power generation and retail electricity businesses. NRG Energy's power plants provide about 52,000 megawatts of generation capacity and its retail businesses serve more than 3 million customers throughout the country. In Southeast Texas, NRG owns more than 11,000 MW of generation capacity from nine electric generating stations. NRG supports clean energy resources and technologies critical to our transition to a sustainable, low carbon society.

The attached reports demonstrate that the ambient air around NRG's Limestone and Parish plants meets the 1-hour SO2 NAAQS. These demonstrations have been made using air dispersion modeling and take into account representative actual emissions from the Limestone and W.A. Parish plants, other nearby SO2 sources, and background SO2 levels. We believe that this information supports Texas' recommendation that all areas of the state should be designated as attainment or unclassifiable for the 1-hour SO2 NAAQS.

NRG appreciates your consideration of this information. Please contact me at 832-357-5291 or craig.eckberg@nrg.com if you have any questions or require additional information.

Sincerely,

Craig Eckberg / by permission:

Craig Eckberg
NRG Texas Power LLC

Attachments(2)

Attachments

A. SO2 Air Dispersion Modeling Report for W.A. Parish Generating Station (July, 2015) ("Parish Report").

B. SO2 Air Dispersion Modeling Report for Limestone Generating Station (July, 2015) ("Limestone Report").

Attachment F

Information Submitted for the Limestone Generating Station and the W A Parish Electric Generating Station

Part 2:

Information on Limestone Generating Station

Baker Botts, L.L.P.

SO_2 Air Dispersion Modeling Report for Limestone Generating Station

July 24, 2015

Project No. 0300448
Farrar, Texas

Peter T. Belmonte, P.E.

Partner-in-Charge

Elizabeth T. Barfield

Project Manager

Environmental Resources Management
CityCentre Four
840 West Sam Houston Parkway North, Suite 600
Houston, Texas 77024-3920
T: 281-600-1000
F: 281-520-4625

Texas Registered Engineering Firm F-2393
Texas Board of Professional Geoscientists Firm 50036

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1.0 INTRODUCTION

Environmental Resources Management (ERM), presents this air dispersion modeling report to Baker Botts, L.L.P (Baker Botts) documenting that maximum model-predicted Sulfur Dioxide (SO_2) impacts from NRG's Limestone Generating Station (Limestone) are in attainment with the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS). This analysis shows that the ambient air quality in the vicinity of Limestone, currently undesignated for the 1-hour SO_2 NAAQS, is below the standard and should be identified as "attainment" status in the next cycle of designations.

This modeling report describes the modeling methodology that was used to evaluate potential impacts of SO_2 emissions from Limestone on ambient air quality.

1.1 PROJECT OVERVIEW

Unlike previous NAAQS attainment demonstrations, EPA has proposed to make 1-hour SO_2 NAAQS attainment determinations using ambient air monitoring data and/or air dispersion modeling. In situations where air modeling is used to make this determination, the approach described in EPA's proposed "Modeling Technical Assistance Document" (TAD)[1] could be used, which sets forth a significantly different technical approach compared to conventional regulatory modeling prescribed by 40 CFR Part 51, Appendix W (EPA's *Guideline on Air Quality Models*). This approach would also be expected to meet EPA's proposed 1-Hour SO_2 Data Requirements Rule (DRR).

EPA distinguishes the approaches described in the SO_2 Modeling TAD to "reflect a view that designations are intended to address current actual air quality (i.e., modeling simulates a monitor), and thus are unlike attainment plan modeling, which must provide assurances that attainment will occur." EPA's proposed approach would utilize several distinctive technical approaches, including but not limited to the following:

- Simulating actual emissions and exhaust conditions (e.g., temperature and flowrate) on an hourly basis reflecting actual operations for a specified historical time period;
- Representing actual stack heights, irrespective of the GEP limitations;
- Limiting modeled ambient air receptors to locations where monitoring could actually take place and locations that would conventionally be considered "ambient air" for regulatory and permitting purposes, by excluding waterways, roadways, railways, restricted access property, and other locations not accessible to the general public or where a monitor could not reasonably be sited; and

[1] http://epa.gov/oaqps001/sulfurdioxide/pdfs/SO2ModelingTAD.pdf

- Simulating a three-year period of meteorological and background monitoring data, concurrent with the actual operating conditions and emissions, to meet EPA's objective that "modeling simulates monitoring" in this context.

ERM performed a modeling analysis evaluating the impacts on ambient air quality from SO_2 emissions at Limestone. In addition, although the approach for considering cumulative ambient impacts with other SO_2 sources in the region is not specifically covered in the proposed DRR, ERM considered other sources of SO_2 within 50 kilometers for inclusion in the modeling.

As discussed in this report, ERM's approach to the modeling analysis used those refinements directly addressed in the proposed DRR, i.e. the use of actual hourly emissions, actual stack heights, and seasonal diurnal ambient background concentrations.

As shown in this modeling report, SO_2 impacts from Limestone Generating Station emission sources, when combined with modeled impacts from other large SO_2 sources in the region and ambient air concentrations taken from a representative nearby monitor, are below the 1-hour SO_2 NAAQS.

This first section of this report describes the modeling methodology that was followed. Section 2 provides a description of the facility and the emissions included in the modeling. Model selection and the methodology used in the modeling are described in Section 3. The modeling results are presented in Section 4. References are provided in Section 5.

1.2 OVERVIEW OF METHODOLOGY

ERM's assessments were conducted in a manner consistent with United States Environmental Protection Agency (EPA) and Texas Commission on Environmental Quality (TCEQ) air quality regulations and modeling guidelines, including the following EPA documents:

- *Guideline on Air Quality Models* – 40 CFR Part 51, Appendix W, Revised November 9, 2005.
- *AERMOD Implementation Guide*, Revised March 19, 2009;
- "SO_2 NAAQS Designations Modeling Technical Assistance Document (Draft)," December 2013;
- "SO_2 NAAQS Designations Monitoring Technical Assistance Document (Draft)," December 2013;
- "Data Requirements Rule for the 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard (NAAQS)," Pre-publication proposed rule, April 17, 2014 (published in the Federal Register on May 13, 2014 79FR 27446); and
- "Guidance for 1-hour SO_2 Nonattainment Area SIP Submissions," April 23, 2014.

As well as:

- "Air Quality Modeling Guidelines, APDG 6232", TCEQ, April, 2015.

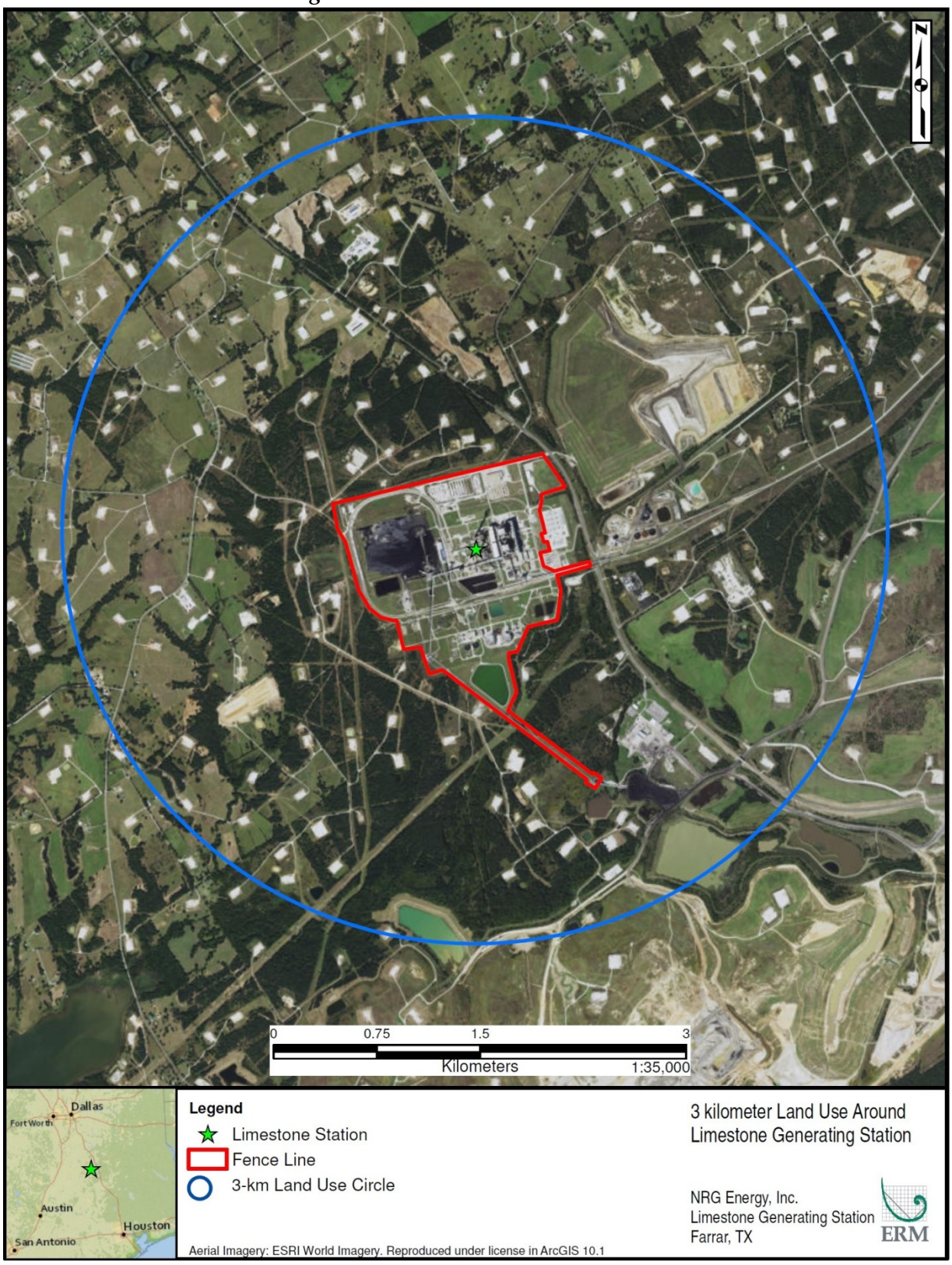
The steps that were undertaken by ERM to conduct the air dispersion modeling analyses are summarized below:

- Compiled information on the parameters and characteristics for all sources of SO_2 emissions at Limestone including the 2 main EGU's.
- Developed a comprehensive receptor grid to capture the maximum off-site impacts from Limestone sources.
- Reviewed regional ambient background monitors to determine the most appropriate ambient background concentration data for SO_2 to represent sources not explicitly included in the modeling runs.
- Developed 3 years (2012-2014) of meteorological data using surface observations from Corsicana Municipal Airport in Corsicana, TX with upper air data from Fort Worth, TX using the most recent version (v.14134) of AERMET, the meteorological data processor for AERMOD, and its two preprocessors: AERSURFACE (v.13016) and AERMINUTE (v.14237).
- Reviewed sources of SO_2 within 50 kilometers of Limestone for possible inclusion in the cumulative modeling analysis using the 2011 National Emission Inventory Database2, based on guidance included in the SO_2 Modeling TAD. Sources above the proposed DRR threshold were included in the cumulative modeling analysis.
- Conducted an air dispersion modeling analysis using the most recent version of EPA's regulatory dispersion model, AERMOD (v.14134) and 3 years of actual emissions data (2012-2014) from Limestone Sources and other large SO_2 sources in the region, consistent with the methodology described in the proposed SO_2 Data Requirements Rule and SO_2 Modeling TAD.
- Summarized the results and compared them with the 1-hour SO_2 NAAQS to determine a recommended attainment designation for the vicinity of Limestone.

Figure 1-1 depicts the location of the Limestone Station and surrounding land use.

[2] http://www.epa.gov/ttnchie1/net/2011inventory.html

Figure 1-1: Limestone Station Surroundings and Land Use



2.0 *FACILITY DESCRIPTION AND REGULATORY SETTING*

2.1 *FACILITY LOCATION*

The Limestone Generating Station is located in the town of Farrar, TX. The station is located about 98 miles south-southwest of downtown Dallas, TX and 126 miles north-northwest of Houston, TX. The site is accessed by Texas Rt. 39. Approximate site coordinates are 31.423° North Latitude, 96.253° West Longitude. The Universal Transverse Mercator ("UTM") coordinates of the facility are 761,111 Easting and 3,479,736 Northing (using North American Datum of 1983 - NAD83) in UTM Zone 14. The base elevation of the facility is 450′ (137.2m) above sea level. A full scale site plan of Limestone is shown in Figure 2-1, and Figure 2-2 shows the site location marked on a United States Geological Survey ("USGS") 7.5-minute topographic map.

2.2 *SO_2 ATTAINMENT STATUS*

In July 2013, EPA issued a rule designating 29 counties or partial counties as non-attainment for 1-hour SO_2. However, the vast majority of the country was not designated by EPA at that time. Neither Limestone County, where Limestone is located, nor any of the surrounding counties have been classified as attainment or non-attainment for 1-hour SO_2 NAAQS.

Figure 2-1: Limestone Station Site Plan

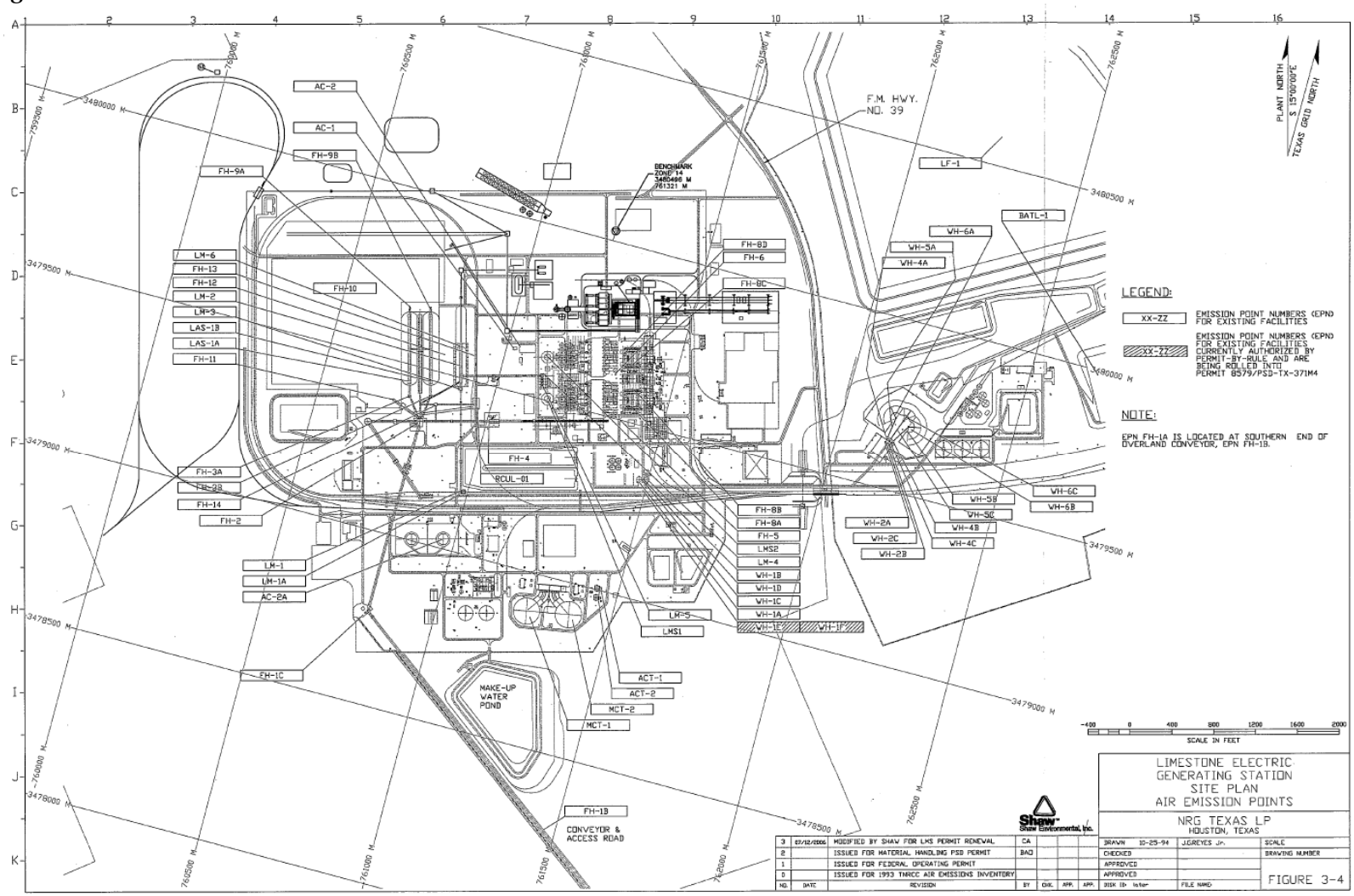
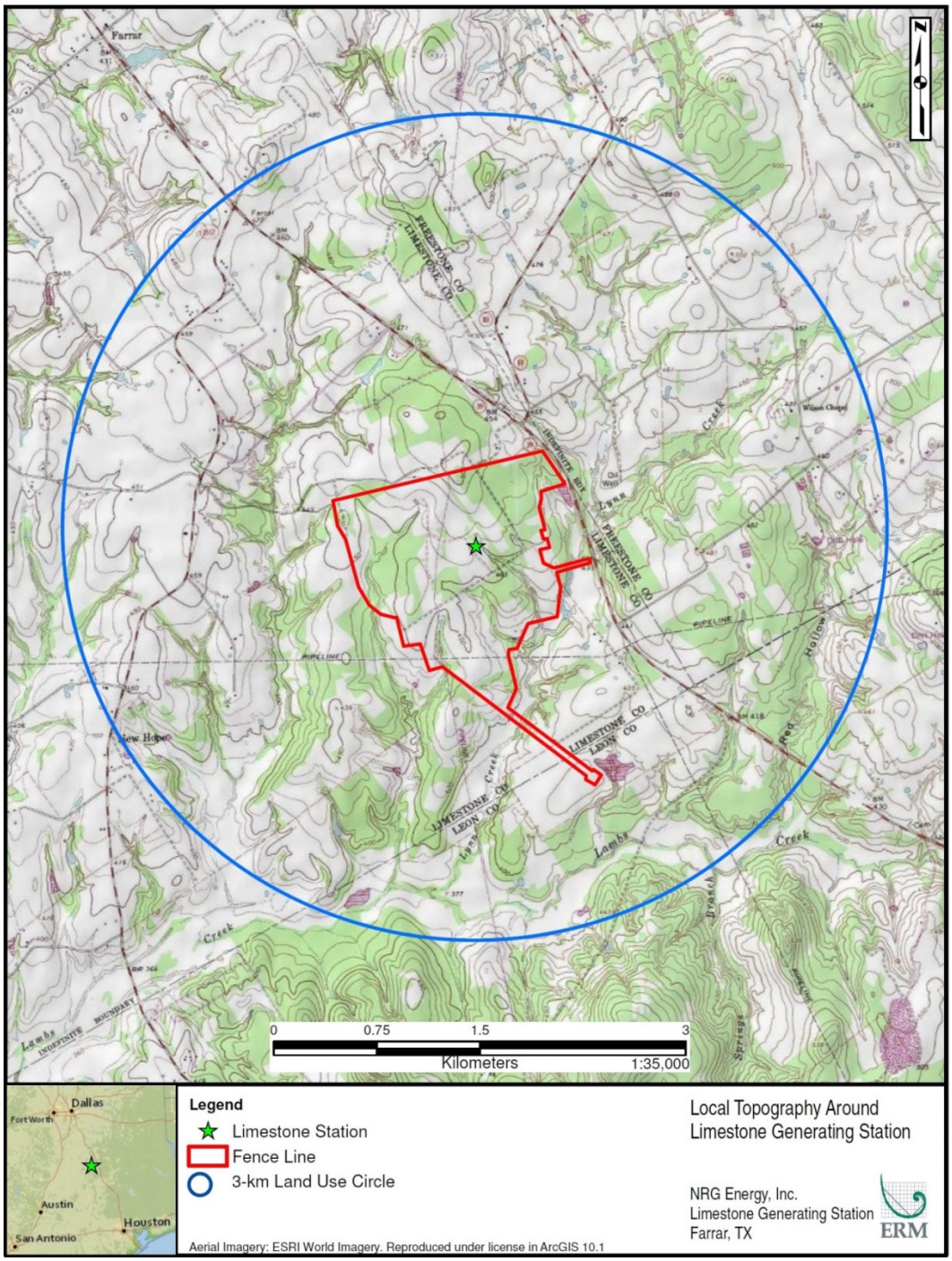


Figure 2-2: Limestone Station Local Topography



2.3 SOURCE PARAMETERS AND EMISSION RATES

For this 1-hour SO_2 NAAQS modeling demonstration, all major sources of SO_2 at the facility were included in the modeling. Per the proposed 1-hour SO_2 Data Requirements Rule and SO_2 Modeling TAD, the most recent 3 years of actual emissions data, along with the actual stack heights of all sources, were used in the modeling. The following provides a description of all Limestone SO_2 emission sources represented in the model. Table 2-1 summarizes the characteristics of the emissions sources that were included in the modeling. The actual emissions data used in the modeling are described below:

- Units No. 1 and No. 2 (Source ID's: LMS1 and LMS2). These units are lignite/coal fired utility boilers that produce steam for the generation of electricity. For these units, three years (2012-2014) of actual hourly emissions, stack temperature, and exhaust flow rate data were input into the model. These data were provided by NRG based on CEMS data collected at each source. As per the proposed 1-hour SO_2 Data Requirements Rule, the actual height of each stack was represented in the model for each source.
- Other sources at the site include emergency engines and fire pumps. These sources are used exclusively in emergency situations except for approximately one hour/week testing. Therefore, in accordance with USEPA guidance for intermittent sources, the emergency generator and fire pump engine were not included in the modeling demonstration for the 1-hour SO_2 NAAQS.

Table 2-1: Limestone Station Point Sources – Stack Parameters

Description	*Model Source*	*Stack Height*		*Exit Temperature*		*Exit Velocity*		*Stack Diameter*	
		(ft)	*(m)*	*(F)*	*(K)*	*(ft/sec)*	*(m/s)*	*(ft.)*	*(m)*
Unit 1 Boiler[1]	LMS1	565	172.21	---	---	---	---	23.6	8.23
Unit 2 Boiler[1]	LMS2	565	172.21	---	---	---	---	23.6	8.23

1. For the 2 main boilers, exit temperature and exit velocity varied on an hourly basis based on CEMS data.

3.0 AIR DISPERSION MODELING ANALYSIS

ERM conducted the modeling analysis for Limestone to quantify ambient impacts of SO_2 relative to the 1-hour NAAQS following the proposed approach described in the SO_2 Modeling TAD.

3.1 MODEL SELECTION AND APPLICATION

The latest version of USEPA's AERMOD model (v.14134) was used for predicting ambient impacts for 1-hour SO_2. Regulatory default options were used in the analysis. Model predicted impacts were combined with an ambient background concentration and compared to the 1-hour SO_2 NAAQS to determine the recommended attainment status of the area in the vicinity of the facility.

3.2 THE 1-HOUR SO_2 NAAQS

This study focuses on the maximum model-predicted 1-hour SO_2 impacts of Limestone and compares them to the 1-hour SO_2 NAAQS. The new standard came into effect in August, 2010. The form of the standard is the 99th percentile of the 3-year average 1-hour daily maximum concentration, and the standard was set to 75 ppb (196.5 $\mu g/m^3$).

3.3 METEOROLOGICAL DATA

Guidance for regulatory air quality modeling recommends the use of one year of on-site meteorological data or five years of representative off-site meteorological data. The SO_2 Modeling TAD however, specifies that 3 years of meteorological data concurrent to the actual emissions data being input into the model be used. Since on-site data are not available for the Limestone site, meteorological data available from the National Weather Service (NWS) were used in this analysis.

Three years (2012-2014) of surface observations from the NWS tower at Corsicana Municipal Airport in Corsicana, TX (WBAN No. 53912) and concurrent upper air data from Fort Worth, TX (WBAN No. 03990) were provided by TCEQ and further refined as described in Section 3.3.1. The meteorological data were processed with the most recent version of AERMET (v.14134) the meteorological preprocessor for AERMOD, along with the two pre-processors to AERMET: AERSURFACE (v.13016) and AERMINUTE (v.14237). AERMET was applied to create the two meteorological data files required for input to AERMOD.

The data characteristics of Corsicana Municipal Airport are shown in Table 3-1. Figure 3-1 shows the relative location of the airport and Limestone, and Figure 3-2 shows the 3-year wind rose for Corsicana Municipal Airport.

Table 3-1: Characteristics of the Corsicana Municipal Airport Meteorological Data

Distance from Limestone Station	42.8 miles
Average Wind Speed	4.25 m/s
Percent Calm Hours	1.83%
Data Completeness	98.72%

Figure 3-1: Relative Location of Facility and Meteorological Site

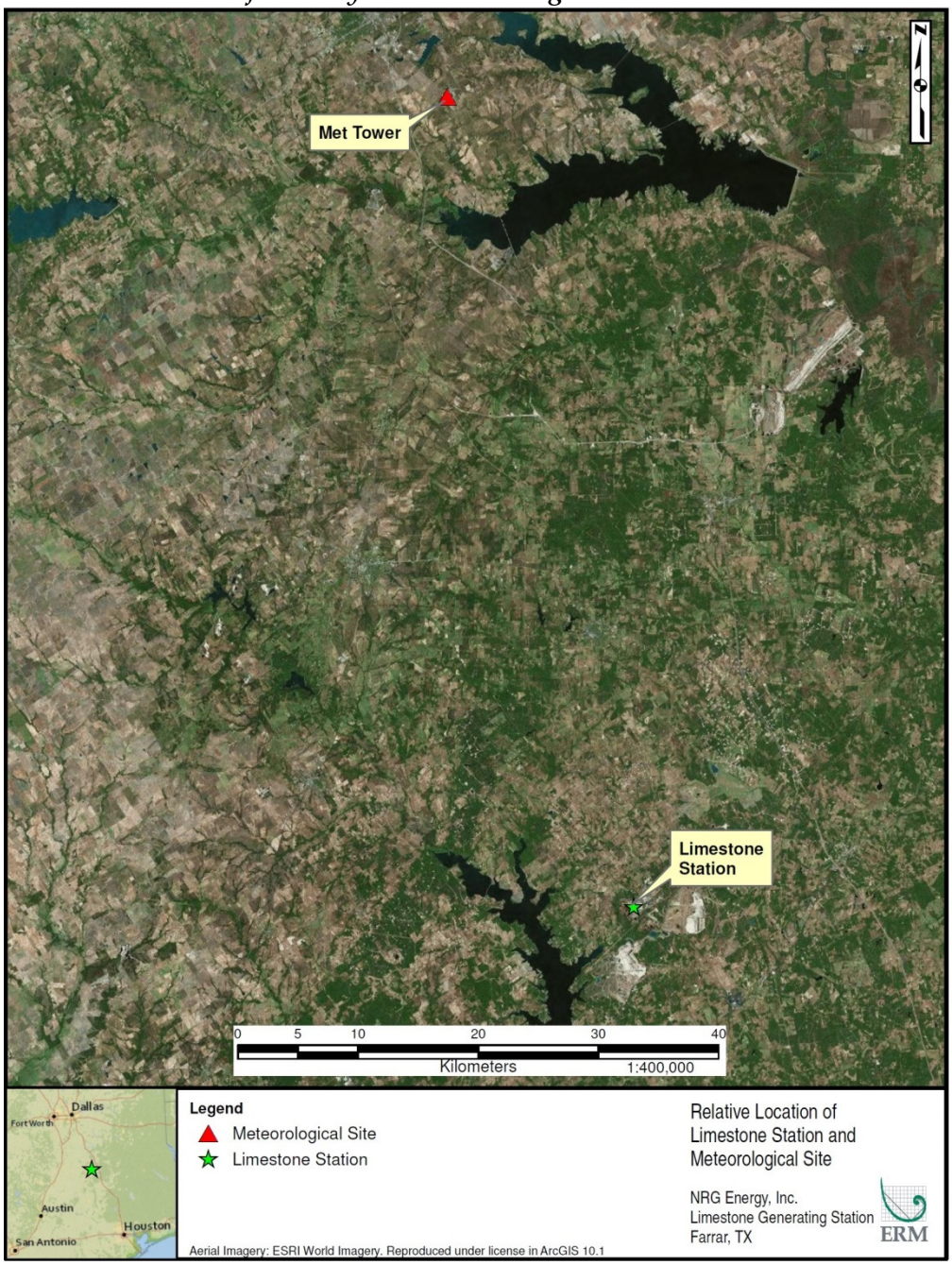


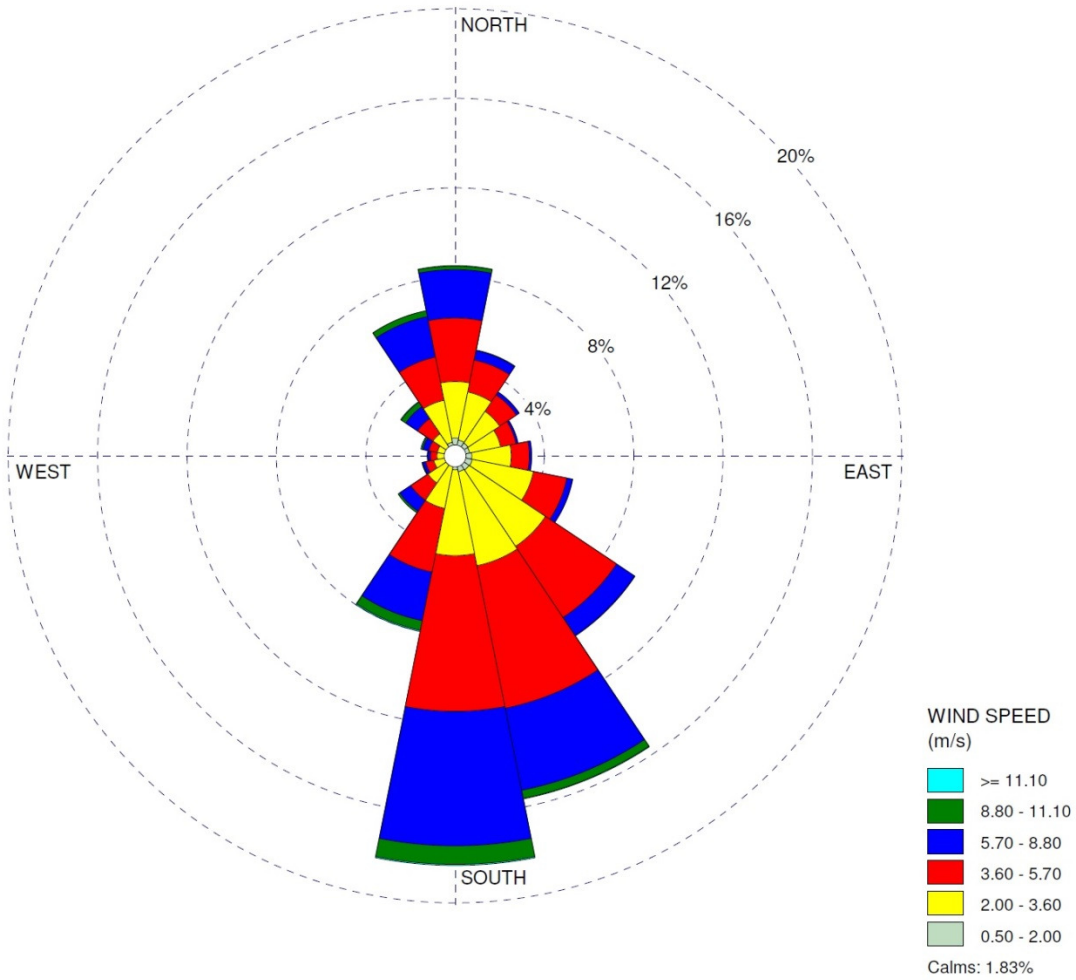
Figure 3-2: Three-year Wind Rose (2012-2014): Corsicana Municipal Airport

WIND ROSE PLOT:

3-Year Wind Rose: Corsicana Municipal Airport
2012-2014

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2012 - 00:00 **End Date: 12/31/2014 - 23:00**	**ERM**	
		MODELER: **R. Hamel**	ERM
	CALM WINDS: **1.83%**	TOTAL COUNT: **25968 hrs.**	
	AVG. WIND SPEED: **4.25 m/s**	DATE: **7/22/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

3.3.1 *Meteorological Data Refinements*

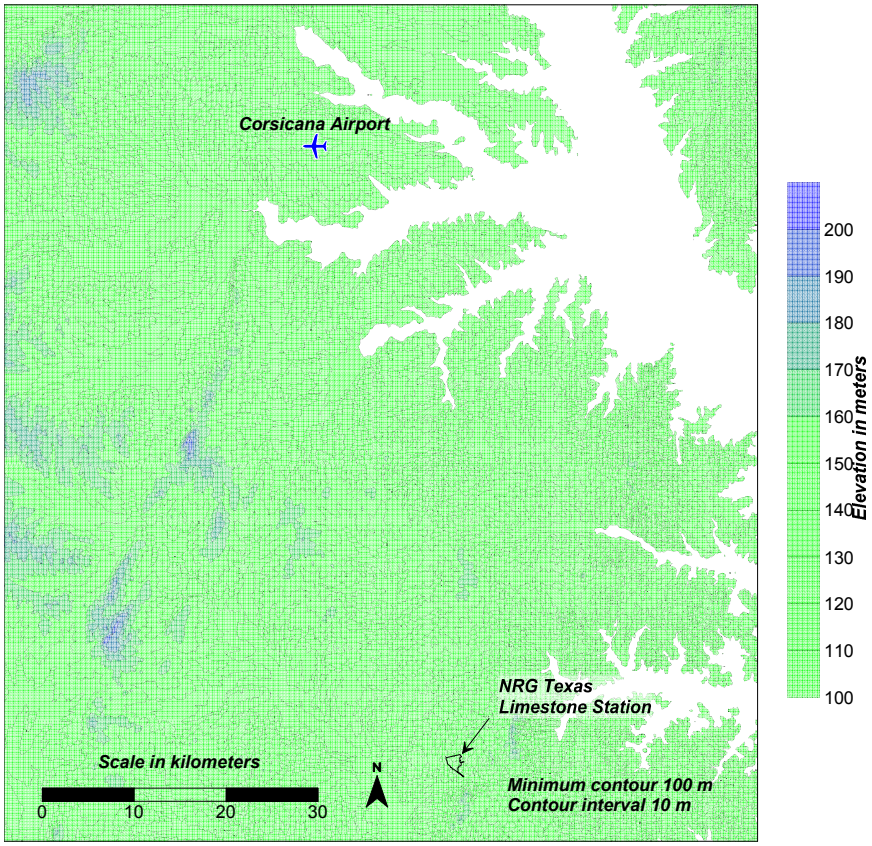
EPA and TCEQ guidelines recommend that meteorological data from a representative measurement station be used in modeling analyses to address ambient impacts. This section discusses the representativeness of data collected at the Corsicana Municipal Airport, and also describes how these data were processed to generate AERMOD-ready input files. AERMET is the recommended processor for developing inputs to AERMOD. AERMET requires, at a minimum, hourly surface data and once-daily (morning) upper air sounding profiles. The processing program produces two files for input to AERMOD: a surface file containing calculated micrometeorological variables (heat flux, stability, and turbulence parameters) that represent the dispersive potential of the atmosphere, and a profile file that provides vertical profiles of wind speed, wind direction, and temperature. In the case of meteorological data files developed from NWS data, the profiles contain only one level (the surface level) and a meteorological interface within AERMOD generates vertical profiles of wind, temperature, and turbulence from the input data files. It is important to consider the full set of processing steps, including the profiling done within AERMOD, when evaluating the representativeness of a measurement site for application at a particular location such as the Limestone Station.

Meteorological representativeness is a function of a number of factors, including distance between the measurement and application site, and land use and terrain near the measurement site compared to land use and terrain in the vicinity of the application site. Differences are expected between airport land use and land use surrounding almost any application site, and frequently there are differences in terrain between measurement and application sites. Neither EPA nor TCEQ have established quantitative criteria for assessing whether differences are significant; therefore, this comparison is made based on a qualitative assessment and consideration of the importance of the land use and terrain differences to the analysis.

Terrain

Figure 3-1 displayed the relative locations of the airport and Limestone Station; as noted previously, the airport is approximately 43 miles (69 kilometers) north of the Station. Figure 3-3 provides a depiction of terrain elevations surrounding the airport and the Station. This part of Texas is relatively flat; the airport is only about 5 meters lower in elevation than the Station, and as Figure 3-3 shows there are no intervening elevated terrain features that could significantly affect wind flow. Figure 3-2 displayed a wind rose based on measurements at the airport; the predominant south to south-southeast flow, with secondary northerly flow, is typical of many locations in East Texas and is thus indicative that the winds measured at the airport are representative of a large area.

Figure 3-3: Area Terrain Elevations



Land Use

Three parameters that represent land use characteristics around a measurement site are the Bowen ratio, noon-time albedo, and surface roughness. The Bowen ratio is an indicator of surface moisture and the albedo is a measure of the reflectivity of the land surface – together they are used by AERMET to estimate heat flux and other boundary layer parameters such as the convective mixing height and indicators of the stability of the atmosphere. The surface roughness is related to the heights of obstacles to the wind flow, and is used to parameterize other surface stability indicators in AERMET and is a factor in determining the strength of mechanical turbulence, and hence the degree of plume dispersion, in AERMOD. The focus of representativeness based on land use is on the three parameters Bowen ratio, albedo, and surface roughness.

The Bowen ratio and albedo associated with land use characteristics are calculated in AERSURFACE within an area 10km by 10km centered on the site being evaluated. Land use within an area this size surrounding the Corsicana Municipal Airport (reference Figure 3-1) contains roughly the same amount of developed areas as the area surrounding Limestone, and both sites have light wooded areas to the north. Most of the development around Corsicana is in the form of small residential neighborhoods, while most of the area surrounding Limestone is characterized by gas and oil extraction, which, while somewhat

industrialized, results in very few large structures in the area. Since there are no heavily industrialized or urbanized areas around the airport or power plant, it is expected that the Bowen ratio and albedo values for the two sites are similar. This is borne out by using AERSURFACE to determine these parameters for both sites. The albedo values produced by AERSURFACE for both sites are nearly identical – 0.15 to 0.18. The Bowen ratio values produced by AERSURFACE for the airport range from 0.42 to 0.80; and almost identical – 0.44 to 0.80 – at the Limestone site. These differences are not significant in terms of the overall effect on AERMET computations for boundary layer parameters and subsequent use in AERMOD.

Surface roughness is calculated by AERMET as a function of land use characteristics within a circle centered on the site being evaluated, with a recommended radius of 1 km. The current version of AERSURFACE utilizes the USGS NLCD 1992 land use data set as the source of land use information. To compare land use as it relates to surface roughness, ERM first evaluated whether significant changes have occurred since 1992 in the vicinity of the airport and the Limestone site, and evaluated on a qualitative basis the characteristics surrounding the airport anemometer compared to characteristics surrounding Limestone.

Figure 3-4 is current aerial view of the area within 1 km of the area within 1 km of the Corsicana anemometer. The NLCD 1992 land use data base identifies land use categories in 30 m cells as of 1992. The land use categories extracted from NLCD 1992 have been superimposed on the aerial image in Figure 3-5. As shown in the aerial image, the majority of the area surrounding the anemometer is relatively flat with occasional obstructions and developed areas, and forested areas to the north and northeast. The NLCD 1992 land use categories shown in Figure 3-5 display a similar pattern, that indicates that the 1992 data set adequately represents the area surrounding the anemometer, but with less developed areas. Figure 3-6 displays the area within 1 km of Limestone on a current aerial image, and Figure 3-7 displays the 1992 land use characteristics superimposed on the current aerial view of the area around Limestone. A qualitative evaluation of Figure 3-7 reveals that there are significant differences between the 1992 land use data and the actual site; it appears as though the 1992 data does not include the Limestone station at all. Because of these errors, ERM undertook an effort to correct the land us characterizations for Limestone, essentially replacing incorrect land use codes with corrected codes that better represent the land use throughout the 1 km circle. Figure 3-8 displays the corrected land use values surrounding Limestone.

Figure 3-4: Corsicana Municipal Airport – 1km Aerial

Figure 3-5: Corsicana Municipal Airport – 1km 1992 NLCD Land Use

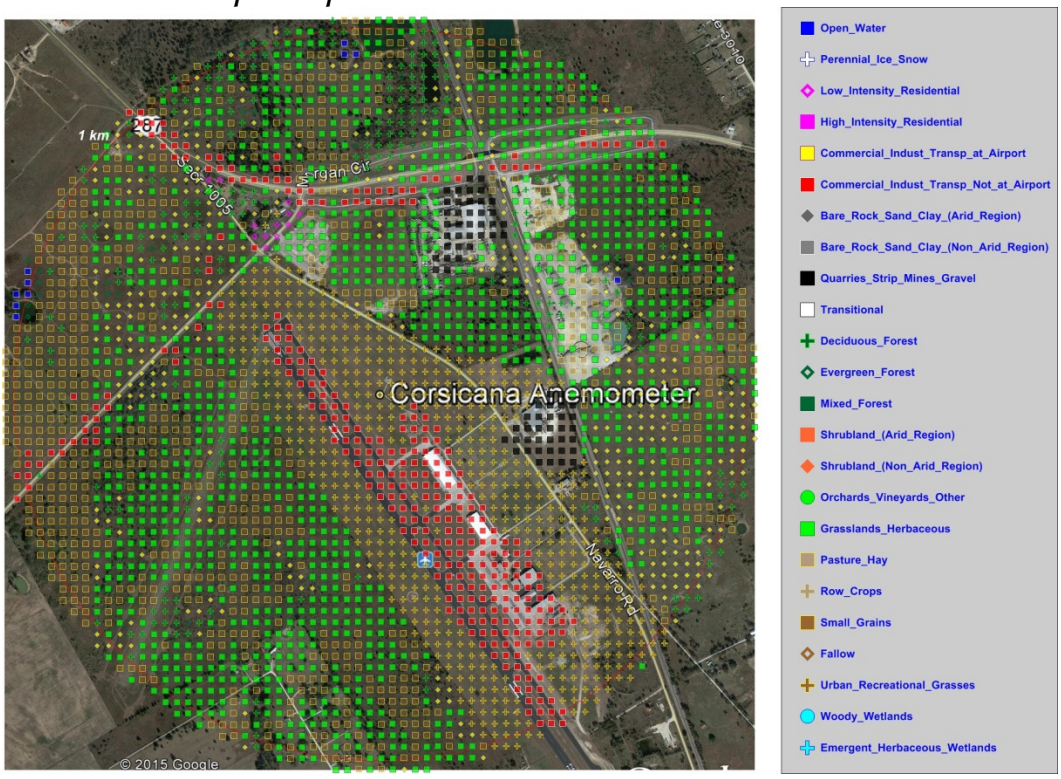


Figure 3-6: Limestone Station – 1km Aerial

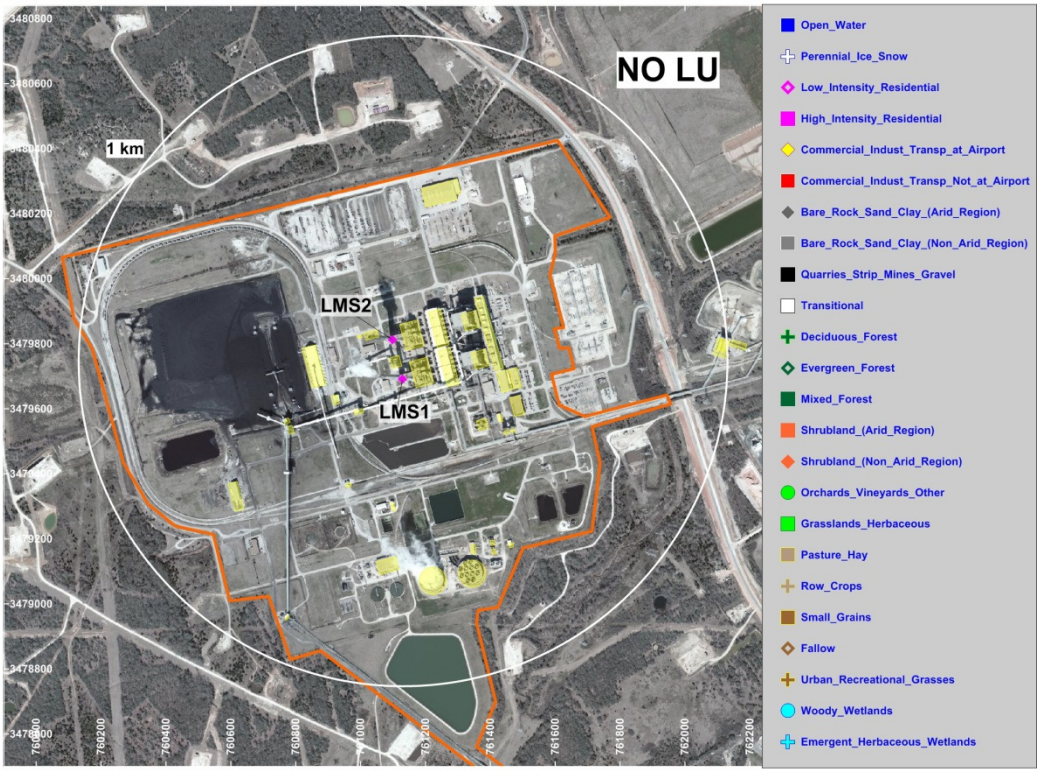


Figure 3-7: Limestone Station – 1km 1992 NLCD Land Use

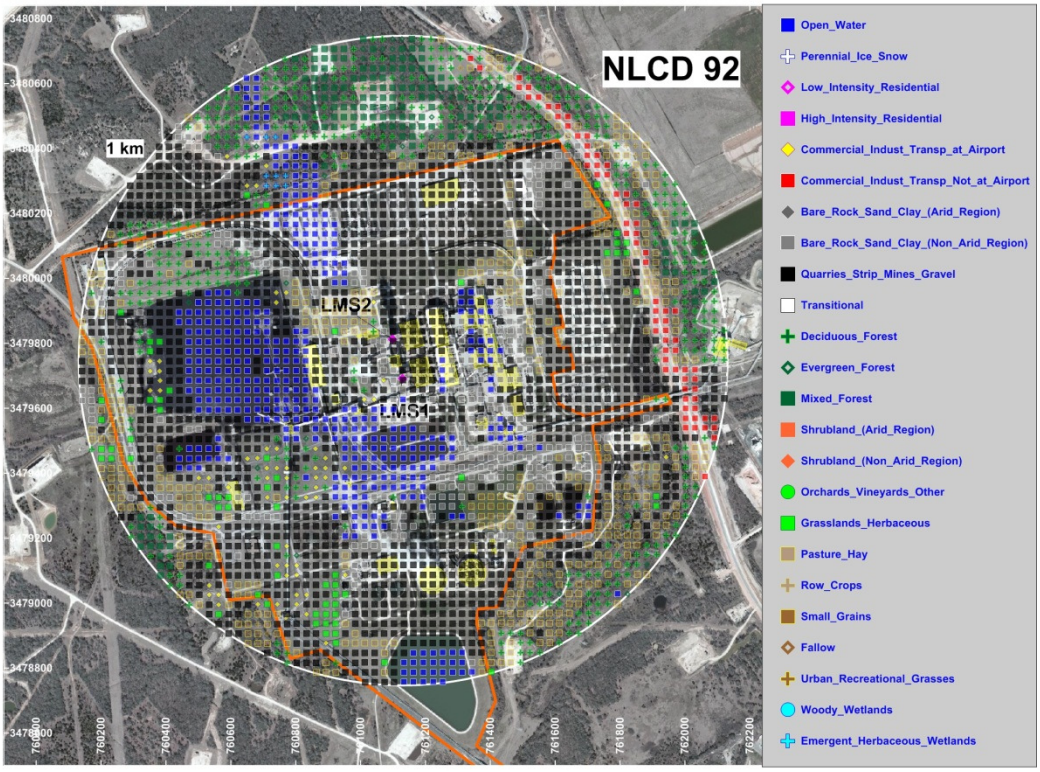
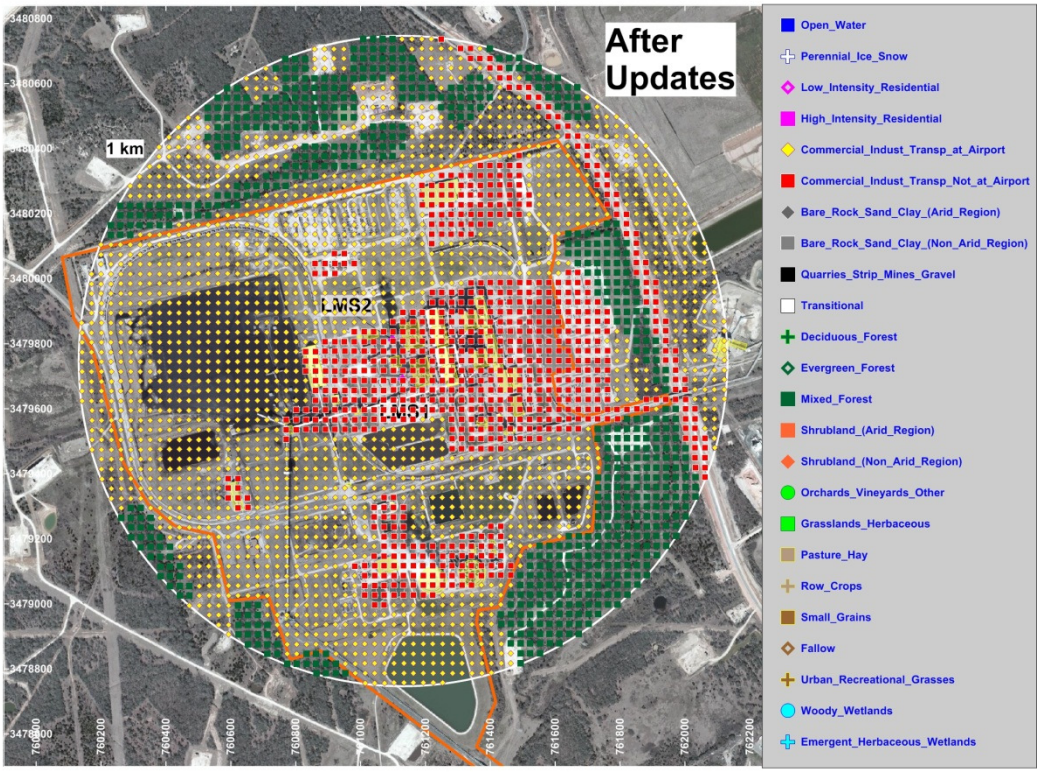


Figure 3-8: Limestone Station – 1km 1992 NLCD Land Use – Corrected



An examination of the figures presented here reveals some differences and some similarities between land use surrounding the airport and land use surrounding the Limestone site. Since in particular some of the "Commercial Industrial Transportation" categories at the airport represent the runways, there is less to contribute to larger values of the roughness length at the airport than at the Limestone site. For some important reasons, however, the corrected land use values surrounding Limestone were used to characterize surface roughness for input to AERMET. The first is to capture directional differences between the airport and Limestone, consistent with the goal of the TAD to reproduce "what a monitor would measure" in mind. The second reason is related to the fact that the important dispersion regime for the stacks being modeled at Limestone is above the surface layer – with an average plume rise of approximately 150 meters, total plume height for the Limestone sources is in the range of 300 meters above the ground. Surface values of turbulence for these plumes are considerably less important than turbulence values determined for the layer several hundred meters above the surface. Since turbulence levels at plume height depend strongly on the roughness length (in addition to the stability parameters), a roughness length more representative of the site provides a more realistic, and ultimately more accurate, estimate of turbulence at plume level and therefore a more accurate depiction of "what a monitor would see" than roughness length values determined for the airport.

ERM calculated roughness length values on a seasonal and direction-specific basis, assigning roughness length values for each land use cell based on the values contained in Table A-3 of the AERSURFACE users' guide (EPA, 2008). Effective roughness was calculated in a manner entirely consistent with AERSURFACE, namely as the distance-weighted geometric mean of all land use cells upwind of the sources being modeled, with the following formula:

$$z_0 \text{ effective} = \exp\hat{}(\sum \ln(z_0)_{xy} / d_{xy}) / (\sum 1 / d_{xy})$$

AERSURFACE is not a required tool in the set of related AERMOD processing programs. ERM took a different approach than AERSURFACE in terms of determining which cells are "upwind" for a particular wind. This different approach is appropriate for situations where the stacks being modeled are separated by up to a few hundred meters, as it more accurately defines "upwind" as not based on a single point. An illustration of the difference between the AERSURFACE approach and the modified "wedge" approach used by ERM is illustrated in Figure 3-9 and Figure 3-10.

Figure 3-9: Example of "Upwind" based on AERSURFACE

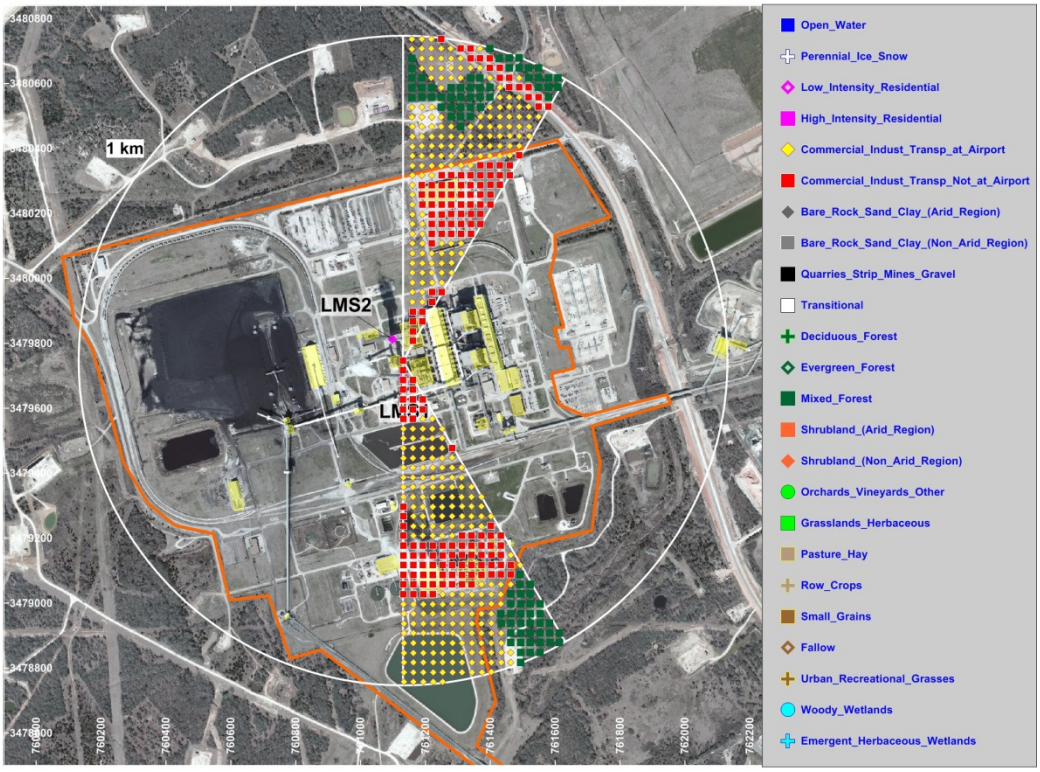
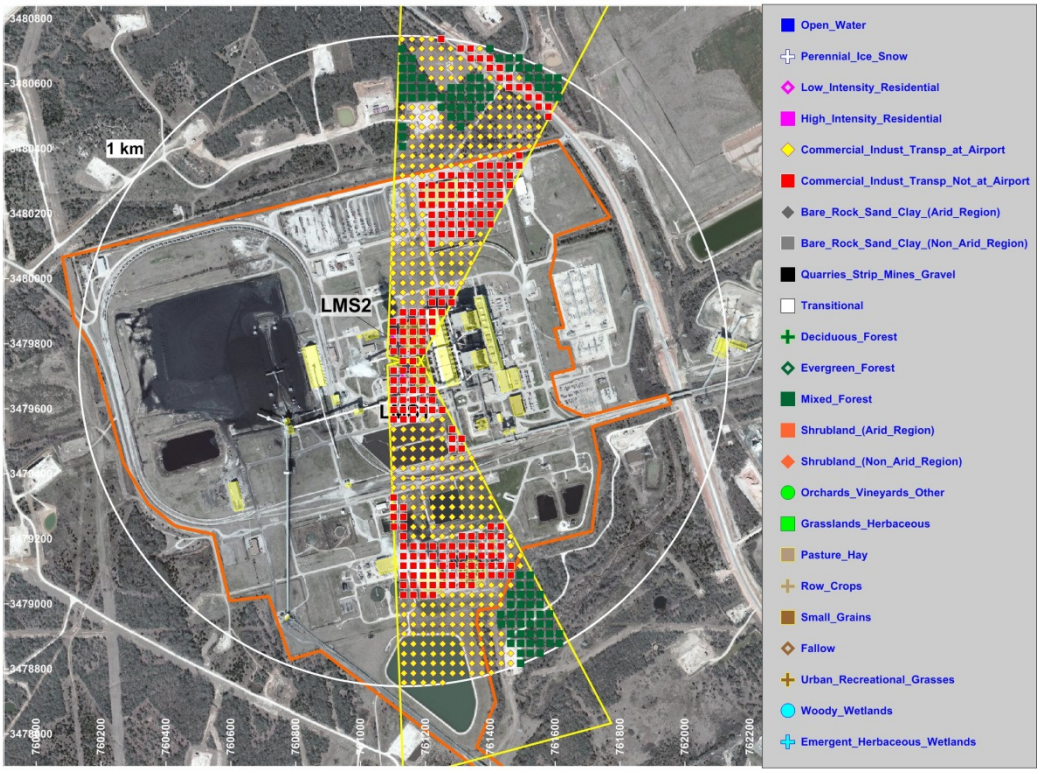


Figure 3-10: Example of "Upwind" based on the "Wedge" Approach



Land use files were created based on this approach and combining the roughness length determinations with the Bowen ratio/albedo values generated by AERSURFACE. AERMINUTE was used to develop speed and direction values for low-wind hours. Upper air profiles were generated and filled in for the Fort Worth, TX upper air sounding station, and AERMET was run to create 3 years (2012-2014) of meteorological files used in AERMOD.

3.4 *RECEPTOR GRID*

A comprehensive Cartesian receptor grid extending out to approximately 20 kilometers (km) from Limestone was used in the AERMOD modeling analysis to assess maximum ground-level 1-hour SO_2 concentrations. The Modeling TAD states that the receptor grid must be sufficient to determine ambient air quality in the vicinity of the source being studied. The 20-kilometer receptor grid is more than sufficient to resolve the maximum 1-hour SO_2 impacts, and it clearly illustrates decreasing SO_2 concentration gradients in relation to the plant. Further, the receptor grid used in the modeling is consistent with the guidelines provided by the TCEQ for regulatory applications.

Specifically, the Cartesian receptor grid consisted of the following receptor spacing:

- 50-meter spacing along the facility fence line;
- 100-meter spacing extending from the fence line to 3 kilometers;
- 200-meter spacing extending from 3 to 5 kilometers;

- 500-meter spacing extending from 5 to 10 kilometers; and
- 1,000-meter spacing extending from 10 to 20 kilometers.

The above receptor data was used without modification in the modeling. Per the 1-hour SO_2 Modeling TAD, receptors located over areas where monitors could not reasonably be sited could be excluded from the modeling, but these receptors were retained in this analysis as a measure of conservatism.

Terrain elevations from National Elevation Data ("NED") from USGS were processed using the most recent version of AERMAP (v.11103) to develop the receptor terrain elevations required by AERMOD. NED data files contain profiles of terrain elevations, which in conjunction with receptor locations are used to generate receptor height scales. The height scale is the terrain elevation in the vicinity of a receptor that has the greatest influence on dispersion at that location and is used for model computations in complex terrain areas. The near-field (within 5 kilometers) and far-field (full grid) receptor grids are shown in Figure 3-11 and Figure 3-12, respectively.

Figure 3-11: Near-Field Model Receptors

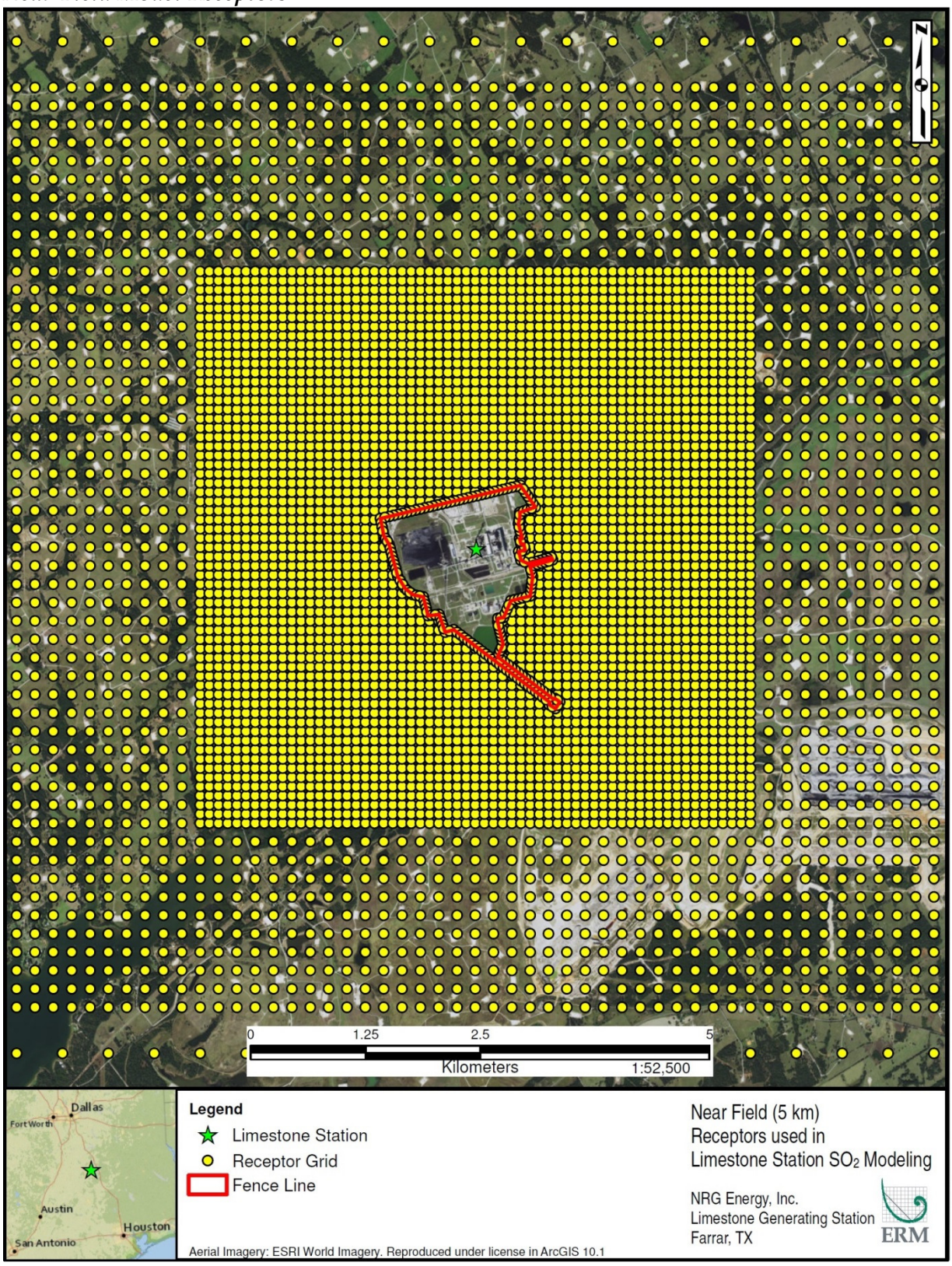
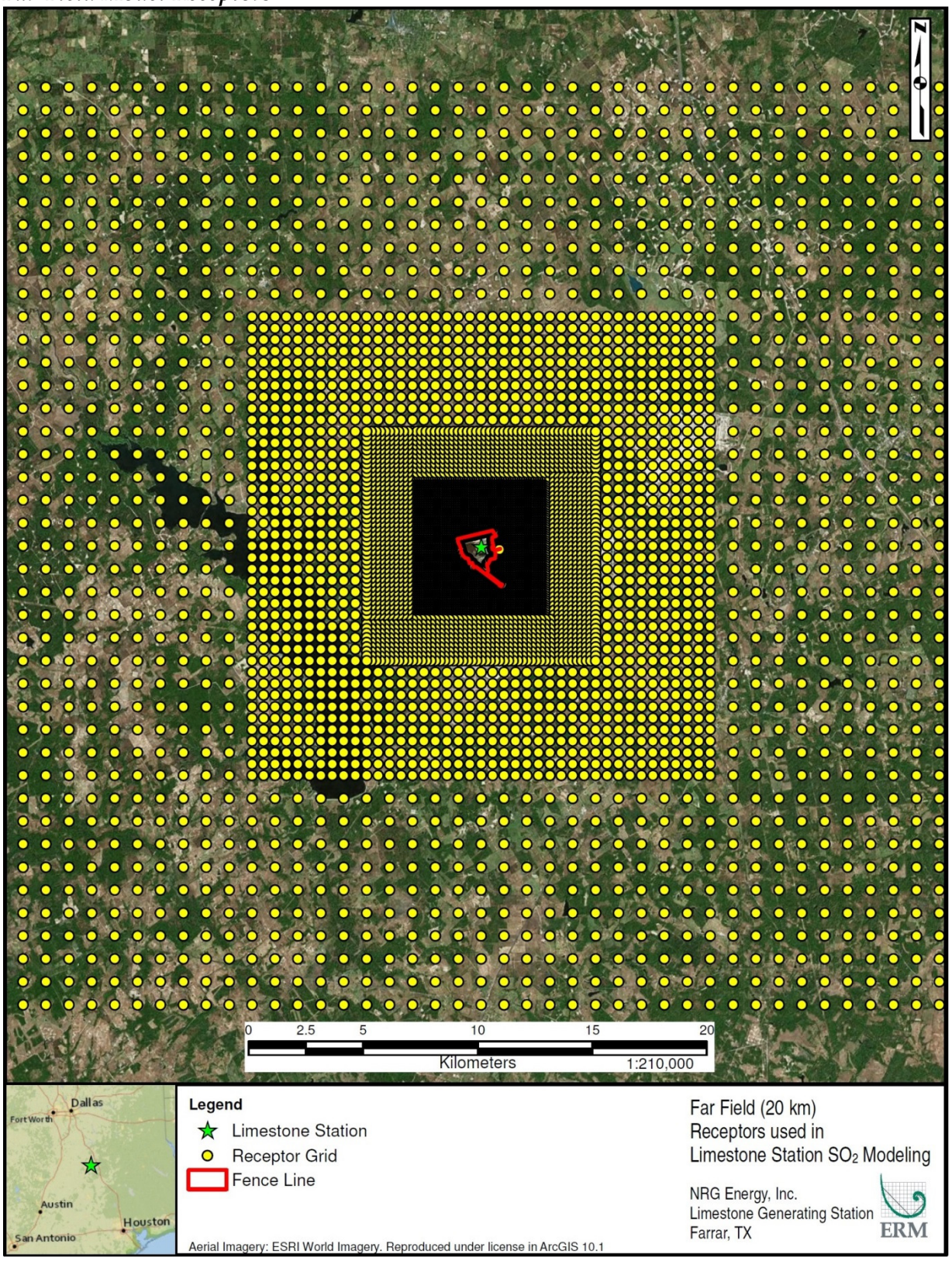


Figure 3-12: Far-Field Model Receptors



3.5 GOOD ENGINEERING PRACTICE STACK HEIGHT ANALYSIS

Good engineering practice ("GEP") stack height is defined as the stack height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, or eddy effects created by the source, nearby structures, or terrain features.

A GEP stack height analysis was performed for each stack using the Building Profile Input Program (BPIP) in accordance with USEPA's guidelines (USEPA 1985). Per the guidelines, the physical GEP height, (H_{GEP}), is determined from the dimensions of all buildings which are within the region of influence using the following equations, depending on the construction data of the stack:

For stacks in existence on January 12, 1979 and for which the owner or operator had obtained all applicable permits or approvals required,

$$H_{GEP} = 2.5H,$$

provided the owner or operator produces evidence that this equation was actually relied on in establishing an emission limitation;

(1) For all other stacks:

$$H_{GEP} = H + 1.5L$$

where:

H = height of the structure within 5L of the stack which maximizes H_{GEP}; and

L = lesser dimension (height or projected width) of the structure.

For a squat structure, i.e., height less than projected width, the formula reduces to:

$$H_{GEP} = 2.5H$$

In the absence of influencing structures, a "default" GEP stack height is creditable up to 65 meters (213 feet).

A summary of the GEP stack height analyses is presented in Table 3-2. As described in the SO_2 Modeling TAD, when modeling actual emissions in order to determine the attainment status of the facility when compared to the 1-hour SO_2 NAAQS, the full height of all stacks is allowed in the modeling regardless of their GEP Formula Heights. Both stacks at Limestone are below their respective GEP heights so application of the SO_2 Modeling TAD did not affect the stack height assumptions for Limestone. The locations of all structures and sources included in the GEP analysis are shown in Figure 3-13. The output from BPIP

was input into AERMOD to represent aerodynamic downwash caused by structures around the stacks.

Figure 3-13: Structures Included in the Limestone GEP Analysis

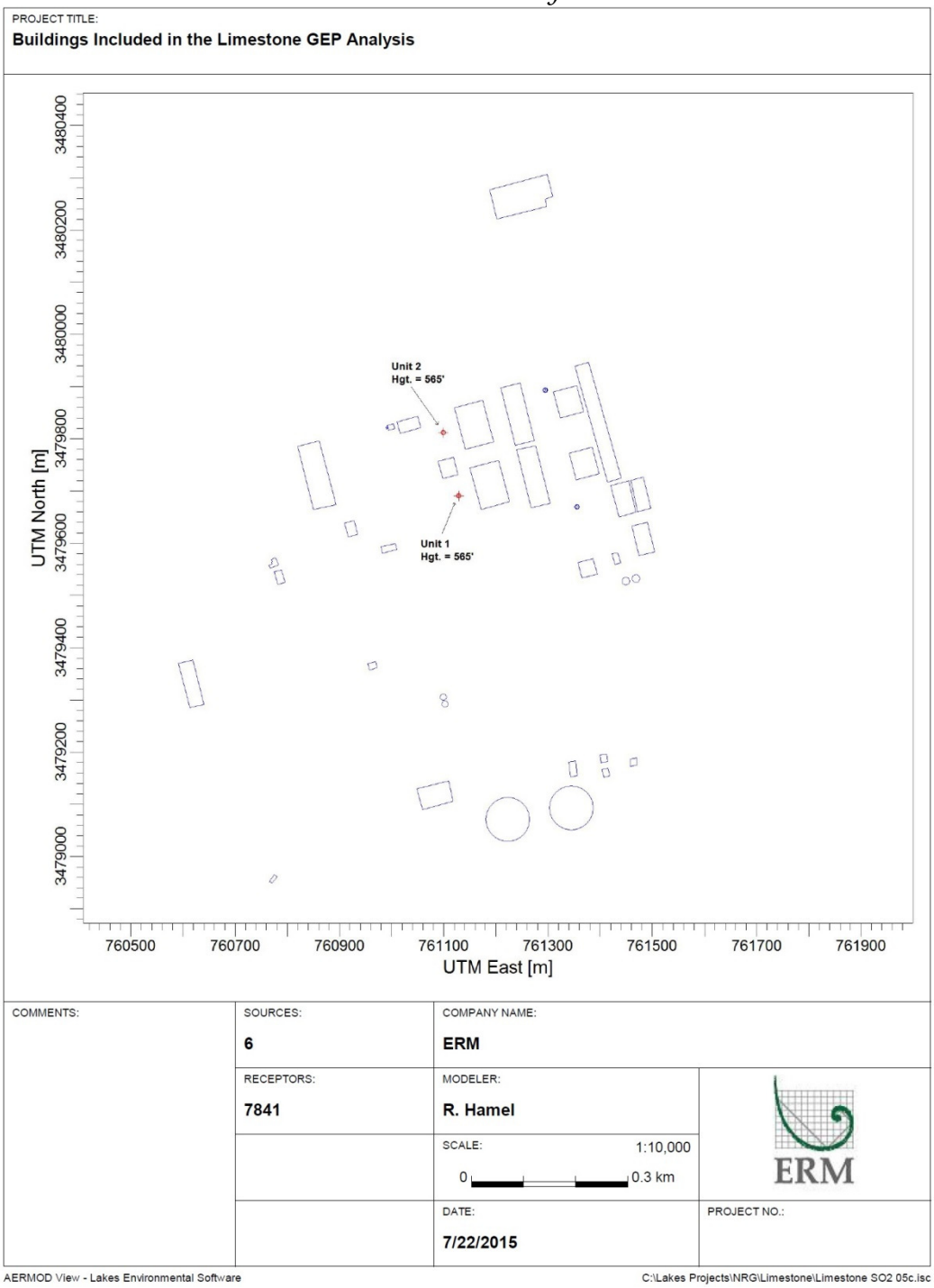


Table 3-2: Summary of Limestone Station GEP Analysis

Emission Source	*Stack Height (m)*	*Controlling Buildings / Structures*	*Building Height (m)*	*Projected Width (m)*	*GEP Formula Height (m)*[1]
LMS1	172.21	Unit 2 Boiler Bldg.	85.04	68.73	188.13
LMS2	172.21	Unit 1 Boiler Bldg.	85.04	69.07	188.64
1. In the absence of influencing structures, a "default" GEP stack height is creditable up to 65 meters (213 feet).					

3.6 AMBIENT SO_2 BACKGROUND DATA FOR CUMULATIVE MODELING

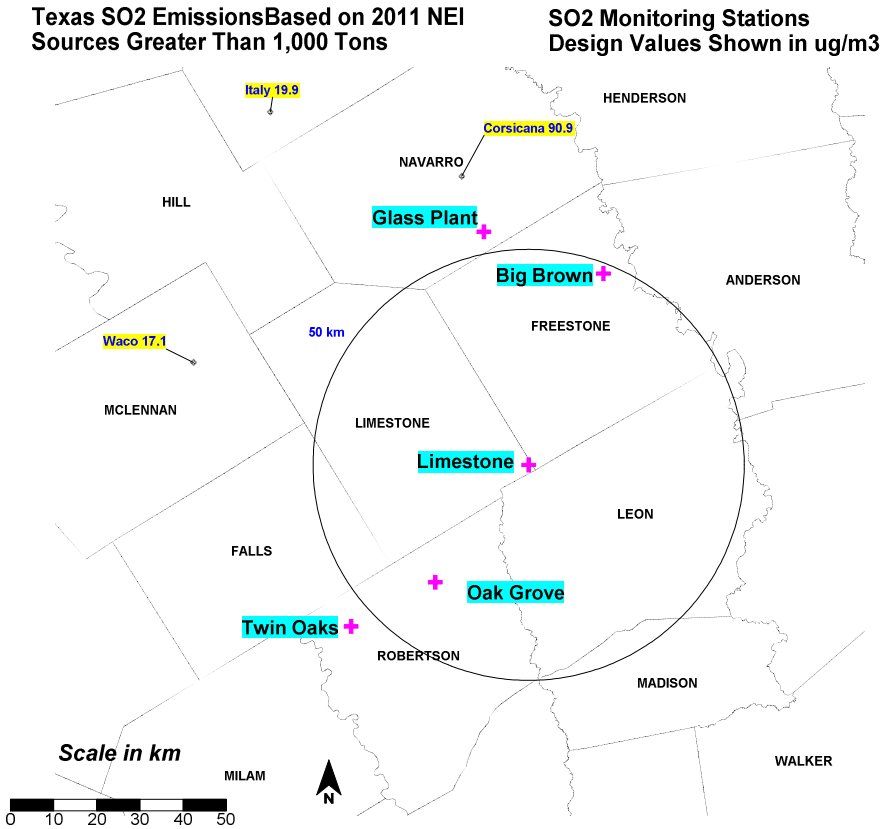
In addition to assessing impacts from Limestone Station sources, the impact from other sources of SO_2 in the region were considered in order to demonstrate that the air quality in the region is in attainment with the NAAQS. Other sources of SO_2 in the vicinity of Limestone that were explicitly included in the modeling are discussed in Section 3.7. In order to account for other minor sources of SO_2 in the area an ambient background concentration was added to model-predicted impacts from Limestone and the other sources for comparison to the NAAQS.

The criteria for determining the monitor best suited to characterize air quality at a given location include:

- Stations with similar influencing SO_2 sources as the source being modeled (not necessarily the closest).
- Avoid stations influenced by the source being modeled to prevent double-counting impacts.
- Avoid stations influenced by sources not likely to interact with the source being modeled.
- Consider predicted concentration patterns for source being modeled, along with wind frequency, to assist in selection.

Figure 3-14 shows the location of the ambient monitors in the vicinity of Limestone Station, as well as the location of all other SO_2 sources in the region that emitted more than 1000 tons of SO_2 according to the 2011 EPA National Emissions Inventory. The figure shows that there are two sources that emitted over 1000 tons of SO_2 in 2011 within 50 km. Additionally, all of the monitors sited in the region are located to the north of Limestone, approaching the Dallas-Ft. Worth area.

Figure 3-14: SO_2 Sources and Monitors in the Region



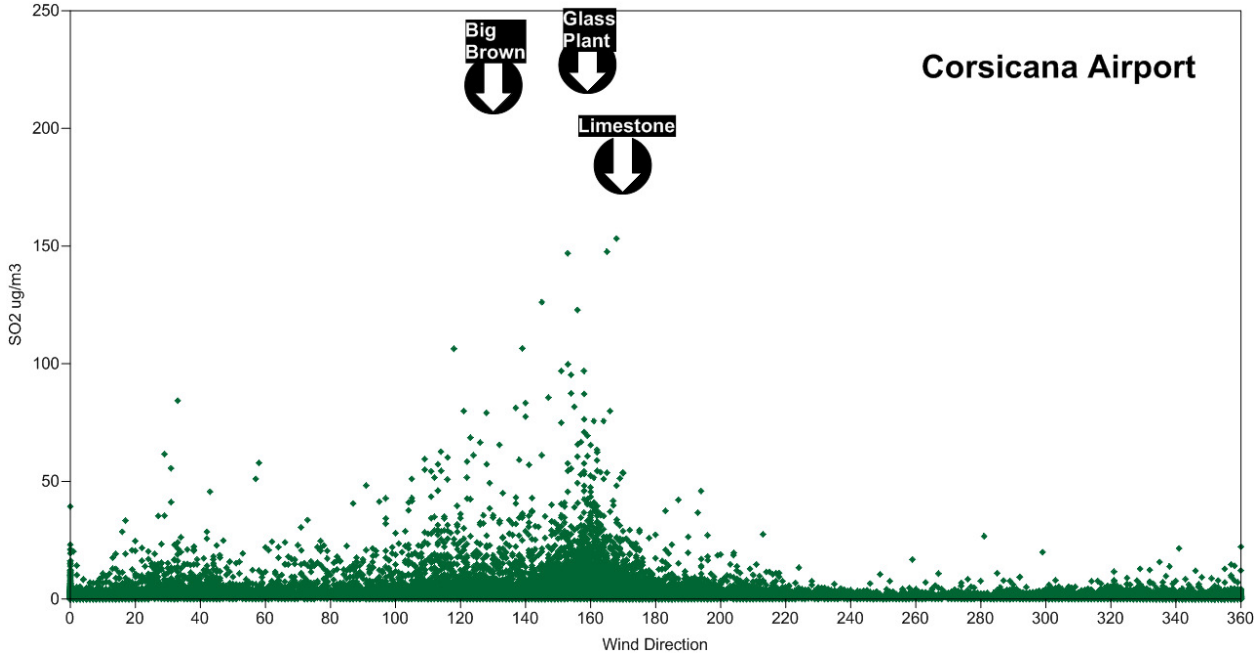
ERM evaluated 3 monitors to determine their representativeness: Corsicana (Monitor ID# 48-349-1051) to the north of Limestone, Waco (Monitor ID# 48-309-1037), located west northwest of Limestone, and Italy (Monitor ID# 48-139-1044), located northwest of Limestone.

The first monitor evaluated was the Corsicana monitor. This monitor is the closest to Limestone in terms of proximity, located 69.5 km to the north. A review of the most recent (2012-2014) years of hourly concentrations at the monitor vs. the wind direction at the time the concentration was reported, shown in Figure 3-15, shows that virtually all of the highest concentrations at the monitor occur when the wind is blowing from the direction of Limestone, Big Brown Generating Station, or Streetman Glass towards the monitor.

Because the monitor is strongly influenced by impacts from Limestone, using the Corsicana monitor would result in "double counting" the impacts from the station. Additionally, Big Brown Generating Station was also explicitly included in the modeling and therefore impacts from that station on the monitor would be "double counting sources already included in the modeling. Lastly, Streetman Glass is much closer to the monitor than it is to Limestone Station and therefore is having a greater impact on the monitor than any source in the vicinity of

Limestone would have. Thus, the monitor is not useful to represent non-facility related impacts in the region.

Figure 3-15: SO_2 Concentration vs. Wind Direction at Corsicana Monitor



The next monitor reviewed was the Waco monitor, located 82.2 km northwest of Limestone, and oriented in a downwind direction from Limestone such that impacts from Limestone itself are no longer noteworthy. As shown in Figure 3-16, the concentrations recorded at the monitor do not appear to be highly influenced by any large sources, as would be the case near Limestone, and the only two large sources within 50 km of Limestone: Big Brown Generating Station and Oak Grove Station are explicitly included in the modeling as described in Section 3.7.

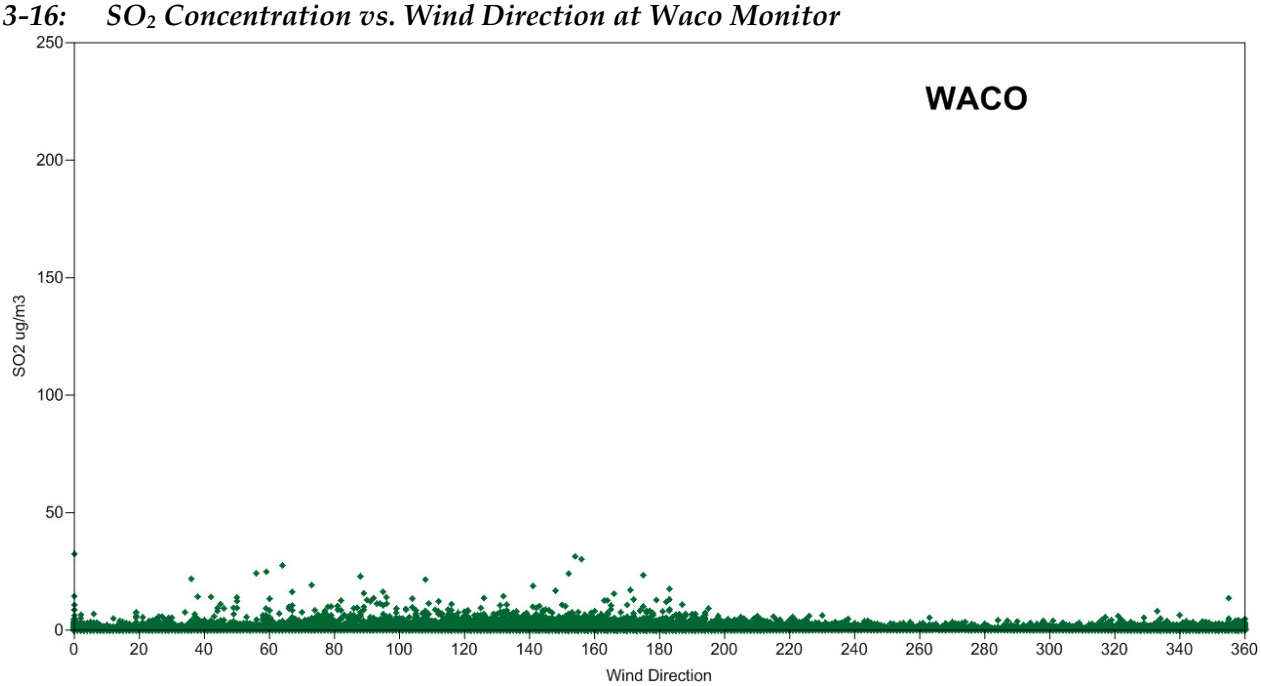
Sources that do not meet the 1,000 tons/year level were also considered. The TAD recommends that smaller sources be reviewed to determine the total magnitude of emissions and whether the smaller sources can be considered to be accounted for by background concentrations and whether they are clustered in areas where collectively the total magnitude may reach or exceed the 1,000 ton level. Table 3-3 provides a summary of the total SO_2 emissions (with and without 1,000 ton sources) within certain distance ranges of Limestone, and a summary of the total SO_2 emissions (with and without 1,000 ton sources) within certain distance ranges of the monitors closest to Limestone. Based on this analysis, the Waco monitor most closely matches the SO_2 emissions in the area around Limestone.

Table 3-3: SO_2 Emissions within 50 km of SO_2 Monitors Closest to Limestone

			SO2 TPY (NEI 2011) within distance shown				Kilometers from Limestone		
			0-10 km	10-25 km	25-50 km		East	North	Distance
	Limestone Station		228	646	69,109				
	Excluding 1000 tpy sources		228	646	0				
Monitor i.d.	Name	City							
48-139-1044	Italy	Not_in_a_city	0	4	898		-59.82	81.91	101.43
48-309-1037	Waco	Waco	0	1,020	387		-77.58	23.81	81.15
48-349-1051	Corsicana	Corsicana	225	0	374		-15.36	66.99	68.72

Lastly, in the initial screening modeling for Limestone the highest impacts were to the north of the plant. Thus any interaction with other sources would have to come from the south of Limestone, and the Waco monitor is more representative than Corsicana in representing ambient impacts coming from that direction. The Italy monitor was also considered, but the monitor is farther away from Limestone than Waco, and the pattern of SO_2 emissions is less similar to that of Limestone than Waco. For all of the reasons described here, Waco was chosen as the monitor most representative of the ambient air quality in the area around Limestone.

Figure 3-16: SO_2 Concentration vs. Wind Direction at Waco Monitor



EPA guidance allows simulation of background values that vary by season and hour of day that could simulate a lower value than the 99th percentile. The modeling was performed with a set of seasonal diurnal values developed using the methodology described in the USEPA March 1st, 2011 Clarification Memorandum for 1-hour NO_2 Modeling. Though this memorandum primarily addresses NO_2 modeling, page 20 describes the process for developing seasonal

diurnal background values for SO_2 as well. The seasonal diurnal values used are shown in Table 3-4.

Table 3-4: Seasonal Diurnal Ambient SO_2 Concentrations ($\mu g/m^3$)

Hour[1]	*Winter*	*Spring*	*Summer*	*Fall*
1	3.05	3.23	3.40	4.80
2	2.70	2.88	3.75	9.60
3	2.97	2.97	3.32	9.07
4	4.01	1.83	3.32	6.98
5	1.83	1.66	2.36	2.53
6	2.18	1.40	2.36	2.70
7	1.92	1.48	2.01	3.23
8	1.83	1.40	1.83	2.62
9	2.70	2.09	4.19	3.75
10	4.01	4.19	7.33	7.77
11	11.34	5.32	6.54	13.44
12	13.26	3.40	4.80	9.07
13	2.74	3.14	5.24	7.68
14	12.13	4.28	5.06	8.99
15	7.07	4.01	4.01	7.15
16	8.73	4.19	3.66	7.33
17	8.64	3.75	4.10	6.81
18	6.81	3.66	3.40	7.07
19	7.77	3.49	3.75	6.81
20	4.54	6.63	4.80	9.34
21	4.54	4.45	8.81	7.33
22	3.05	4.89	6.02	6.20
23	3.75	5.93	4.36	5.50
24	2.88	3.58	3.66	8.46

1. Hours in AERMOD are defined as hour-ending. i.e., Hour 1 is the period from midnight through 1 AM, etc.

3.7 REVIEW OF NON-FACILITY SOURCES FOR CUMULATIVE INVENTORY

Section 4.1 of the SO_2 Modeling TAD discusses the criteria for the addition of major SO_2 sources in the region for cumulative modeling purposes when determining the recommended attainment status of the area surrounding a facility as described in the 1-hour SO_2 Data Requirements Rule. The TAD describes sources that should be included in the modeling as those expected to have an impact on the air quality in the vicinity of the source being studied, in this case Limestone Station. Additionally, the TAD states that except in cases where numerous smaller sources are close together in the study area, consideration of sources to include should begin at sources with emissions in excess of the threshold selected in the Data Requirements Rule. For purposes of this analysis, ERM assumed not only that the lowest threshold described in the proposed final rule will be the one selected, but also that there would be no differentiation between low- and high-population areas in the final rule.

The 2011 EPA National Emissions Inventories (NEI) was reviewed to determine candidate major sources. For the purpose of this study, all major sources of SO_2 within 50 kilometers of Limestone that had at least 1000 tons (the lowest possible threshold in the proposed final Data Requirements Rule) of SO_2 emissions were considered for inclusion in the modeling. Two facilities were identified in the NEI search: Big Brown Generating Station, located 47.9 kilometers to the north-northeast, and Oak Grove Generating Station located 34.9 kilometers to the southwest. Table 3-5 presents the emissions, distance, and bearing for each facility. The locations of the facility relative to the location of Limestone are shown in Figure 3-17.

Table 3-5: Major Source Considered for Cumulative Modeling Study

Facility Name	*Distance (km)*	*Bearing from Limestone Station (deg)*	*SO_2 Emissions (tpy)[1]*			
			2011	*2012*	*2013*	*2014*
Big Brown	47.9	23	64,198	60,681	62,494	57,460
Oak Grove	34.9	220	4,911	6,531	6,950	7,404

1. Emissions data from EPA Clear Air Markets Database. (http://www.epa.gov/airmarkets/)

Cumulative Sources for 1-hour NO_2 and SO_2 NAAQS Modeling:
On Page 16 of the 1 March 2011 USEPA Memorandum "*Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 Ambient Air Quality Standard*" (USEPA 2011)[3], the following statement is made regarding the focus area for consideration for 1-hour NO_2 cumulative modeling:

"..Even accounting for some terrain influences on the location and gradients of maximum 1-hour concentrations, these considerations suggest that the emphasis

[3] http://www.epa.gov/scram001/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

on determining which nearby sources to include in the modeling analysis should focus on the area within about 10 kilometers of the project location in most cases. The routine inclusion of all sources within 50 kilometers of the project location, the nominal distance for which AERMOD is applicable, is likely to produce an overly conservative result in most cases."

While the memo specifically refers to NO_2 modeling, the similarity in the form of the 1-hour NO_2 and SO_2 standards and their probabilistic nature suggest that the same approach would be appropriate for identifying major sources for inclusion in a SO_2 cumulative modeling exercise as well.

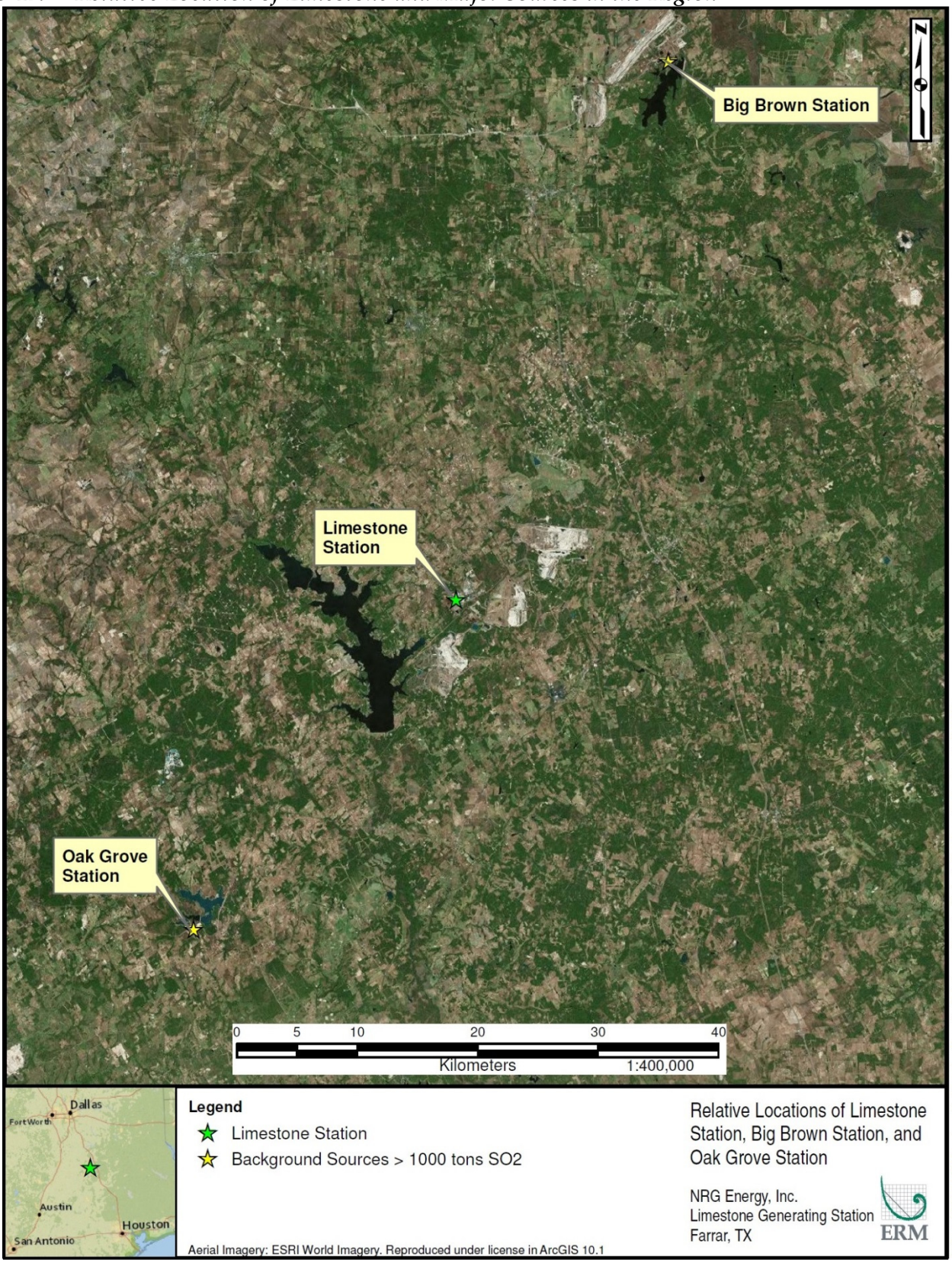
Despite the above EPA memorandum and the considerable distance of Big Brown and Oak Grove from Limestone Station, for conservatism both sources were included in the modeling. Hourly emissions data for each EGU at both stations were downloaded from the Clean Air Markets database for use in the modeling, and stack parameters for each unit were provided by TCEQ via email on July 16, 2015. Table 3-6 shows the stack parameters for each source located at Big Brown Station and Oak Grove Station. Based on the review of SO_2 emissions from smaller sources described in Section 3.6, the measured background concentration accounts for all other SO_2 sources in the area surrounding Limestone.

Table 3-6: Cumulative Inventory Source Parameters

Description	*Model Source*	*Stack Height*		*Exit Temperature*		*Exit Velocity*		*Stack Diameter*	
		(ft)	*(m)*	*(F)*	*(K)*	*(ft/sec)*	*(m/s)*	*(ft.)*	*(m)*
Big Brown Generating Station									
Unit 1	BB1	400	121.92	250.0	394.26	77.69	23.68	27.0	8.23
Unit 2	BB2	400	121.92	250.0	394.26	77.69	23.68	27.0	8.23
Oak Grove Generating Station									
Unit 1 Boiler	OG1	450	137.16	138.0	332.04	56.00	17.07	32.61	9.94
Unit 2 Boiler	OG2	450	137.16	132.8	329.15	54.99	16.76	33.99	10.36

1. Hourly SO_2 emissions from each unit were downloaded from the EPA Clean Air Markets Database

Figure 3-17: Relative Location of Limestone and Major Sources in the Region



4.0 MODELING RESULTS

The modeling results are shown in Table 4-1 below. The modeled design value represents the modeled 3-year average of the 99th percentile, maximum daily 1-hour average impact for Limestone. The predicted impacts when the seasonal diurnal background is added are then shown and compared to the NAAQS to demonstrate attainment.

Contours of the predicted impacts, as well as the location of the maximum predicted impact of 176.6 µg/m^3 for the cumulative NAAQS modeling including emissions from Limestone, Big Brown, Oak Grove, along with the ambient background concentration, are shown in Figure 4-1. The table shows that Limestone emissions, when modeled using the most recent three years of actual emissions data and combined with impacts from other nearby sources, the maximum design value is within the level of the 1-hour SO_2 NAAQS.

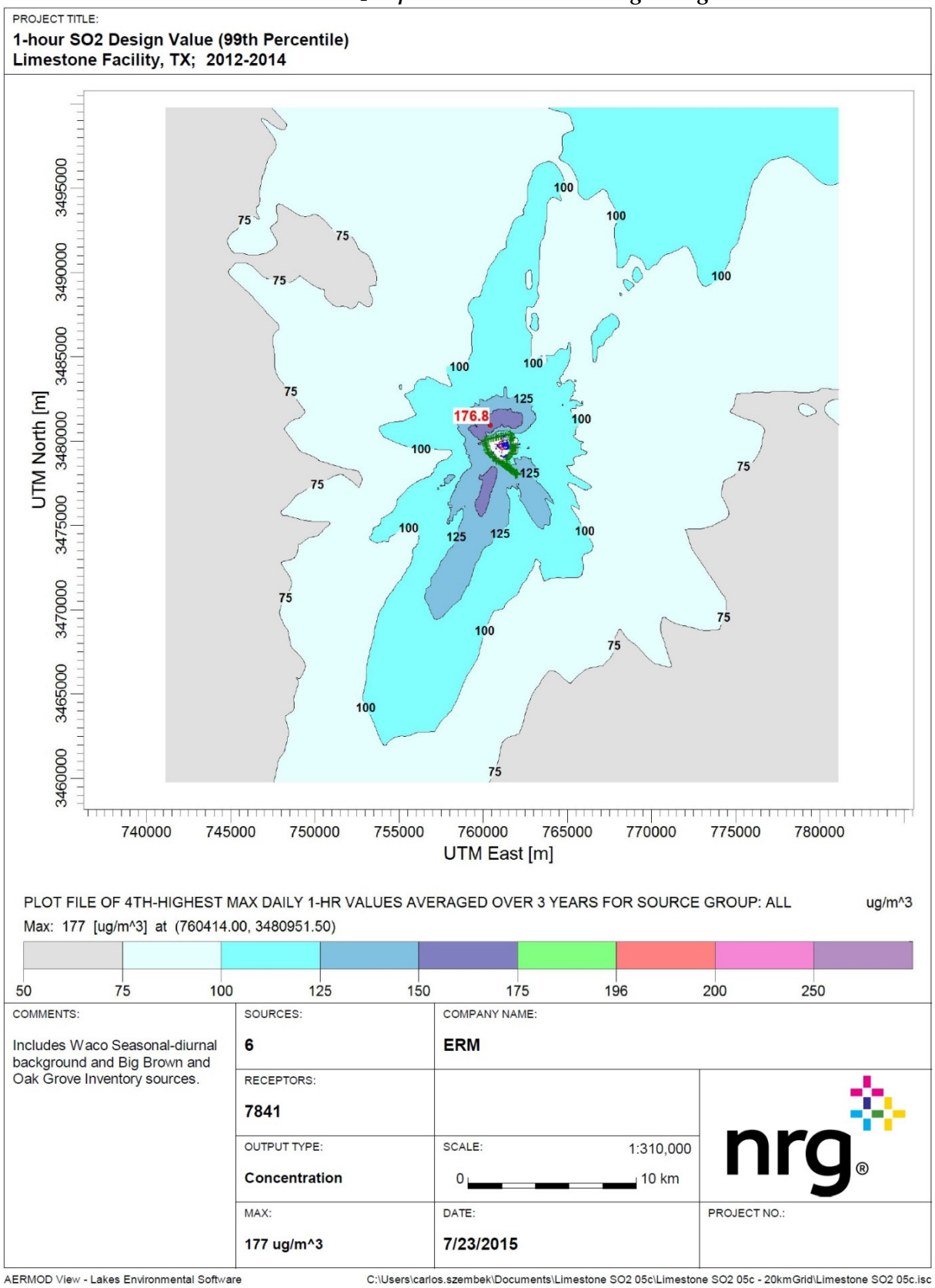
Table 4-1: 1-hour SO_2 Modeling Results for Limestone Station (µg/m^3)

Source	*Limestone Station Only*	*Cumulative Impacts*	*1-hr.SO_2 NAAQS*	*Below NAAQS?*
Limestone Station	170.1	176.6	196.5	Yes

4.1 CONCLUSIONS

The air dispersion modeling performed as described in this report shows that the SO_2 emissions from Limestone Generating Station, when combined with the impacts from other major sources and ambient background monitoring data, result in maximum predicted impacts below the 1-hour SO_2 National Ambient Air Quality Standard and therefore an attainment designation for the vicinity of Limestone Generating Station is recommended.

Figure 4-1: Limestone Station 1-hour SO_2 Impact Contours Including Background



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Attachment F

Information Submitted for the Limestone Generating Station and the W A Parish Electric Generating Station

Part 3:

Information on W A Parish Electric Generating Station

SO_2 Air Dispersion Modeling Report for W. A. Parish Generating Station

Baker Botts, L.L.P.

July 2015

www.erm.com

Baker Botts, L.L.P.

SO_2 Air Dispersion Modeling Report for W. A. Parish Generating Station

July 2015

Project No. 0266075

Peter T. Belmonte, P.E.
Partner-in-Charge

Elizabeth T. Barfield
Project Manager

Environmental Resources Management
CityCentre Four
840 West Sam Houston Parkway North, Suite 600
Houston, Texas 77024-3920
T: 281-600-1000
F: 281-520-4625

Texas Registered Engineering Firm F-2393
Texas Board of Professional Geoscientists Firm 50036

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1.0 INTRODUCTION

Environmental Resources Management (ERM), presents this air dispersion modeling report to Baker Botts, L.L.P (Baker Botts) documenting that maximum model-predicted Sulfur Dioxide (SO_2) impacts from NRG's W. A. Parish Generating Station (Parish) are in attainment with the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS). This analysis shows that the ambient air quality in the vicinity of Parish, currently undesignated for the 1-hour SO_2 NAAQS, is within the standard and should be identified as "attainment" in the next cycle of designations.

This modeling report describes the modeling methodology that was used to evaluate potential impacts of SO_2 emissions from Parish on ambient air quality.

1.2 PROJECT OVERVIEW

Unlike previous NAAQS attainment demonstrations, EPA has proposed to make 1-hour SO_2 NAAQS attainment determinations using ambient air monitoring data and/or air dispersion modeling. In situations where air modeling is used to make this determination, the approach described in EPA's proposed "Modeling Technical Assistance Document" (TAD)[1], which sets forth a significantly different technical approach compared to conventional regulatory modeling prescribed by 40 CFR Part 51, Appendix W (EPA's *Guideline on Air Quality Models*) could be used. This approach would also be expected to meet EPA's proposed 1-Hour SO_2 Data Requirements Rule (DRR).

EPA distinguishes the approaches described in the SO_2 Modeling TAD to "reflect a view that designations are intended to address current actual air quality (i.e., modeling simulates a monitor), and thus are unlike attainment plan modeling, which must provide assurances that attainment will occur." EPA's proposed approach would utilize several distinctive technical approaches, including but not limited to the following:

Simulating actual emissions and exhaust conditions (e.g., temperature and flowrate) on an hourly basis reflecting actual operations for a specified historical time period:

- Representing actual stack heights, irrespective of the GEP limitations;
- Limiting modeled ambient air receptors to locations where monitoring could actually take place and locations that would conventionally be considered "ambient air" for regulatory and permitting purposes, by excluding waterways, roadways, railways, restricted access property, and other locations not accessible to the general public or where a monitor could not reasonably be sited; and

[1] http://epa.gov/oaqps001/sulfurdioxide/pdfs/SO2ModelingTAD.pdf

- Simulating a three-year period of meteorological and background monitoring data, concurrent with the actual operating conditions and emissions, to meet EPA's objective that "modeling simulates monitoring" in this context.

ERM performed a modeling analysis evaluating the impacts on ambient air quality from SO_2 emissions at Parish. In addition, although the approach for considering cumulative ambient impacts with other SO_2 sources in the region is not specifically covered in the proposed DRR, ERM considered other sources of SO_2 within 50 kilometers for inclusion in the modeling.

As discussed in this report, ERM's approach to the modeling analysis used those refinements directly addressed in the proposed DRR, i.e. the use of actual hourly emissions, actual stack heights, and seasonal diurnal ambient background concentrations.

As shown in this modeling report, SO_2 impacts from W. A. Parish Station emission sources, when combined with ambient air concentrations taken from a representative monitor, are below the 1-hour SO_2 NAAQS.

This first section of this report describes the modeling methodology that was followed. Section 2 provides a description of the facility and the emissions included in the modeling. Model selection and the methodology used in the modeling are described in Section 3. The modeling results are presented in Section 4. References are provided in Section 5.

1.3 OVERVIEW OF METHODOLOGY

ERM's assessments were conducted in a manner consistent with United States Environmental Protection Agency (EPA) and Texas Commission on Environmental Quality (TCEQW) air quality regulations and modeling guidelines, including the following EPA documents:

- *Guideline on Air Quality Models* – 40 CFR Part 51, Appendix W, Revised November 9, 2005.
- AERMOD Implementation Guide, Revised March 19, 2009;
- "SO_2 NAAQS Designations Modeling Technical Assistance Document (Draft)," December 2013;
- "SO_2 NAAQS Designations Monitoring Technical Assistance Document (Draft)," December 2013;
- "Data Requirements Rule for the 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard (NAAQS)," Pre-publication proposed rule, April 17, 2014 (published in the Federal Register on May 13, 2014 79FR 27446); and
- "Guidance for 1-hour SO_2 Nonattainment Area SIP Submissions," April 23, 2014.

As well as:

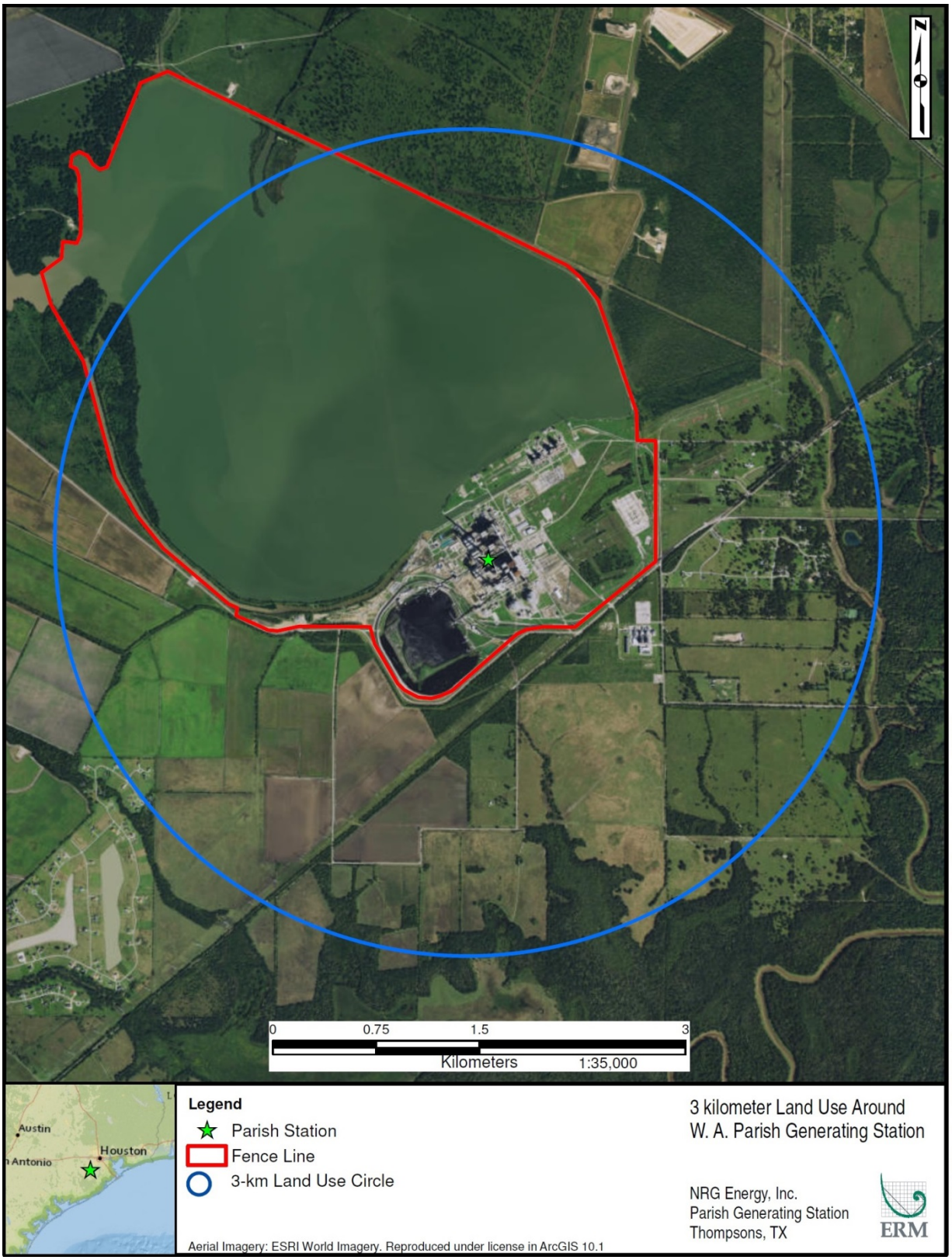
- "Air Quality Modeling Guidelines, APDG 6232", TCEQ, April, 2015.

The steps that were undertaken by ERM to conduct the air dispersion modeling analyses are summarized below:

- Compiled information on the parameters and characteristics for sources of SO_2 emissions at Parish including the 8 main EGU's, the auxiliary boiler, and the gas turbine.
- Developed a comprehensive receptor grid to capture the maximum off-site impacts from Parish sources using AERMAP (v.11103).
- Reviewed regional ambient background monitors to determine the most appropriate ambient background concentration data for SO_2 to represent sources not explicitly included in the modeling runs.
- Developed 3 years (2012-2014) of meteorological data using surface observations from Sugar Land Regional Airport in Sugar Land, TX with upper air data from Lake Charles, LA using the most recent version (v.14134) of AERMET, the meteorological data processor for AERMOD, and its two preprocessors: AERSURFACE (v.13016) and AERMINUTE (v.14237).
- Reviewed all major sources of SO_2 within 50 kilometers of Parish for possible inclusion in the cumulative modeling analysis using the 2011 National Emission Inventory Database[2], based on guidance included in the SO_2 Modeling TAD.
- Conducted an air dispersion modeling analysis using the most recent version of EPA's regulatory dispersion model, AERMOD (v.14134) and 3 years (2012-2014) of actual emissions data from Parish Sources, consistent with the methodology described in the proposed SO_2 Data Requirements Rule and SO_2 Modeling TAD.
- Summarized the results and compared them with the 1-hour SO_2 NAAQS to determine a recommended attainment designation for the vicinity of Parish.

[2] http://www.epa.gov/ttnchie1/net/2011inventory.html

FIGURE 1-1: Parish Station Surroundings and Land Use



2.0 *FACILITY DESCRIPTION AND REGULATORY SETTING*

2.1 *FACILITY LOCATION*

The W. A. Parish Generating Station is located in the town of Thompsons, Texas. The station is located about 25 miles southwest of downtown Houston, Texas. The site is accessed by FM 762 off Interstate 69. Approximate site coordinates are 29.477° North Latitude, 95.635° West Longitude. The Universal Transverse Mercator ("UTM") coordinates of the facility are 244,480 Easting and 3,263,763 Northing (using North American Datum of 1983 - NAD83) in UTM Zone 15. The base elevation of the facility is 71' (21.6m) above sea level. A full scale site plan of Parish is shown in Figure 2.1, and Figure 2.2 shows the site location marked on a United States Geological Survey ("USGS") 7.5-minute topographic map.

2.2 *SO_2 ATTAINMENT STATUS*

In July 2013, EPA issued a rule designating 29 counties or partial counties as non-attainment for 1-hour SO_2. However, the vast majority of the country was not designated by EPA at that time. None of the counties surrounding Parish, including Fort Bend, the county in which Parish is located, have been designated as attainment or non-attainment for the 1-hour SO_2 NAAQS.

FIGURE 2-1: Parish Station Site Plan

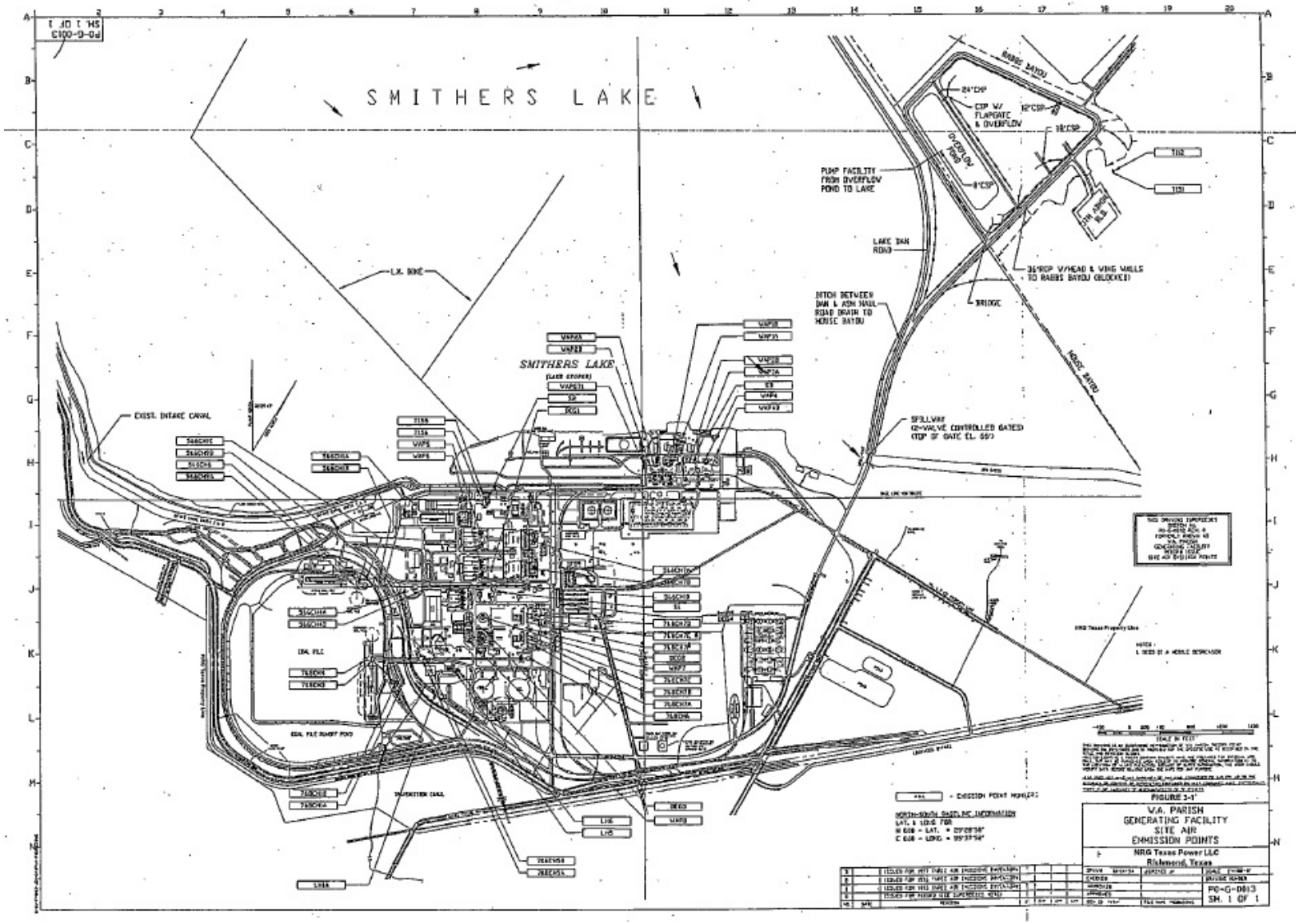
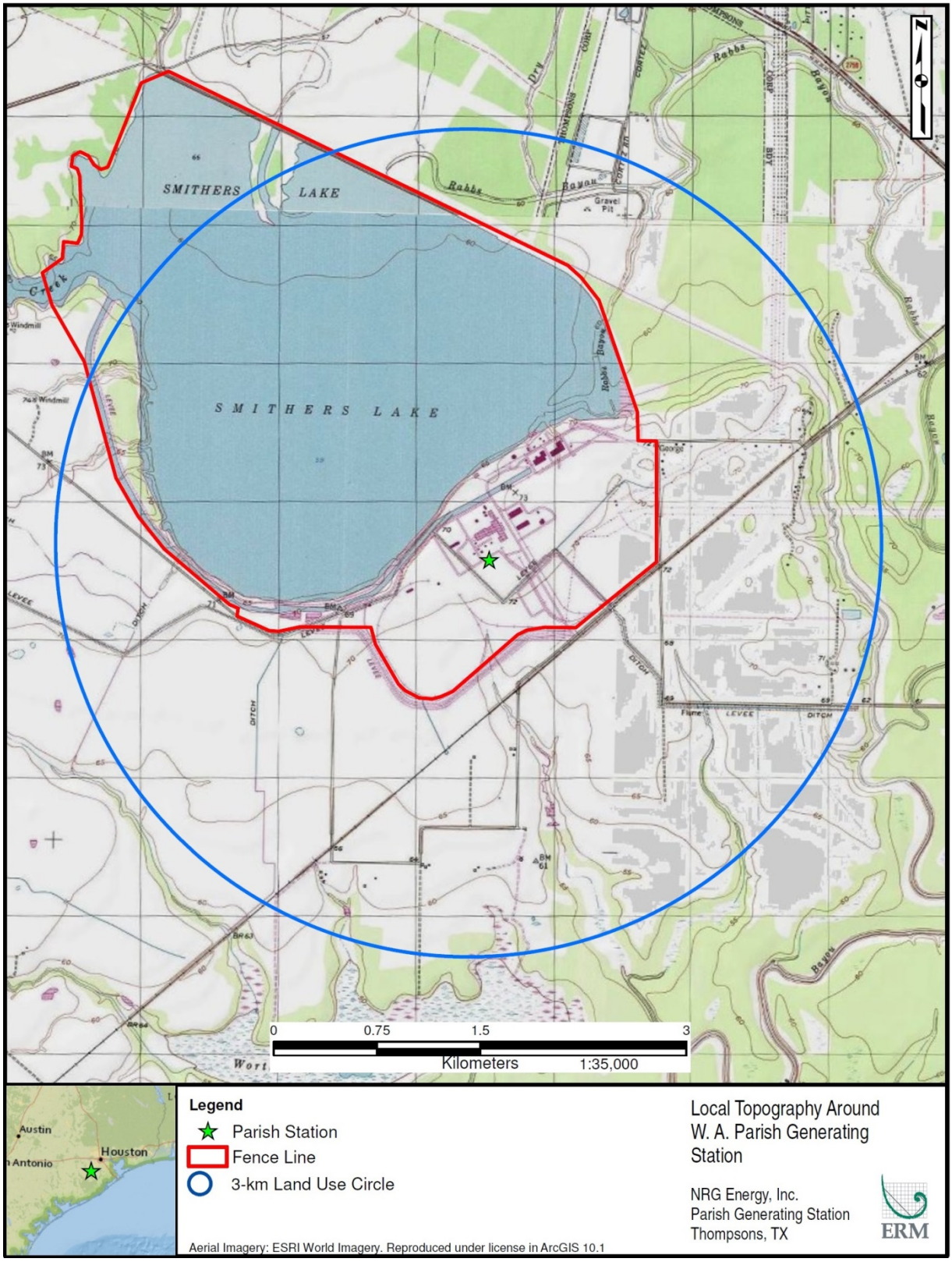


FIGURE 2-2: Parish Station Local Topography



2.3 SOURCE PARAMETERS AND EMISSION RATES

For this 1-hour SO_2 NAAQS modeling demonstration, all major sources of SO_2 at the facility were included in the modeling. Per the proposed 1-hour SO_2 Data Requirements Rule and SO_2 Modeling TAD, the most recent 3 years of actual emissions data, along with the actual stack heights of all sources, were used in the modeling. The following provides a description of all Parish SO_2 emission sources represented in the model. Table 2-1 summarizes the characteristics of the emissions sources that were included in the modeling.

TABLE 2-1: Parish Station Point Sources – Stack Parameters

Description	*Model Source*	*Stack Height*		*Exit Temperature*		*Exit Velocity*		*Stack Diameter*	
		(ft)	*(m)*	*(F)*	*(K)*	*(ft/sec)*	*(m/s)*	*(ft.)*	*(m)*
Unit 1 Boiler[1]	UNIT1A, UNIT 1B	168	51.21	---	---	---	---	10.5	3.20
Unit 2 Boiler[1]	UNIT2A, UNIT 2B	167.6	51.08	---	---	---	---	10.5	3.20
Unit 3 Boiler[1]	UNIT3A, UNIT 3B	181	55.17	---	---	---	---	12.5	3.81
Unit 4 Boiler[1]	UNIT4	182	55.47	---	---	---	---	18.0	5.49
Unit 5 Boiler[1]	UNIT5	600	182.88	---	---	---	---	24.0	7.32
Unit 6 Boiler[1]	UNIT6	600	182.88	---	---	---	---	24.0	7.32
Unit 7 Boiler[1]	UNIT7	500	152.40	---	---	---	---	24.0	7.32
Unit 8 Boiler[1]	UNIT8	500	152.50	---	---	---	---	22.5	6.86
Auxiliary Boiler[2]	AUXBOIL	45	13.72	450	505	---	---	4.5	1.37
Gas Turbine[2]	GASTURB	28	8.53	975	797	---	---	9.5	2.90

1. For the 8 main boilers, exit temperature and exit velocity varied on an hourly basis based on CEMS data.
2. For the auxiliary boiler and gas turbine, exit velocity varied on an hourly basis based on CEMS data

The actual emissions data used in the modeling are described below:

- Units No. 1 through No. 4 (Source ID's: UNIT1A, UNIT1B, UNIT2A, UNIT2B, UNIT3A, UNIT3B, and UNIT4). These units are gas-fired utility boilers that produce steam for the generation of electricity. For these units, three years (2012-2014) of actual hourly emissions, stack temperature, and exhaust flow rate data were input into the model. These data were provided by NRG based on CEMS data collected at each source. As per the proposed 1-hour SO_2 Data Requirements Rule, the actual height of each stack was represented in the model for each source.
- Units No. 5 through No. 8 (Source ID's UNIT5, UNIT6, UNIT7, and UNIT8). These units are coal and gas-fired utility boilers that produce steam for the generation of electricity and are the primary focus of this analysis. For these units, three years (2012-2014) of actual hourly emissions, stack temperature, and exhaust flow rate data were input into the model. These data were

provided by NRG based on CEMS data collected at each source. As per the proposed 1-hour SO_2 Data Requirements Rule, the actual height of each stack was represented in the model for each source.

- Auxiliary Boiler (Source ID: AUXBOIL). The auxiliary boiler provides steam for the startup of gas-fired Unit's 1, 2, and 4. The auxiliary boiler was also modeled using actual hourly emissions data and exhaust flow data provided by NRG based on CEMS data collected at the source. For this source, however, hourly exhaust temperature data was not available, so for all hours the exit temperature was set to the values located in the facility's operating permit.
- Gas Turbine (Source ID: GASTURB). The station also has a gas turbine that is available to supply electricity in emergency situations. The gas turbine was also modeled using actual hourly emissions data and exhaust flow data provided by NRG based on CEMS data collected at the source. For this source, hourly exhaust temperature data was not available, so for all hours the exit temperature was set to the values located in the facility's operating permit.
- Other sources at the site include emergency engines and fire pumps. These sources are used exclusively in emergency situations except for approximately one hour/week testing. Therefore, in accordance with USEPA guidance for intermittent sources, the emergency generator and fire pump engine were not included in the modeling demonstration for the 1-hour SO_2 NAAQS.

3.0 AIR DISPERSION MODELING ANALYSIS

ERM conducted the modeling analysis for Parish to quantify ambient impacts of SO_2 relative to the 1-hour NAAQS following the proposed approach described in the SO_2 Modeling TAD.

3.1 MODEL SELECTION AND APPLICATION

The latest version of USEPA's AERMOD model (v.14134) was used for predicting ambient impacts for 1-hour SO_2. Regulatory default options were used in the analysis. Model predicted impacts were combined with an ambient background concentration and compared to the 1-hour SO_2 NAAQS to determine the recommended attainment status of the area in the vicinity of the facility.

3.2 THE 1-HOUR SO_2 NAAQS

This study focuses on the maximum model-predicted 1-hour SO_2 impacts of Parish and compares them to the 1-hour SO_2 NAAQS. The new standard came into effect in August, 2010. The form of the standard is the 99th percentile of the 3-year average 1-hour daily maximum concentration, and the standard was set to 75 ppb (196.5 $\mu g/m^3$).

3.3 METEOROLOGICAL DATA

Guidance for regulatory air quality modeling recommends the use of one year of on-site meteorological data or five years of representative off-site meteorological data. The SO_2 Modeling TAD however, specifies that 3 years of meteorological data concurrent to the actual emissions data being input into the model be used. Since on-site data are not available for the Parish site, meteorological data available from the National Weather Service (NWS) were used in this analysis.

Three years (2012-2014) of surface observations from the NWS tower at Sugar Land Regional Airport in Sugar Land, TX (WBAN No. 12977) and concurrent upper air data from Lake Charles, LA (WBAN No. 03937) were provided by TCEQ and further refined as described in Section 3.3.1. The meteorological data were processed with the most recent version of AERMET (v.14134) the meteorological preprocessor for AERMOD, along with the two pre-processors to AERMET: AERSURFACE (v.13016) and AERMINUTE (v.14237). AERMET was applied to create the two meteorological data files required for input to AERMOD.

The data characteristics of Sugar Land Regional Airport are shown in Table 3-1. Figure 3-1 shows the relative location of the airport and Parish Station, and Figure 3-2 shows the 3-year wind rose for Sugar Land Regional Airport.

TABLE 3-1: Characteristics of the Sugar Land Regional Airport Meteorological Data

Distance from Parish Station	10.0 miles
Average Wind Speed	3.73 m/s
Percent Calm Hours	0.97%
Data Completeness	99.86%

FIGURE 3-1: Relative Location of Facility and Meteorological Site

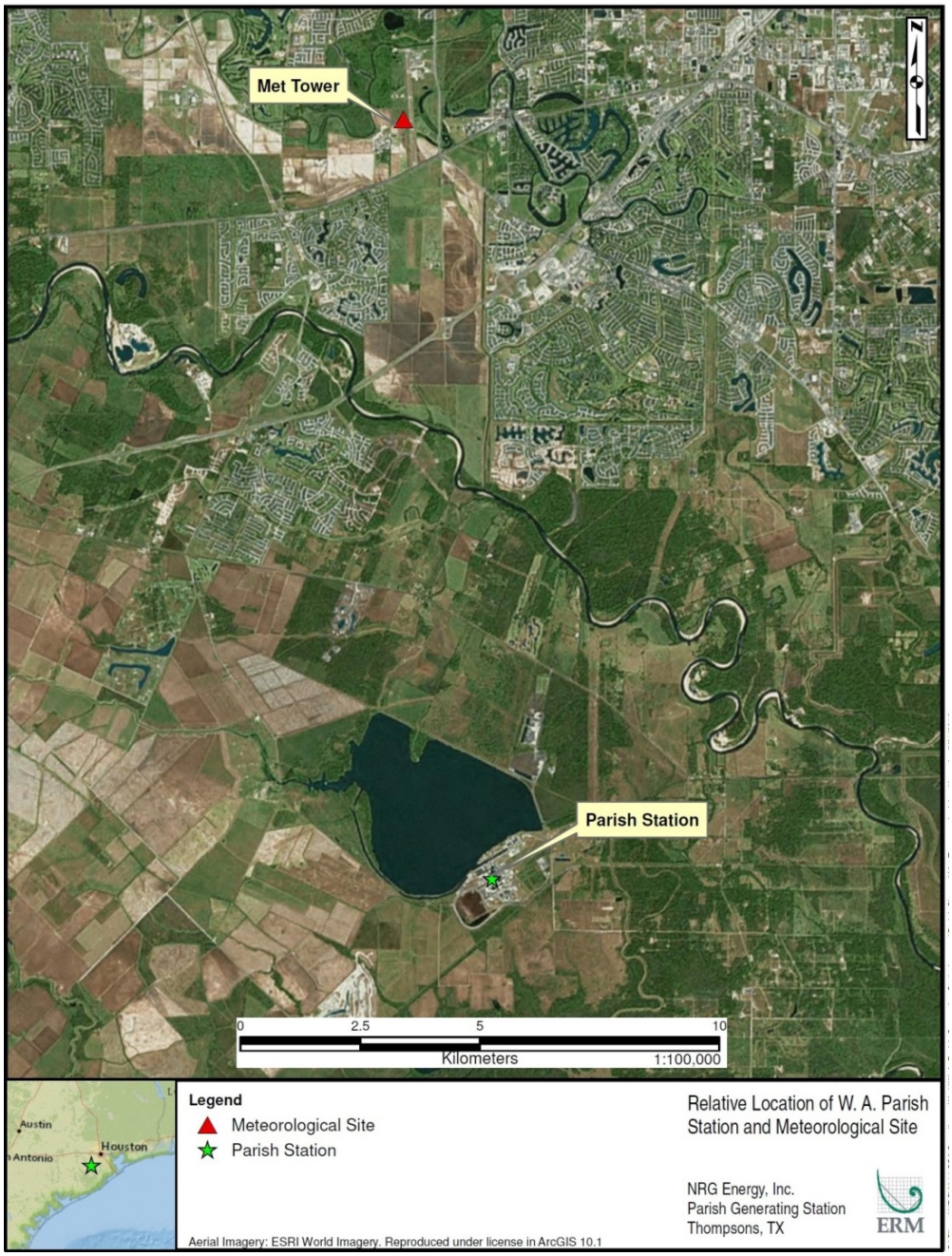
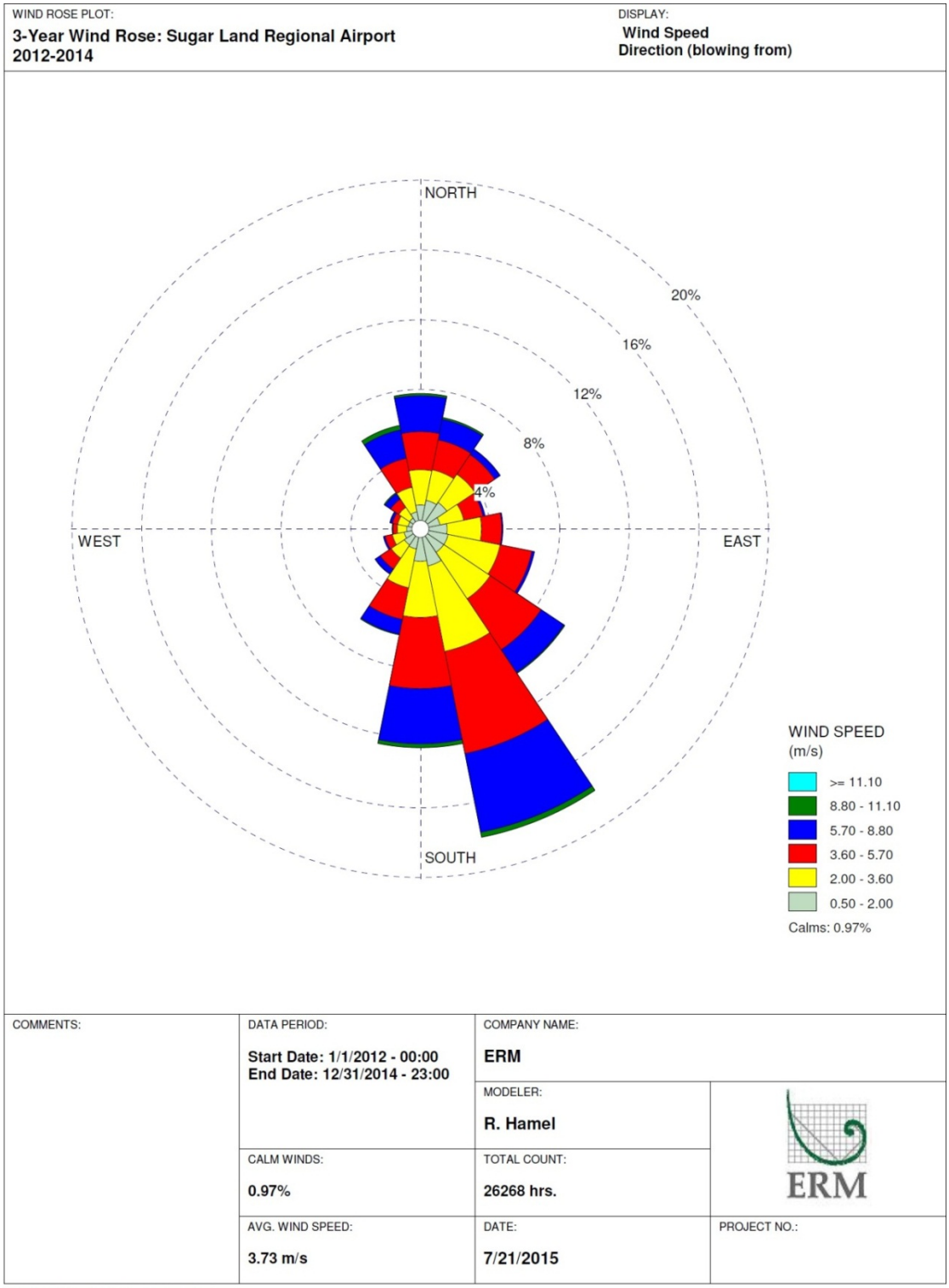


FIGURE 3-2: Three-year Wind Rose (2012-2014): Sugar Land Regional Airport



3.3.1 *Meteorological Data Refinements*

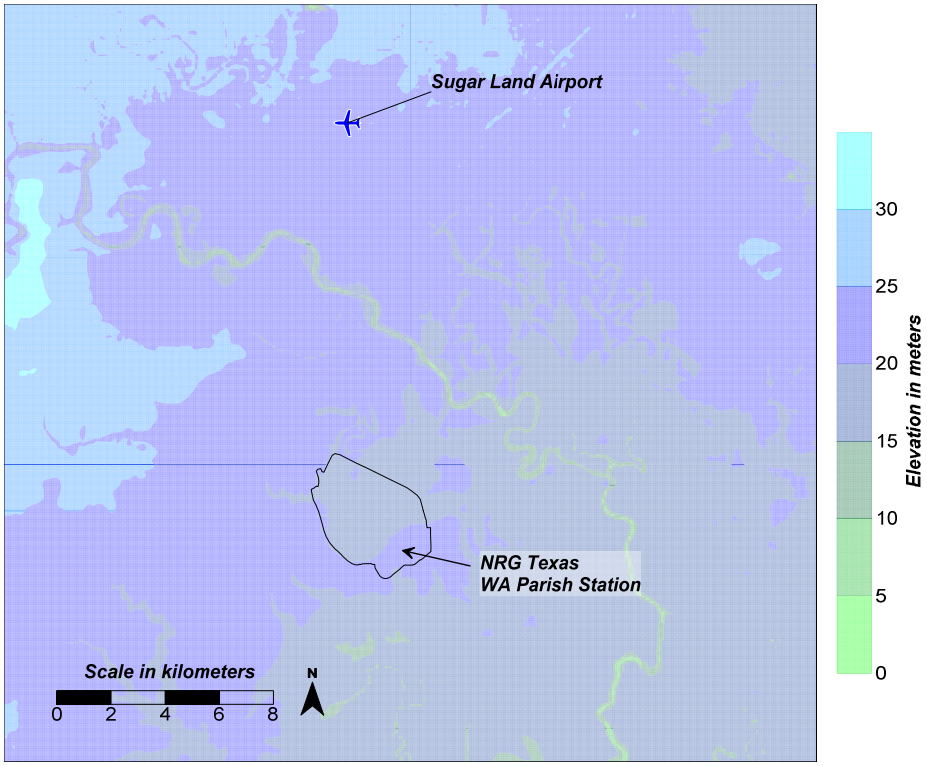
EPA and TCEQ guidelines recommend that meteorological data from a representative measurement station be used in modeling analyses to address ambient impacts. This section discusses the representativeness of data collected at the Sugar Land Airport, and also describes how these data were processed to generate AERMOD-ready input files. AERMET is the recommended processor for developing inputs to AERMOD. AERMET requires, at a minimum, hourly surface data and once-daily (morning) upper air sounding profiles. The processing program produces two files for input to AERMOD: a surface file containing calculated micrometeorological variables (heat flux, stability, and turbulence parameters) that represent the dispersive potential of the atmosphere, and a profile file that provides vertical profiles of wind speed, wind direction, and temperature. In the case of meteorological data files developed from NWS data, the profiles contain only one level (the surface level) and a meteorological interface within AERMOD generates vertical profiles of wind, temperature, and turbulence from the input data files. It is important to consider the full set of processing steps, including the profiling done within AERMOD, when evaluating the representativeness of a measurement site for application at a particular location such as the W.A. Parish Station.

Meteorological representativeness is a function of a number of factors, including distance between the measurement and application site, and land use and terrain near the measurement site compared to land use and terrain in the vicinity of the application site. Differences are expected between airport land use and land use surrounding almost any application site, and frequently there are differences in terrain between measurement and application sites. Neither EPA nor TCEQ have established quantitative criteria for assessing whether differences are significant; therefore, this comparison is made based on a qualitative assessment and consideration of the importance of the land use and terrain differences to the analysis.

Terrain

Figure 3-1 displayed the relative locations of the airport and Parish Station; as noted previously, the airport is approximately 10 miles (15 kilometers) north of the Station. Figure 3-3 provides a depiction of terrain elevations surrounding the airport and the Station. This part of Texas is flat; the airport is only about 3 meters higher in elevation than the Station, and as Figure 3-3 shows there are no intervening terrain features that could significantly affect wind flow. Figure 3-2 displayed a wind rose based on measurements at the airport; the predominant south to south-southeast flow, with secondary northerly flow, is typical of many locations in East Texas and is thus indicative that the winds measured at the airport are representative of a large area.

FIGURE 3-3: Area Terrain Elevations



Land Use

Three parameters that represent land use characteristics around a measurement site are the Bowen ratio, noon-time albedo, and surface roughness. The Bowen ratio is an indicator of surface moisture and the albedo is a measure of the reflectivity of the land surface – together they are used by AERMET to estimate heat flux and other boundary layer parameters such as the convective mixing height and indicators of the stability of the atmosphere. The surface roughness is related to the heights of obstacles to the wind flow, and is used to parameterize other surface stability indicators in AERMET and is a factor in determining the strength of mechanical turbulence, and hence the degree of plume dispersion, in AERMOD. The focus of representativeness based on land use is on the three parameters Bowen ratio, albedo, and surface roughness.

The Bowen ratio and albedo associated with land use characteristics are calculated in AERSURFACE within an area 10km by 10km centered on the site being evaluated. Land use within an area this size surrounding the Sugar Land Regional Airport (reference Figure 3-1) contains more developed areas than an area this size surrounding the Parish station. Most of the development around the airport is in the form of residential neighborhoods, while most of the area surrounding Parish is undeveloped farmland or water (Smithers Lake). Since there are no heavily industrialized or urbanized areas around the airport, it is expected that the Bowen ratio and albedo values for the two sites are similar.

This is borne out by using AERSURFACE to determine these parameters for both sites. The albedo values produced by AERSURFACE for both sites are nearly identical – 0.17 to 0.18. The Bowen ratio values produced by AERSURFACE for the airport range from 0.44 to 0.77; and somewhat lower – 0.33 to 0.53 – at the Parish site. These differences are not significant in terms of the overall effect on AERMET computations for boundary layer parameters and subsequent use in AERMOD.

Surface roughness is calculated by AERMET as a function of land use characteristics within a circle centered on the site being evaluated, with a recommended radius of 1 km. The current version of AERSURFACE utilizes the USGS NLCD 1992 land use data set as the source of land use information. To compare land use as it relates to surface roughness, ERM first evaluated whether significant changes have occurred since 1992 in the vicinity of the airport and the Parish site, and evaluated on a qualitative basis the characteristics surrounding the airport anemometer compared to characteristics surrounding Parish.

Figure 3-4 is a current aerial view of the area within 1 km of the Sugar Land Airport anemometer. The NLCD 1992 land use data base identifies land use categories in 30 m cells as of 1992. The land use categories extracted from NLCD 1992 have been superimposed on the image in Figure 3-5. As shown in the aerial image, the majority of the area surrounding the anemometer is relatively flat with occasional obstructions and forested areas to the northwest. The NLCD 1992 land use categories shown in Figure 3-5 display a similar pattern that indicates that the 1992 data set adequately represents the area surrounding the anemometer, but with much less of a forested area to the northwest. Figure 3-6 displays the area within 1 km of Parish, and Figure 3-7 displays the 1992 land use characteristics superimposed on the current aerial view of the area around Parish. A qualitative evaluation of Figure 3-7 reveals that there are areas where the 1992 land use data is not correct for the site – most significantly, the coal pile is coded as "wetlands" and there are several water cells scattered throughout the plant site. Because of these errors, ERM undertook an effort to correct the land use characterizations for Parish, essentially replacing incorrect land use codes with corrected codes that better represent the land use throughout the 1 km circle. Figure 3-8 displays the corrected land use values surrounding Parish.

FIGURE 3-4: Sugar Land Airport – 1km Aerial

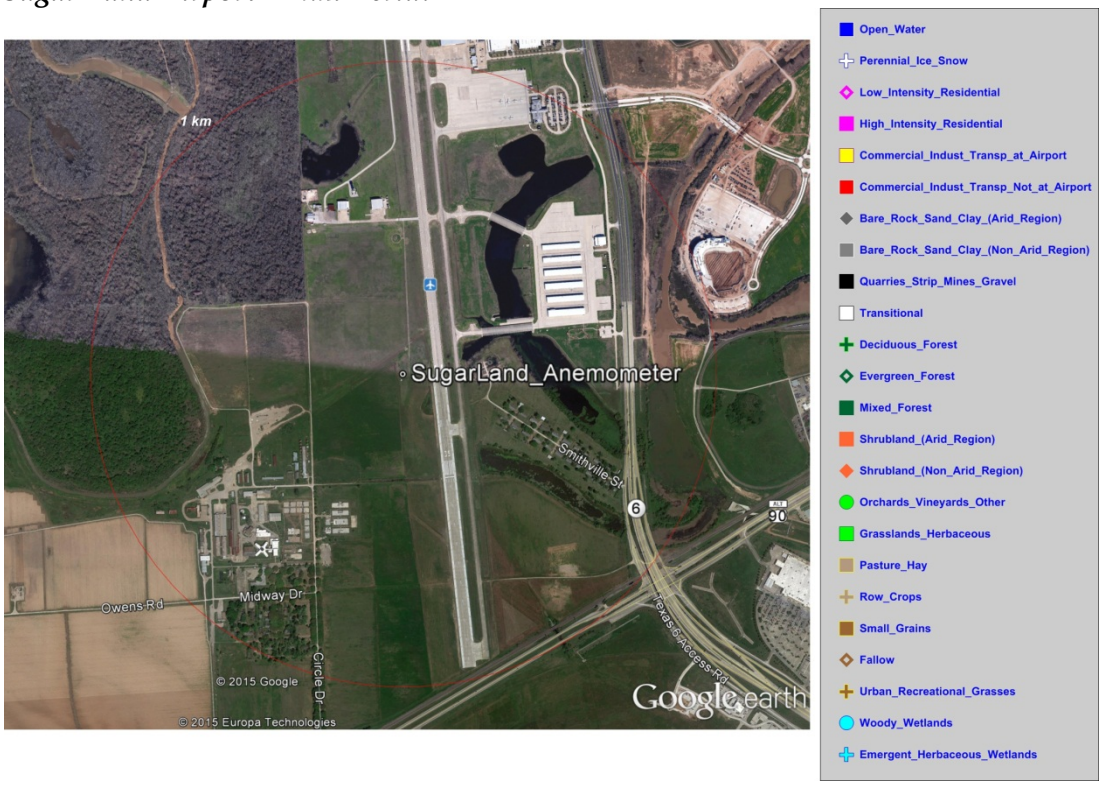


FIGURE 3-5: Sugar Land Airport – 1km 1992 NLCD Land Use

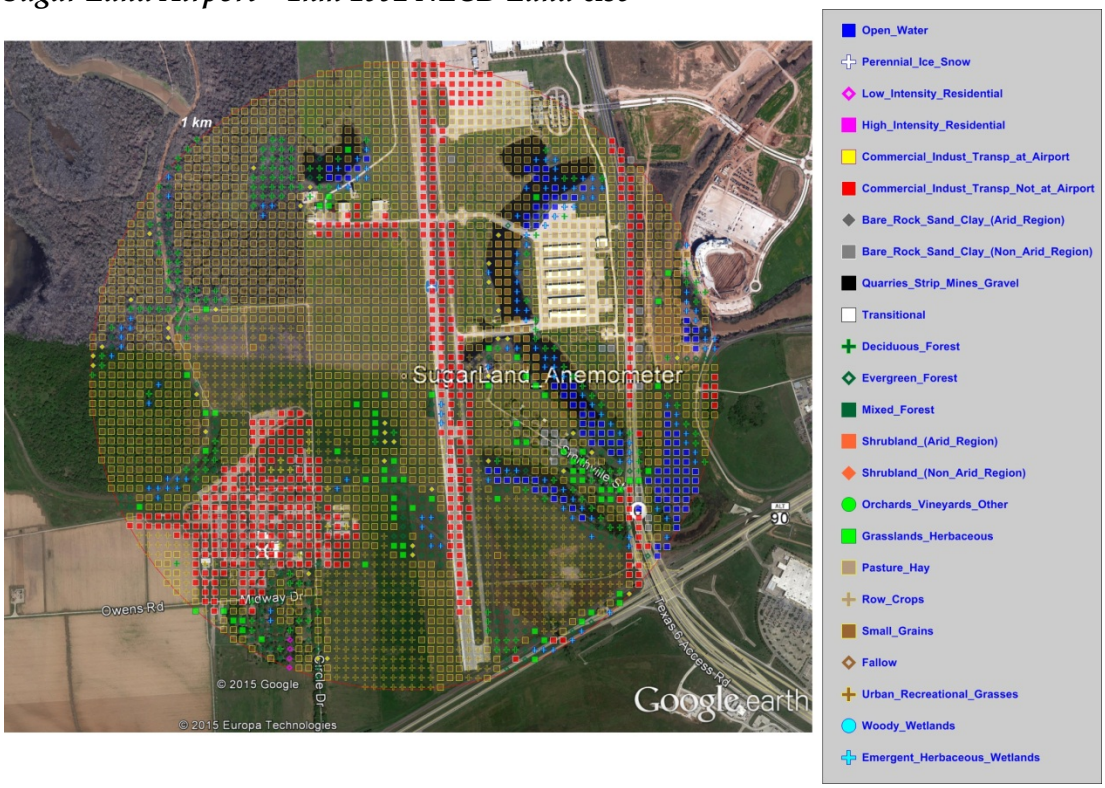


FIGURE 3-6: Parish Station – 1km Aerial

FIGURE 3-7: Parish Station – 1km 1992 NLCD Land Use

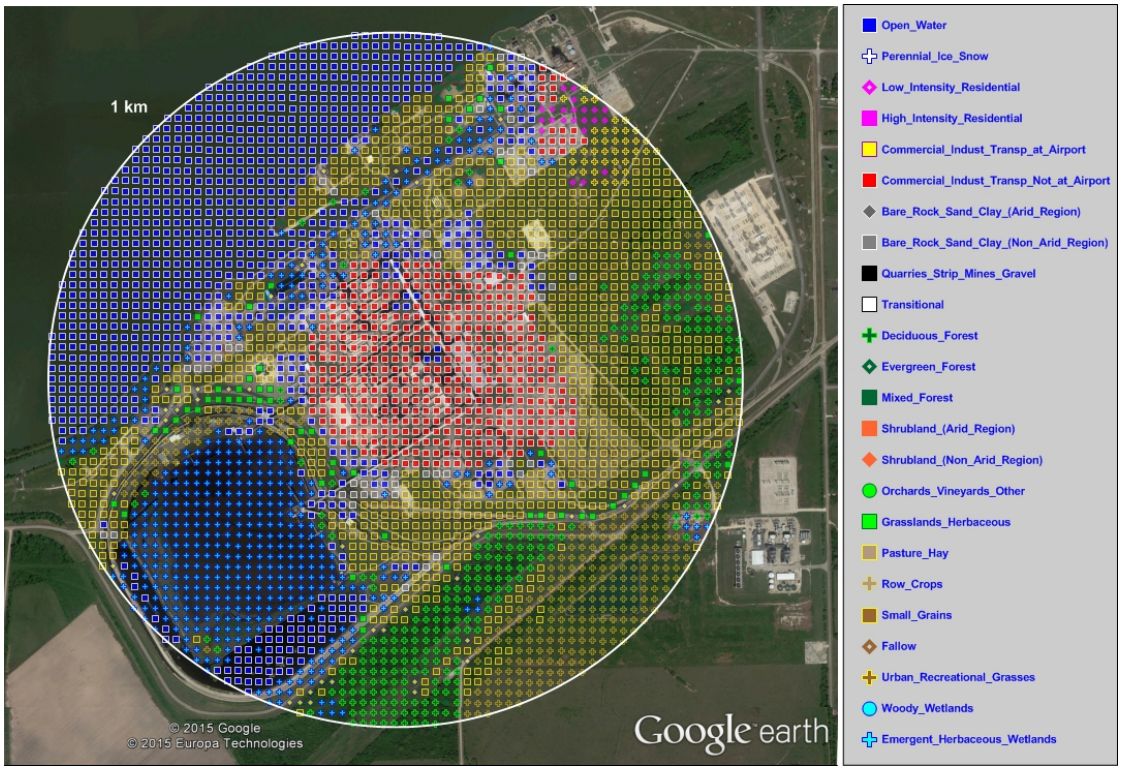
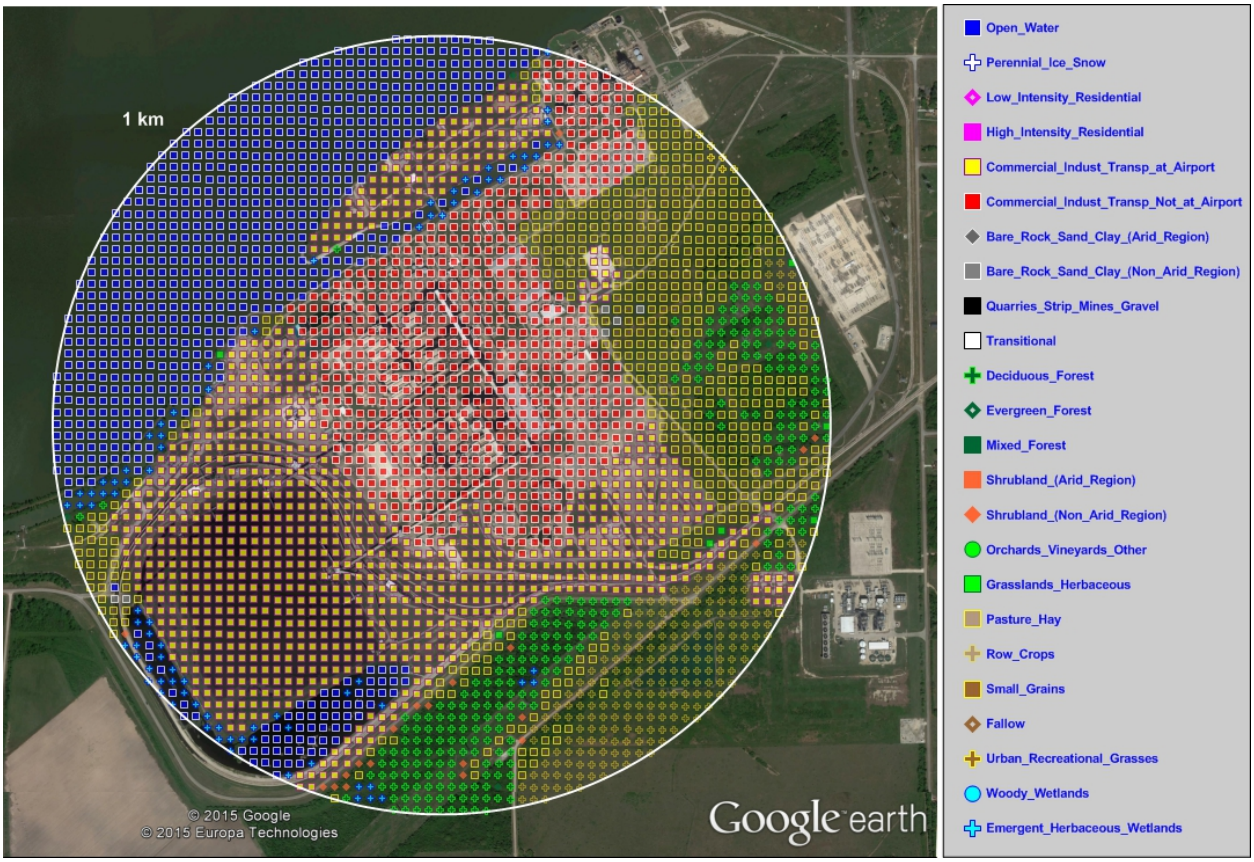


FIGURE 3-8: Parish Station – 1km 1992 NLCD Land Use – Corrected



An examination of the figures presented here reveals some differences and some similarities between land use surrounding the airport and land use surrounding the Parish site. Since in particular some of the "Commercial Industrial Transportation" categories at the airport represent the runways, there is less to contribute to larger values of the roughness length at the airport than at the Parish site. For some important reasons, however, the corrected land use values surrounding Parish were used to characterize surface roughness for input to AERMET. The first is to capture directional differences between the airport and Parish, consistent with the goal of the TAD to reproduce "what a monitor would measure" in mind. The second reason is related to the fact that the important dispersion regime for the stacks being modeled at Parish is above the surface layer – with an average plume rise of approximately 150 meters, total plume height for the Parish sources is in the range of 300 meters above the ground. Surface values of turbulence for these plumes are considerably less important than turbulence values determined for the layer several hundred meters above the surface. Since turbulence levels at plume height depend strongly on the roughness length (in addition to the stability parameters), a roughness length more representative of the site provides a more realistic, and ultimately more accurate, estimate of turbulence at plume level and therefore a more accurate depiction of "what a monitor would see" than roughness length values determined for the airport.

ERM calculated roughness length values on a seasonal and direction-specific basis, assigning roughness length values for each land use cell based on the values contained in Table A-3 of the AERSURFACE users' guide (EPA, 2008). Effective roughness was calculated in a manner entirely consistent with AERSURFACE, namely as the distance-weighted geometric mean of all land use cells upwind of the sources being modeled, with the following formula:

$$z_0 \text{ effective} = \exp\hat{}(\sum \ln(z_0)_{xy}/d_{xy})/(\sum 1/d_{xy})$$

AERSURFACE is not part of the AERMOD system; rather it is a recommended, but not required, tool in the set of related AERMOD processing programs. ERM took a different approach than AERSURFACE in terms of determining which cells are "upwind" for a particular wind direction (note that). This different approach is appropriate for situations where the stacks being modeled are separated by up to a few hundred meters, as it more accurately defines "upwind" as not based on a single point. An illustration of the difference between the AERSURFACE approach and the modified "wedge" approach used by ERM is illustrated in Figures 3-9 and 3-10.

FIGURE 3-9: Example of "Upwind" based on AERSURFACE

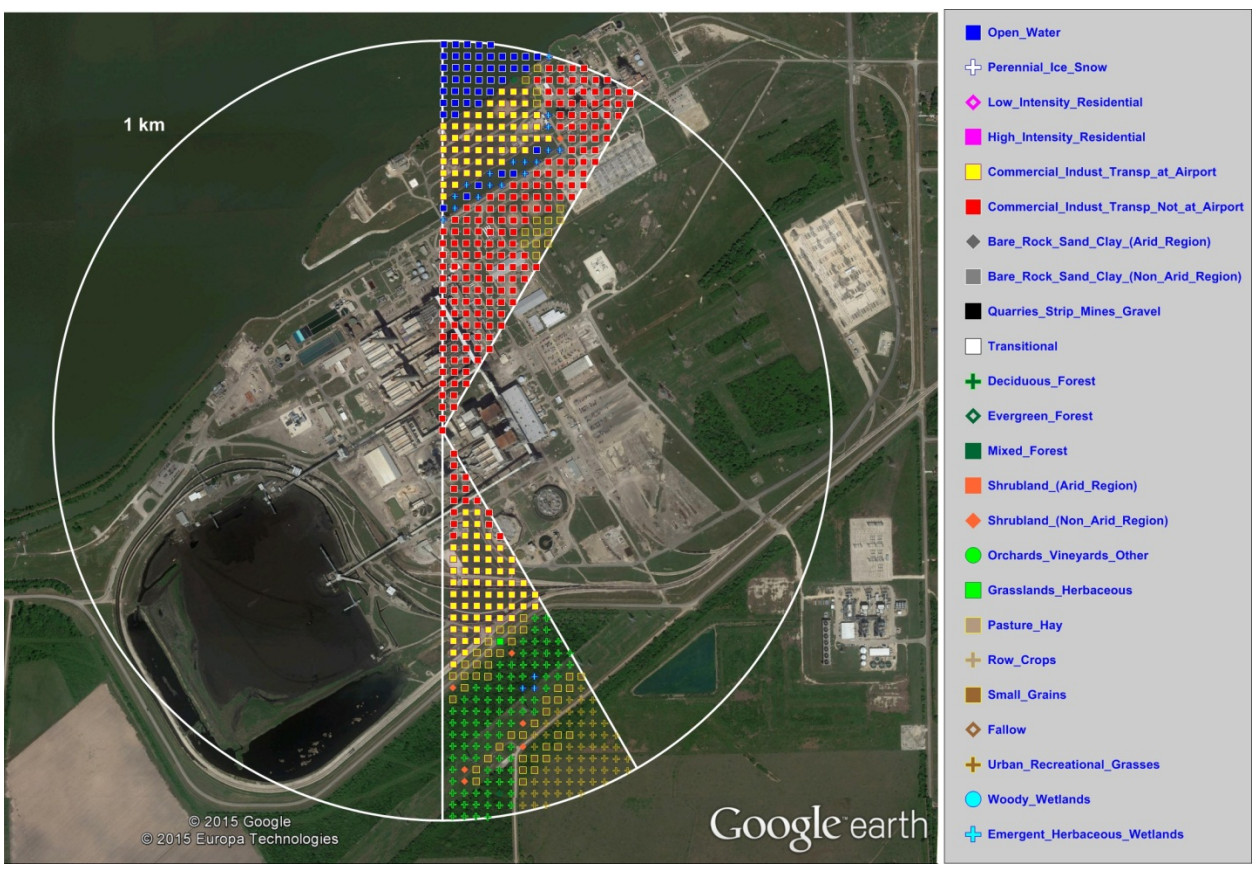
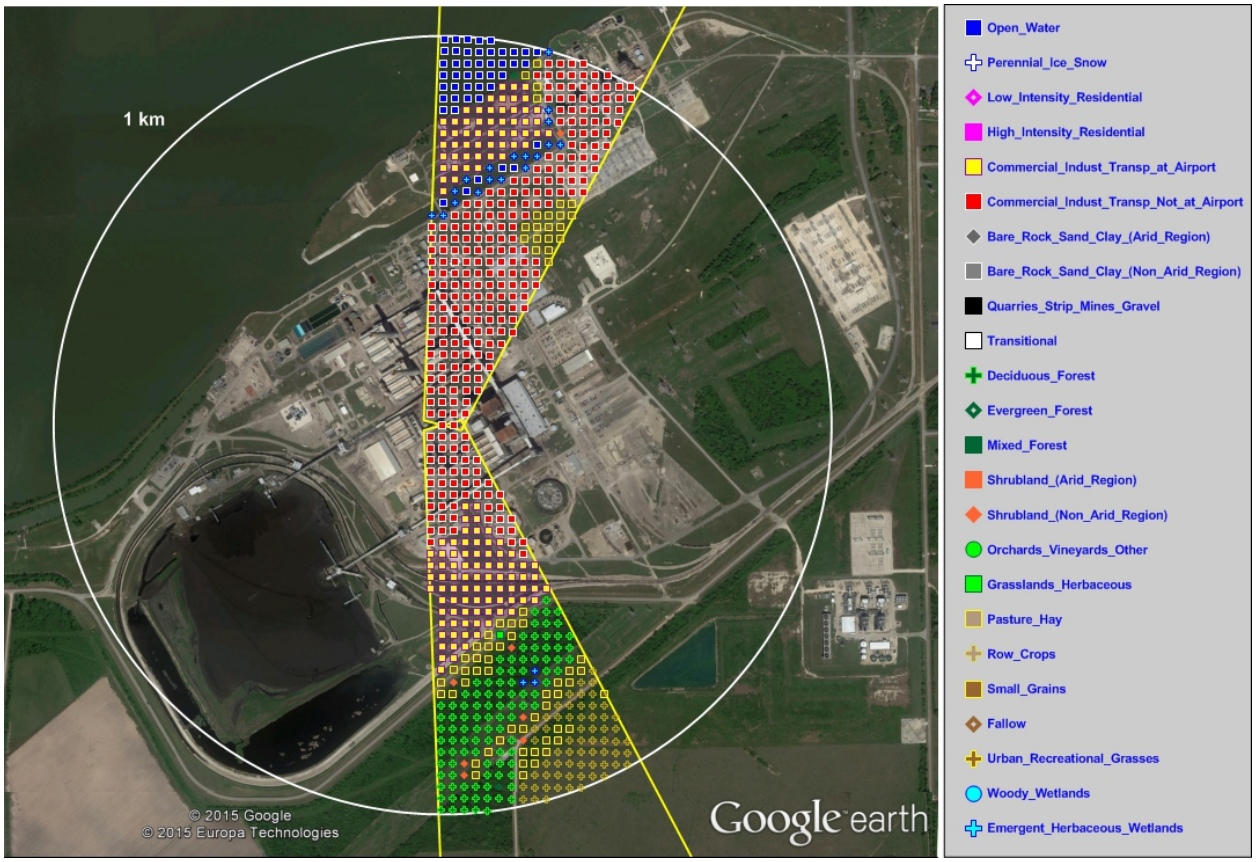


FIGURE 3-10: Example of "Upwind" based on the "Wedge" Approach



Land use files were created based on this approach and combining the roughness length determinations with the Bowen ratio/albedo values generated by AERSURFACE. AERMINUTE was used to develop speed and direction values for low-wind hours. Upper air profiles were generated and filled in for the Lake Charles, LA upper air sounding station, and AERMET was run to create 3 years (2012-2014) of meteorological files used in AERMOD.

3.4 *RECEPTOR GRID*

A comprehensive Cartesian receptor grid extending out to approximately 20 kilometers (km) from Parish was used in the AERMOD modeling analysis to assess maximum ground-level 1-hour SO_2 concentrations. The Modeling TAD states that the receptor grid must be sufficient to determine ambient air quality in the vicinity of the source being studied. The 20-kilometer receptor grid is more than sufficient to resolve the maximum 1-hour SO_2 impacts, and it clearly illustrates decreasing SO_2 concentration gradients in relation to the plant. Further, the receptor grid used in the modeling is consistent with the guidelines provided by the TCEQ for regulatory applications.

Specifically, the Cartesian receptor grid consisted of the following receptor spacing:

- 50-meter spacing along the facility fence line;
- 100-meter spacing extending from the fence line to 3 kilometers;
- 200-meter spacing extending from 3 to 5 kilometers;
- 500-meter spacing extending from 5 to 10 kilometers; and
- 1,000-meter spacing extending from 10 to 20 kilometers.

The above receptor data was used without modification in the modeling. Per the 1-hour SO_2 Modeling TAD, receptors located over areas where monitors could not reasonably be sited could be excluded from the modeling, but these receptors were retained in this analysis as a measure of conservatism.

Terrain elevations from National Elevation Data ("NED") from USGS were processed using the most recent version of AERMAP (v.11103) to develop the receptor terrain elevations required by AERMOD. NED data files contain profiles of terrain elevations, which in conjunction with receptor locations are used to generate receptor height scales. The height scale is the terrain elevation in the vicinity of a receptor that has the greatest influence on dispersion at that location and is used for model computations in complex terrain areas. The near-field (within 5 kilometers) and far-field (full grid) receptor grids are shown in Figures 3-11 and 3-12, respectively.

FIGURE 3-11: Near-Field Model Receptors

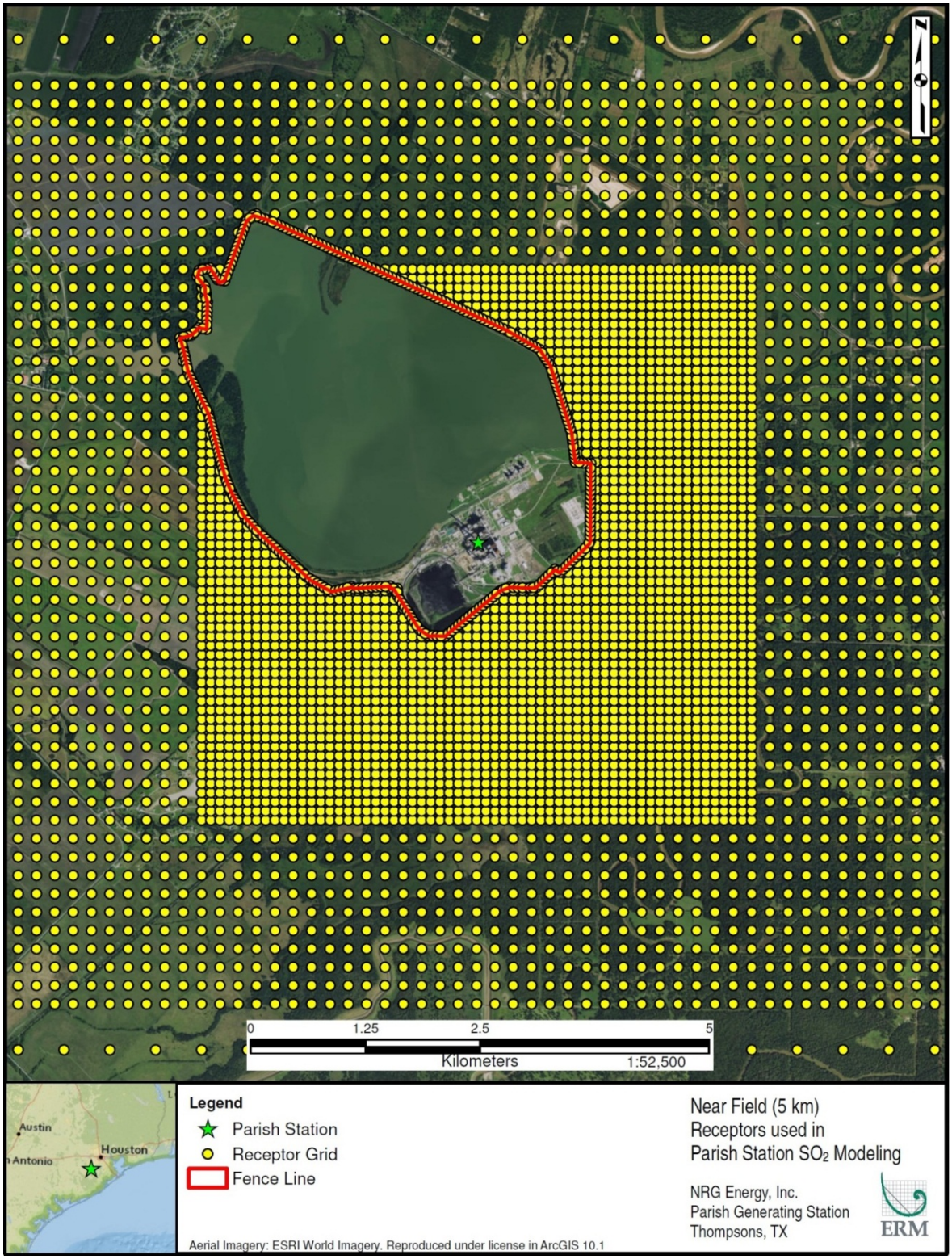
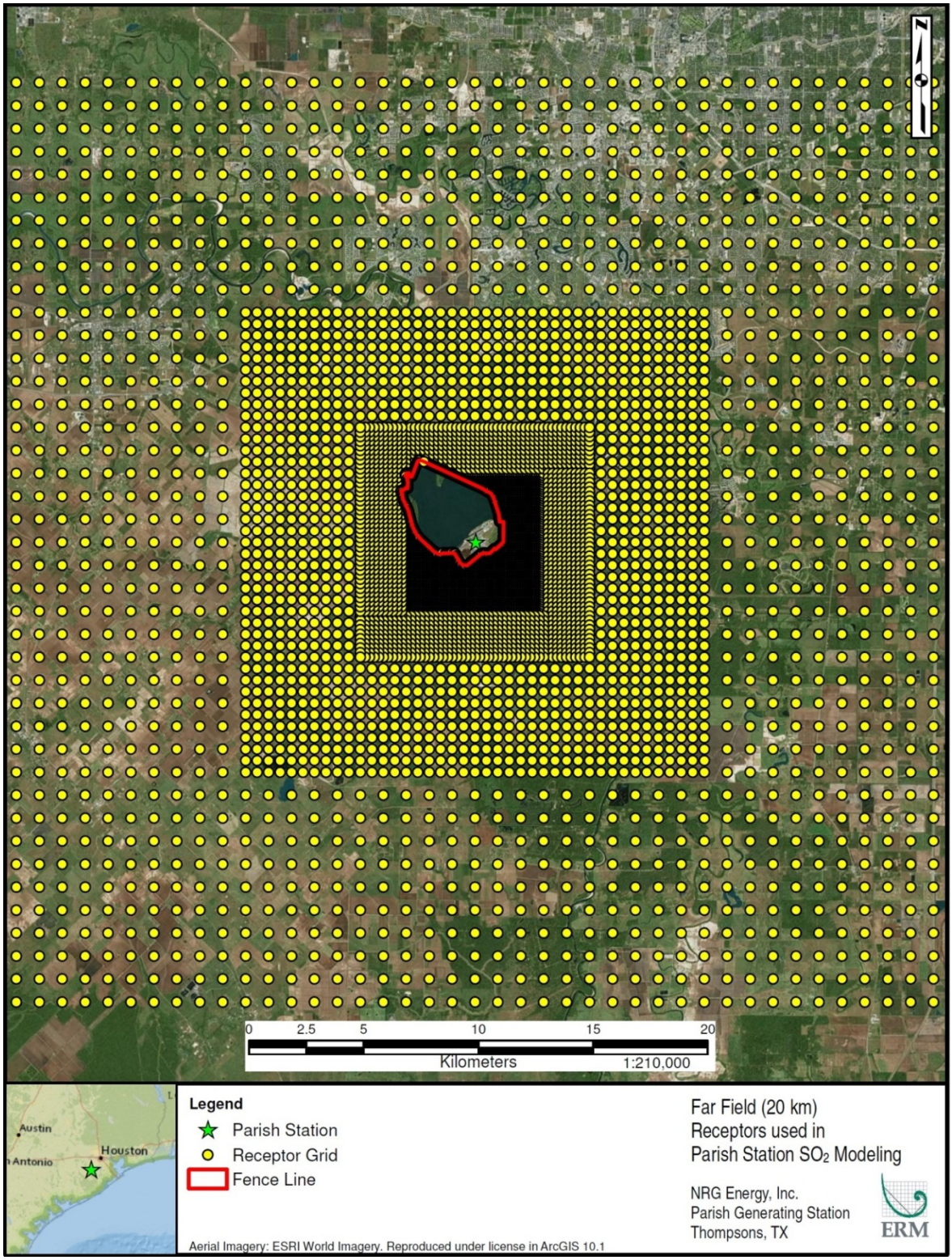


FIGURE 3-12: Far-Field Model Receptors



3.5 GOOD ENGINEERING PRACTICE STACK HEIGHT ANALYSIS

Good engineering practice ("GEP") stack height is defined as the stack height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, or eddy effects created by the source, nearby structures, or terrain features.

A GEP stack height analysis was performed for all stacks using the Building Profile Input Program (BPIP) in accordance with USEPA's guidelines (USEPA 1985). Per the guidelines, the physical GEP height, (H_{GEP}), is determined from the dimensions of all buildings which are within the region of influence using the following equations, depending on the construction data of the stack:

(1) For stacks in existence on January 12, 1979 and for which the owner or operator had obtained all applicable permits or approvals required,

$$H_{GEP} = 2.5H,$$

provided the owner or operator produces evidence that this equation was actually relied on in establishing an emission limitation;

(2) For all other stacks:

$$H_{GEP} = H + 1.5L$$

where:

H = height of the structure within 5L of the stack which maximizes H_{GEP};
and
L = lesser dimension (height or projected width) of the structure.

For a squat structure, i.e., height less than projected width, the formula reduces to:

$$H_{GEP} = 2.5H$$

In the absence of influencing structures, a "default" GEP stack height is creditable up to 65 meters (213 feet).

A summary of the GEP stack height analyses is presented in Table 3-2. As described in the SO_2 Modeling TAD, when modeling actual emissions in order to determine the attainment status of the facility when compared to the 1-hour SO_2 NAAQS, the full height of all stacks is allowed in the modeling regardless of their GEP Formula Heights. All stacks at Parish are below their respective GEP heights so application of the SO_2 Modeling TAD did not affect the stack height assumptions for Parish. The locations of all structures and sources included in the GEP analysis are shown in Figure 3-13 (Units 1-4 and ancillary sources) and Figure 3-14 (Units 5-8). The output from BPIP was input into AERMOD to represent aerodynamic downwash caused by structures around the stacks.

FIGURE 3-13: Structures Included in the Parish GEP Analysis (Units 1-4 area)

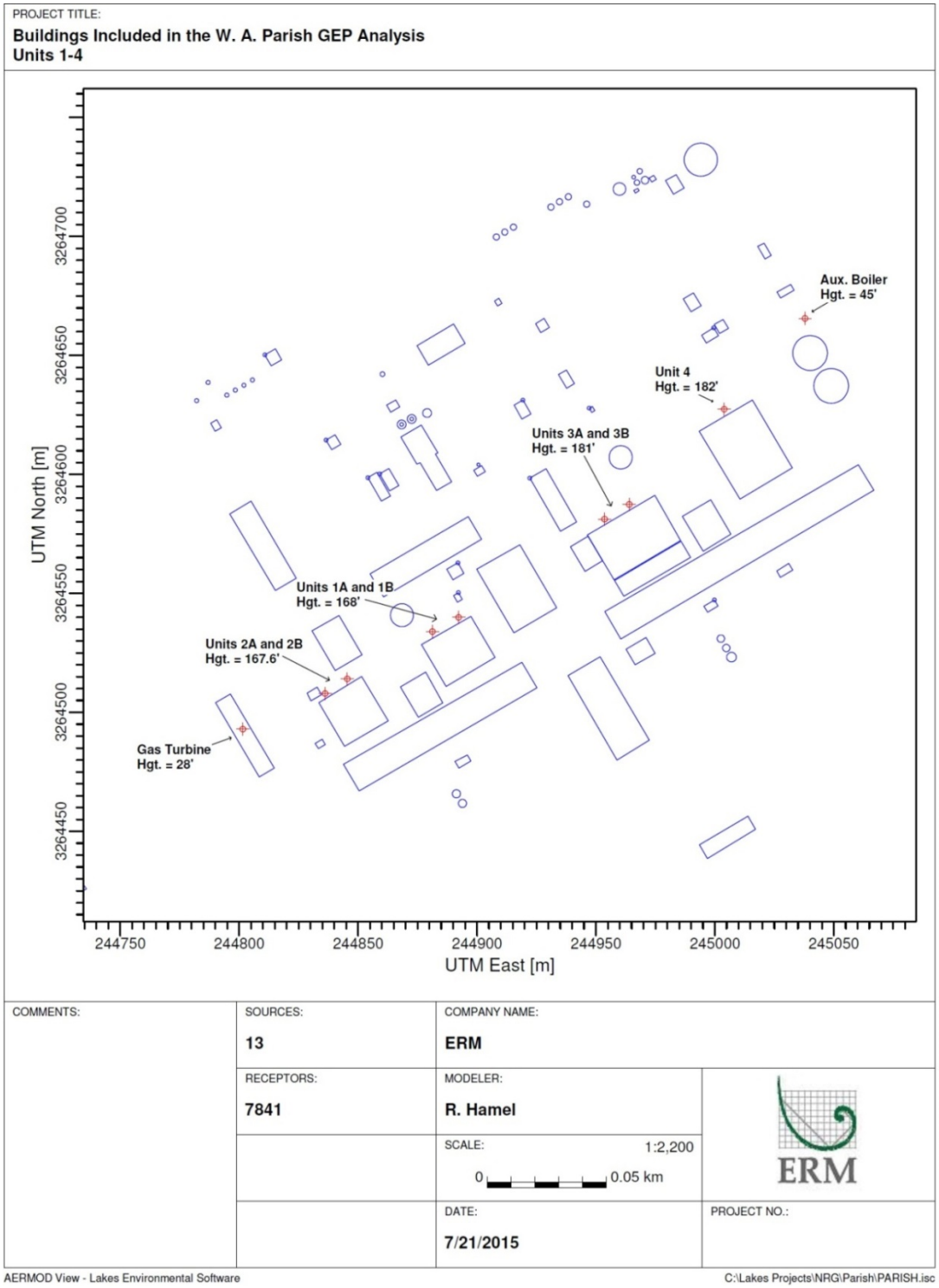


FIGURE 3-14: Structures Included in the Parish GEP Analysis (Units 5-8 area)

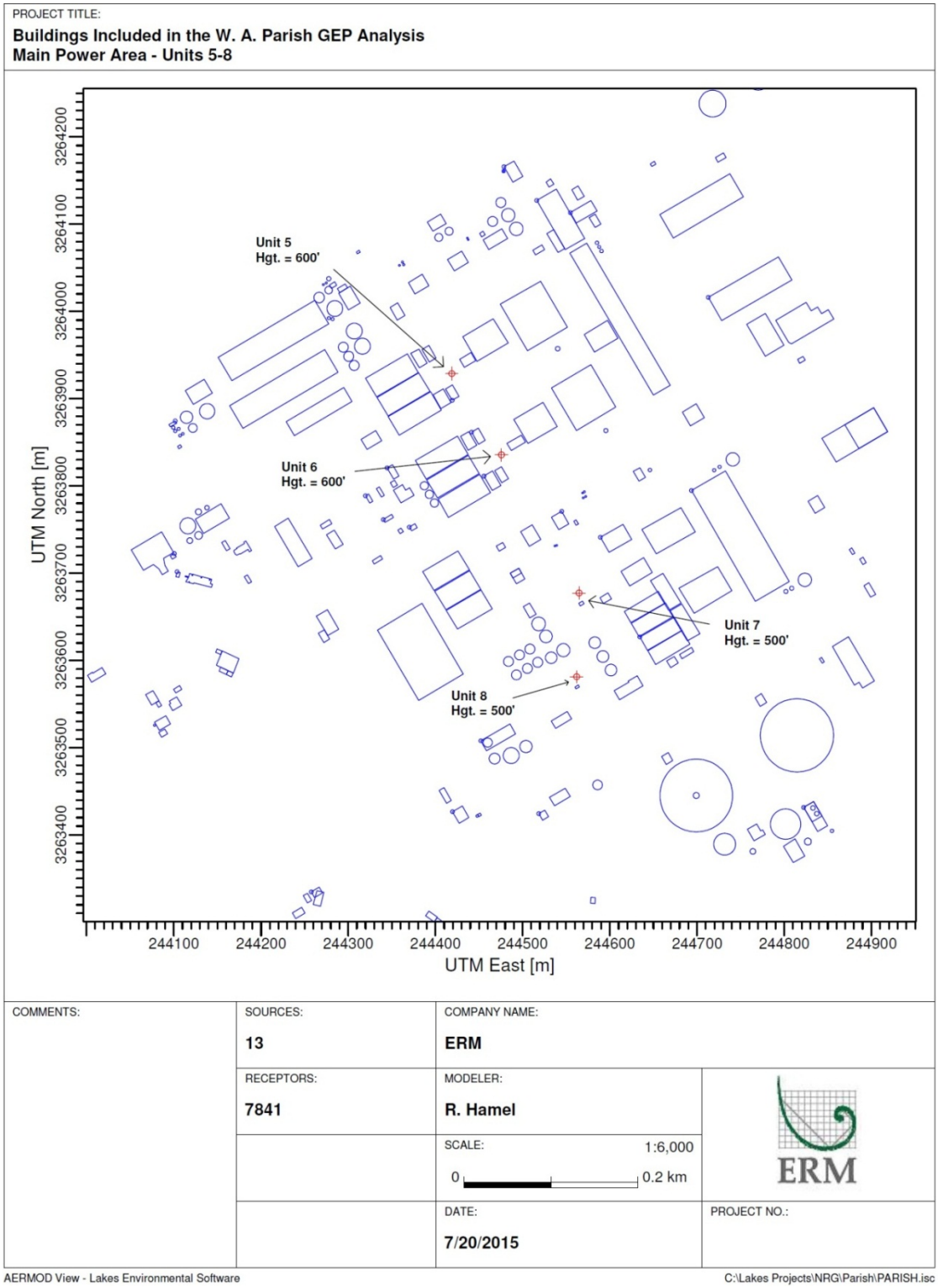


TABLE 3-2: Summary of Parish Station GEP Analysis

Emission Source	*Stack Height (m)*	*Controlling Buildings / Structures*	*Building Height (m)*	*Projected Width (m)*	*GEP Formula Height (m)[1]*
UNIT 1A	51.08	Unit 3 Boiler Bldg.	21.34	21.90	52.66
UNIT 1B	51.08	Unit 3 Boiler Bldg.	21.34	21.90	52.66
UNIT 2A	51.21	Unit 2 Boiler Bldg.	21.34	21.37	53.15
UNIT 2B	51.21	Unit 1 Boiler Bldg.	21.34	21.35	53.15
UNIT 3A	55.17	Unit 4 Boiler Bldg.	21.34	33.22	53.73
UNIT 3B	55.17	Unit 4 Boiler Bldg.	21.34	33.22	53.73
UNIT 4	55.47	Unit 4 Boiler Bldg.	21.34	25.93	53.35
UNIT 5	182.88	Unit 8 Boiler Bldgs.	75.59	82.87	188.36
UNIT 6	182.88	Unit 8 Boiler Bldgs.	75.59	84.84	188.36
UNIT 7	152.40	Unit 7 Boiler Bldgs.	75.59	75.79	188.66
UNIT 8	152.40	Unit 7 Boiler Bldgs.	75.59	80.51	188.66
AUXBOIL	13.72	Unit 4 Boiler Bldg.	21.34	39.08	53.68
GASTURB	8.53	Unit 1 Boiler Bldg.	21.34	21.75	53.15

1. In the absence of influencing structures, a "default" GEP stack height is creditable up to 65 meters (213 feet).

3.6 *AMBIENT SO_2 BACKGROUND DATA FOR CUMULATIVE MODELING*

In addition to assessing impacts from Parish Station sources, the impact from other sources of SO_2 in the region were considered to demonstrate that the air quality in the region is in attainment with the NAAQS. While there are no sources of SO_2 in the vicinity of Parish that warranted explicit inclusion in the modeling as discussed in Section 3.7, in order to account for other minor sources of SO_2 in the area an ambient background concentration was added to model-predicted impacts from Parish for comparison to the NAAQS.

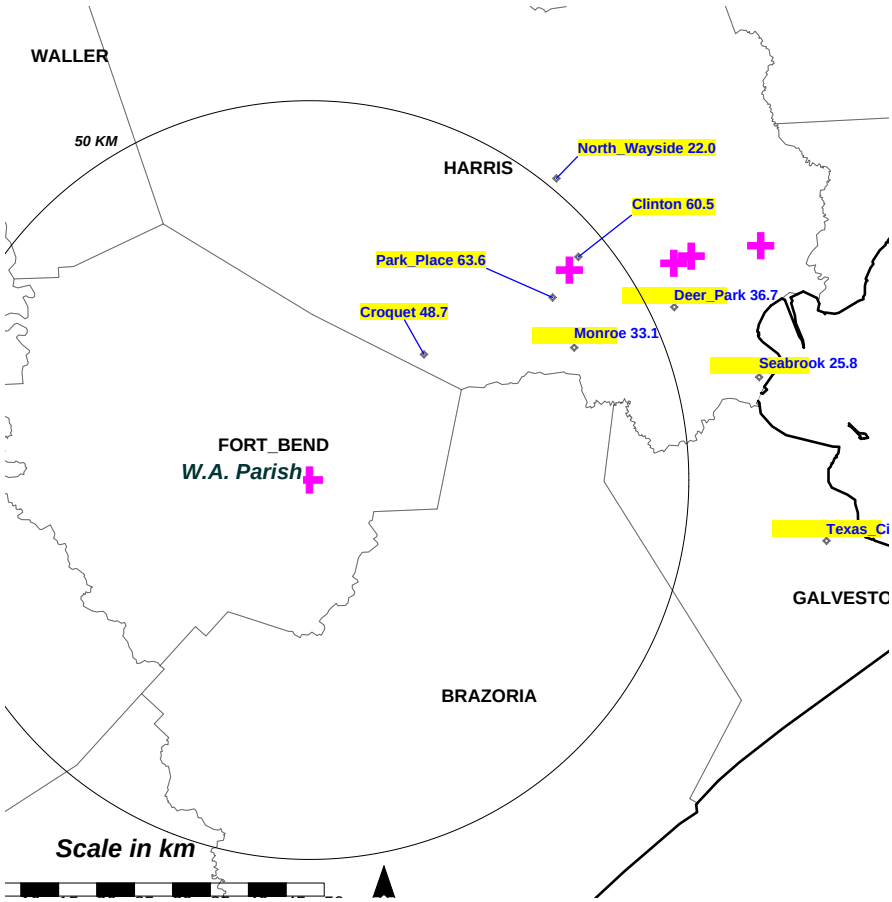
The criteria for determining the monitor best suited to characterize air quality at a given location include:

- Stations with similar influencing SO_2 sources as the source being modeled (not necessarily the closest).
- Avoid stations influenced by the source being modeled to prevent double-counting impacts.

- Avoid stations influenced by sources not likely to interact with the source being modeled.
- Consider predicted concentration patterns for source being modeled, along with wind frequency, to assist in selection.

Figure 3-15 shows the location of the ambient monitors in the vicinity of Parish Station and the 1-hour SO_2 design value, as well as the location of all other SO_2 sources in the region that emitted more than 1,000 tons of SO_2 according to the 2011 EPA National Emissions Inventory. The figure shows that there are no significant sources of SO_2 near Parish, but there are several 1,000 ton sources concentrated around the Houston Ship Channel 50 km to the northeast, only one of which is within 50 km. Additionally, all of the monitors sited in the region are located in the Houston metropolitan area or Galveston. It should also be noted that the design value of all monitors is less than 35% of the 1-hour SO_2 NAAQS, and that the design value decreases significantly with distance from these larger sources.

FIGURE 3-15: SO_2 Sources and Monitors in the Region

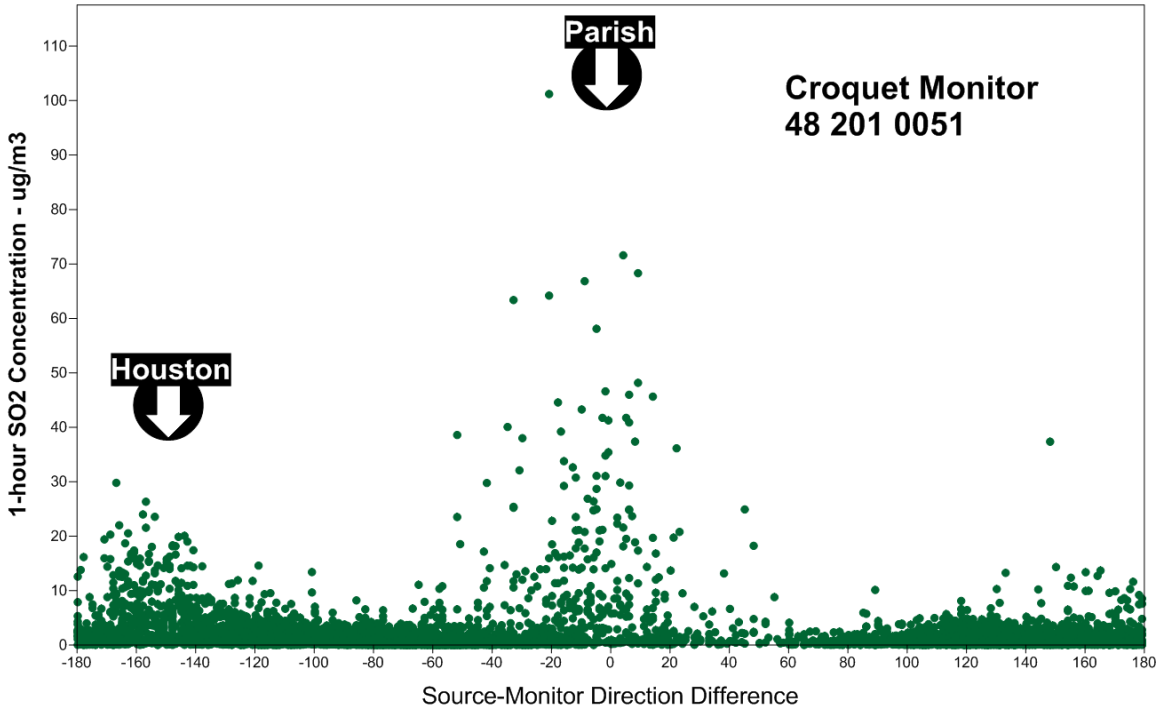


ERM initially evaluated 3 monitors to determine their representativeness: Croquet (Monitor ID# 48-201-0051) and North Wayside (Monitor ID# 48-201-0046), both located northeast of Parish in Greater Houston, and the TCEQ monitor in Freeport, TX (Monitor ID# 48-039-1012), located 60 km south-southeast of Parish.

The first monitor evaluated was the Croquet monitor. This monitor is the closest to Parish in terms of proximity, located 22.4 km north-northeast of Parish. A review of the most recent (2012-2014) years of hourly concentrations at the monitor vs. the wind direction relative to Parish at the time the monitor was reported, shown in Figure 3-16, shows that virtually all of the highest concentrations at the monitor occur when the wind is blowing from Parish Station towards the monitor. Additional higher impacts occur when the wind is blowing from the direction of the Houston Ship Channel, which is much closer to the monitor than to Parish. Additional higher impacts occur when the wind is blowing from the direction of the Houston Ship Channel, which is much closer to the monitor than to Parish.

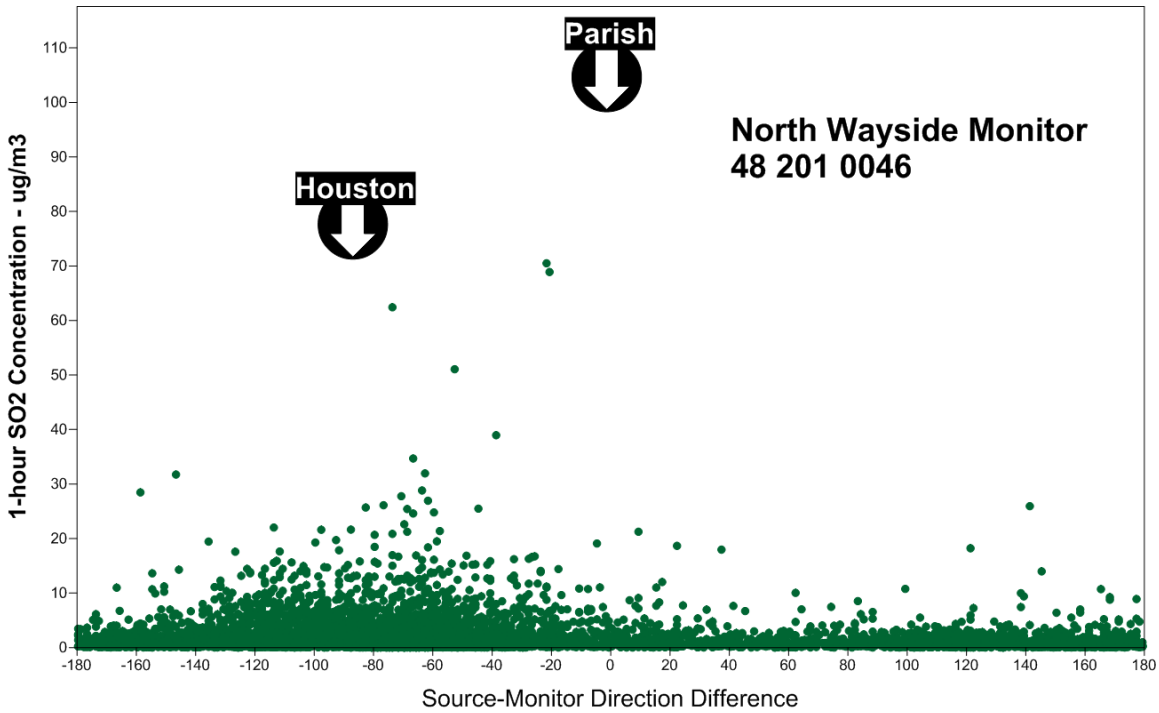
Because the monitor is strongly influenced by impacts from Parish Station, using the Croquet monitor would result in "double counting" the impacts from the station. Therefore the station is not useful to represent non-facility related impacts in the region. It should be noted however that when the monitor is being impacted by Parish Station, the concentrations never approach the standard, and are less than one-third of the standard the vast majority of the time.

FIGURE 3-16: SO_2 Concentration vs. Wind Direction at Croquet Monitor



The next monitor reviewed was the North Wayside monitor, located 51.4 km north-northeast of Parish, far enough away that impacts from Parish itself are no longer noteworthy. At North Wayside however, the highest concentrations are all associated with Houston Ship Channel and other metropolitan Houston sources, as shown in Figure 3-17. These impacts again are not representative of the types of sources located in close proximity to Parish, and therefore North Wayside was also dismissed as being unrepresentative of ambient air conditions near Parish.

FIGURE 3-17: SO_2 Concentration vs. Wind Direction at North Wayside Monitor



The last monitor in the same approximate area as Parish Station reviewed was the Freeport, TX monitor (CAMS 1012). This monitor, located 60 km south-southeast of Parish, was discounted for two reasons: First, the TCEQ website notes that "Data from this instrument does not meet EPA quality assurance criteria and cannot be used for regulatory purposes"[3]. Secondly, the monitor is sited in a heavily industrialized area between two large chemical manufacturing facilities. Because of the data quality issues and the siting of the monitor in an area far more industrialized than the area around Parish Station, this monitor was also eliminated from consideration.

[3] http://www.tceq.state.tx.us/cgi-bin/compliance/monops/site_photo.pl?cams=1012. Click on "Generate Report", bottom of page.

With the monitors in the same general region as Parish determined to not be representative of air quality around Parish, all monitors in Texas were reviewed and the total tons of SO_2 from all sources emitted within 50 km of the monitor per the 2011 NEI were compared to the total tons emitted around Parish Station as shown in Table 3-3:

TABLE 3-3: SO_2 Emissions within 50 km of Texas SO_2 Monitors

			SO2 TPY (NEI 2011) within distance shown				Kilometers from Parish		
			0-10 km	10-25 km	25-50 km		East	North	Distance
	W A Parish Station		5	1	5,673				
Monitor i.d.	Name	City							
48-029-0059	Calaveras_Lake	San_Antonio	23,269	9	1,213		-257.61	-26.98	259.02
48-139-0016	Midlothian	Midlothian	6,704	54	743		-139.95	329.06	357.58
48-139-1044	Italy	Not_in_a_city	0	4	7,026		-124.67	295.42	320.65
48-167-0005	Texas_City	Texas_City	1,046	16	11,993		68.02	-7.85	68.48
48-183-0001	Longview	Not_in_a_city	37	76,339	852		76.41	323.72	332.61
48-201-0046	North_Wayside	Houston	194	10,056	2,257		32.42	39.91	51.42
48-201-0051	Croquet	Houston	1	53,864	8,130		14.97	16.72	22.44
48-201-0062	Monroe	Houston	87	10,140	52,911		34.77	17.61	38.97
48-201-0416	Park_Place	Houston	5,287	4,974	52,608		31.93	24.22	40.07
48-201-1035	Clinton	Houston	5,915	6,278	49,874		35.32	29.57	46.06
48-201-1039	Deer_Park	Deer_Park	5,103	7,097	1,386		47.95	22.95	53.16
48-201-1050	Seabrook	Seabrook	49	8,419	4,930		59.15	13.72	60.72
48-245-0009	Beaumont	Beaumont	1,067	10,756	6,830		147.69	67.46	162.37
48-245-0011	Port_Arthur	Port_Arthur	10,459	1,361	6,832		156.03	52.45	164.62
48-245-1050	Beaumont	Beaumont	1,065	1,081	16,506		145.64	70.77	161.93
48-257-0005	Kaufman	Kaufman	0	152	474		-74.01	339.61	347.58
48-309-1037	Waco	Waco	0	1,020	387		-142.44	237.32	276.78
48-349-1051	Corsicana	Corsicana	225	3,506	64,572		-80.22	280.5	291.74
48-355-0025	Corpus_Christi_West	Corpus_Christi	818	155	35		-170.59	-193.23	257.76
48-355-0026	Corpus_Christi_Tuloso	Corpus_Christi	323	624	61		-182.56	-185.97	260.6
48-355-0032	Corpus_Christi_Huisache	Corpus_Christi	933	40	35		-170.39	-188.89	254.38
48-453-0014	Austin	Austin	9	308	1,438		-205.73	92.81	225.7
48-113-0069	Dallas_Hinton	Dallas	275	422	8,000		-125.1	366.71	387.46

Based on the table, the monitor with the closest emissions pattern relative to Parish was the Italy, TX monitor. Although physically located a long distance from Parish (320.7 km), the pattern of emissions near the monitor was very close: limited emissions within 25 km, but over 5000 tons SO_2 emitted at a distance of between 25 and 50 km. Therefore, though still slightly conservative, Italy was determined to be the most representative ambient background monitor for use in the cumulative modeling.

EPA guidance allows simulation of background values that vary by season and hour of day that could simulate a lower value than the 99th percentile. The modeling was performed with a set of seasonal diurnal values developed using the methodology described in the USEPA March 1st, 2011 Clarification Memorandum for 1-hour NO_2 Modeling. Though this memorandum primarily addresses NO_2 modeling, page 20 describes the process for developing seasonal

diurnal background values for SO_2 as well. The seasonal diurnal values used are shown in Table 3-4.

TABLE 3-4: Seasonal Diurnal Ambient SO_2 Concentrations for the Italy Monitor ($\mu g/m^3$)

Hour[1]	*Winter*	*Spring*	*Summer*	*Fall*
1	3.66	2.70	3.23	3.05
2	2.62	2.27	2.18	2.88
3	2.53	2.44	2.36	3.32
4	2.62	2.18	2.09	3.66
5	2.18	1.75	1.48	2.97
6	2.27	1.66	1.40	3.32
7	2.18	1.57	1.75	2.18
8	2.36	2.36	3.05	4.01
9	3.58	3.32	3.66	6.37
10	4.71	6.20	6.02	10.38
11	7.33	5.24	6.98	9.77
12	8.73	4.54	6.28	16.93
13	9.16	5.85	5.06	10.30
14	7.42	5.76	5.06	9.77
15	7.33	5.76	6.02	8.20
16	9.07	4.36	4.28	8.73
17	6.46	3.75	3.66	13.26
18	8.38	4.28	5.24	8.20
19	4.89	3.58	5.67	4.89
20	13.00	4.19	8.55	6.54
21	4.01	2.62	6.72	6.02
22	2.79	2.53	5.15	4.54
23	2.27	3.32	2.88	5.06
24	2.36	2.79	2.88	4.62

1. Hours in AERMOD are defined as hour-ending. i.e., Hour 1 is the period from midnight through 1 AM, etc.

3.7 REVIEW OF NON-FACILITY SOURCES FOR CUMULATIVE INVENTORY

Section 4.1 of the SO_2 Modeling TAD discusses the criteria for the addition of major SO_2 sources in the region for cumulative modeling purposes when determining the recommended attainment status of the area surrounding a facility as described in the proposed 1-hour SO_2 Data Requirements Rule. The TAD describes sources that should be included in the modeling as those expected to have an impact on the air quality in the vicinity of the source being studied, in this case Parish Station. Additionally, the TAD states that except in cases where numerous smaller sources are close together in the study area, consideration of sources to include should begin at sources with emissions in excess of the threshold selected in the Data Requirements Rule. For purposes of this analysis, ERM assumed not only that the lowest threshold described in the proposed final rule will be the one selected, but also that there would be no differentiation between low- and high-population areas in the final rule.

The 2011 EPA National Emissions Inventories (NEI) was reviewed to determine candidate major sources. For the purpose of this study, all major sources of SO_2 within 50 kilometers of Parish that had at least 1000 tons (the lowest possible threshold in the proposed final Data Requirements Rule) of SO_2 emissions were considered for inclusion in the modeling. Only one facility was identified in the NEI search: the Rhodia Chemical Plant in Houston, located 44.6 kilometers to the northeast of Parish. Table 3-6 presents the emissions, distance, and bearing for this facility. The locations of the facility relative to the location of Parish were shown in Figure 3-13.

TABLE 3-5: Major Source Considered for Cumulative Modeling Study

Facility Name	*Distance (km)*	*Bearing from Parish Station (deg)*	*2011 NEI SO_2 Emissions (tpy)*
Rhodia Houston Plant	44.6	53	3755

Once the candidate facility was identified, a number of factors were reviewed to determine whether or not the impacts from the Rhodia plant were likely to have significant crossover of impacts with Parish, and thus needed to be included in the cumulative modeling analysis. The factors reviewed included:

- Distance from Parish.
- Direction upwind and downwind of Parish and frequency that the wind blows in those directions.
- The presence of a significant concentration gradient in the direction of the sources being considered.

Based on this review the Rhodia Houston Plant was not included in the cumulative modeling for the following reasons:

Wind Frequency

For the modeled impacts of two facilities not immediately proximate to each other to intersect, the receptors in question must be on a line drawn through the two sources. Further, in 1-hour modeling periods, for both sources to impact the same receptor simultaneously the receptor must be downwind of both facilities, since AERMOD holds the winds constant for the entire hour. To review the frequency at which the winds were blowing on a line intersecting both facilities, the 3 most recent years of meteorological data from Sugar Land Regional Airport (2012-2014) were reviewed to assess the frequency of winds in a 30 degree arc centered on each facility: For potential cumulative impacts from Parish and Rhodia, winds blowing from the arcs of 38-68 degrees (towards Parish from Rhodia) and 218- 248 degrees (towards Rhodia from Parish) were considered. Additionally, for hours falling within those 30-degree arcs, the speed of the wind was examined to assess whether an emission from one source could reach the other source in that hour. Table 3-7 shows the frequency of occurrence of winds capable of transporting the emission plumes from one source to the other.

TABLE 3-6: Directional Wind Frequency between Parish Station and Rhodia Houston Plant

Direction of Travel	*30 degree arc*	*Number of hours*	*% Hours*	*Hours that reach source[1]*	*% Hours*
Towards Parish	38-68	1621	6.2%	0	0%
Towards Rhodia	218-248	990	3.8%	0	0%
1. Minimum speed for wind to travel from Parish Station to Rhodia in one hour is 12.33 m/s.					

As shown in the table above, the winds only blow between the locations of Rhodia and Parish Station 10% of the time, and during those hours the wind is never strong enough to transport a parcel from one location to the other in an hour.

Cumulative Sources for 1-hour NO_2 and SO_2 NAAQS Modeling:

On Page 16 of the 1 March 2011 USEPA Memorandum "*Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 Ambient Air Quality Standard*" (USEPA 2011)[4], the following statement is made regarding the focus area for consideration for 1-hour NO_2 cumulative modeling:

"..Even accounting for some terrain influences on the location and gradients of maximum 1-hour concentrations, these considerations suggest that the emphasis on determining which nearby sources to include in the modeling analysis should focus on the area within about 10 kilometers of the project location in most cases.

[4]http://www.epa.gov/scram001/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

The routine inclusion of all sources within 50 kilometers of the project location, the nominal distance for which AERMOD is applicable, is likely to produce an overly conservative result in most cases."

While the memo specifically refers to NO_2 modeling, the similarity in the form of the 1-hour NO_2 and SO_2 standards and their probabilistic nature suggest that the same approach would be appropriate for identifying major sources for inclusion in a SO_2 cumulative modeling exercise as well.

Because the Rhodia Houston Plant is more than four times the distance away from Parish as recommended by USEPA in the guidance memorandum, and because during the rare (10%) of the time that the wind blows roughly from one plant to the other it is never strong enough to transport the plume from one facility to the other in one hour the predictive impacts from the Rhodia Houston Plant are not expected to significantly intersect with the Parish emissions such that the cumulative predicted impacts would exceed the NAAQS.

Concentration Gradient:

Figure 4-1 shows impacts contours of the modeling with seasonal diurnal ambient background added for Parish sources only. As shown in the figure, the maximum predicted impact occurs approximately 3.2 km due west of Parish Station. The predicted impacts remain above 100 $\mu g/m^3$ (or approximately 50% of the standard) as far as 14 km to the west and south, and 12 km to the east the east and north. The concentration gradient then decreases on a steady slope in all directions, with predicted impacts to the west being slightly higher than in the other directions. Predicted impacts fall off steadily to the northeast, supporting the conclusion that impacts from Parish should not significantly interact with those from Rhodia, or for that matter the combined impacts of all sources in the Houston Ship Channel area. This is further demonstrated in the discussion of ambient background monitors in Section 3.6, where it was shown that the Croquet monitor, roughly halfway to Houston from Parish Station is impacted by emissions from Parish, but the North Wayside monitor, which is much closer to the sources around the Houston Ship Channel, shows no discernable impact from Parish Station at all. Additionally, it should be noted that there are several ambient SO_2 monitors sited in the Houston area, which is far more industrial than the area around Parish, and none of those monitors show ambient concentrations greater than the one hour NAAQS.

For the reasons above, the Rhodia Houston Plant was therefore not explicitly modeled in the 1-hour SO_2 cumulative modeling analyses.

4.0 MODELING RESULTS

The modeling results are shown in Table 4-1 below. The modeled design value represents the modeled 3-year average of the 99th percentile, maximum daily 1-hour average impact for Parish. The predicted impacts when the seasonal diurnal background is added are then shown and compared to the NAAQS to demonstrate attainment.

Contours of the predicted impacts, as well as the location of the maximum predicted impact of 168.6 μg/m^3 for the seasonal diurnal background modeling, are shown in Figure 4-1. The table shows that Parish Station emissions, when modeled using the most recent three years of actual emissions data, are below the level of the 1-hour SO_2 NAAQS.

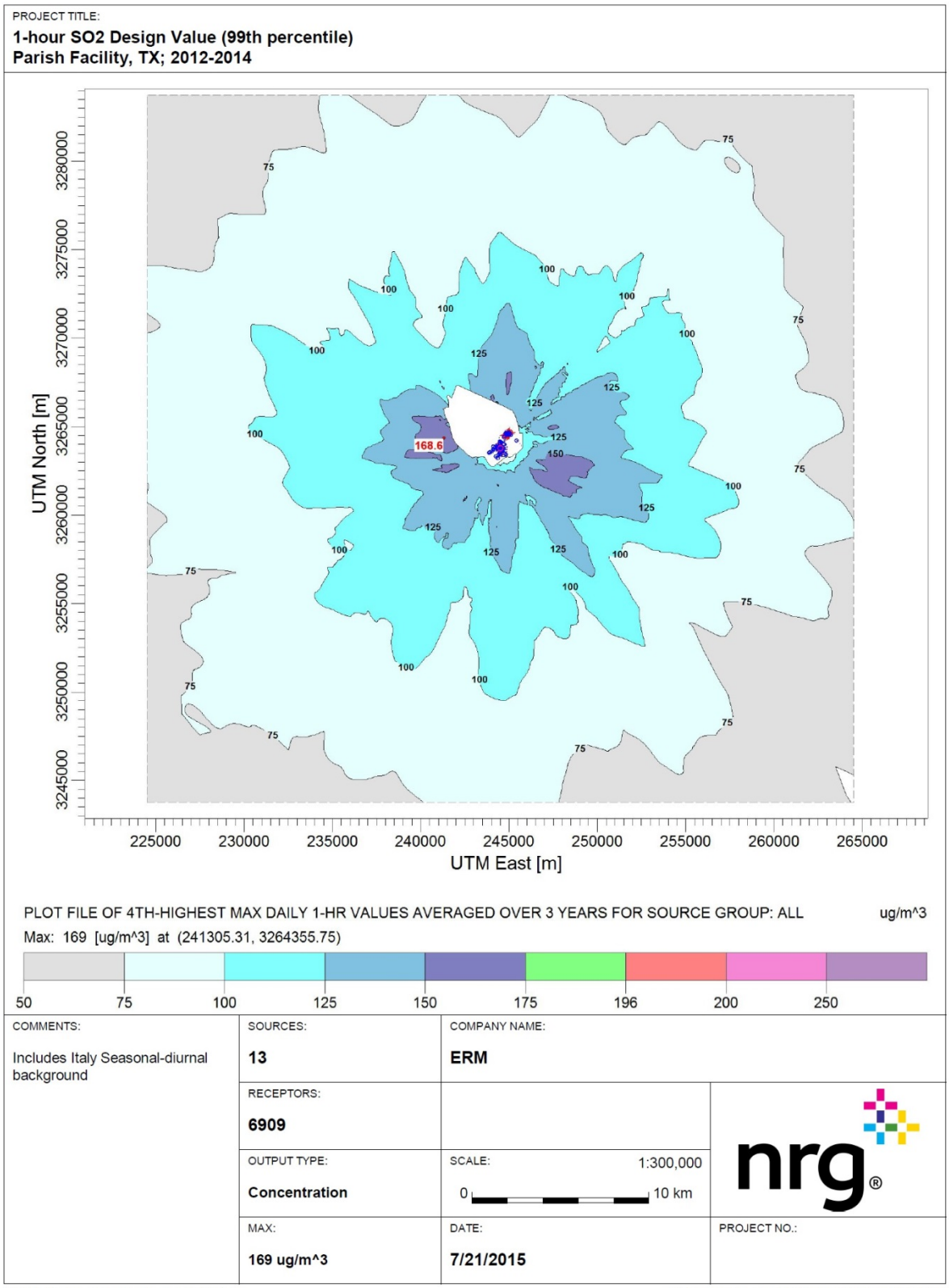
TABLE 4-1: 1-hour SO_2 Modeling Results for Parish Station and background (μg/m^3)

Source	*Parish Station Only*	*Parish and Background*	*1-hr.SO_2 NAAQS*	*Below NAAQS?*
Parish Station	163.2	168.6	196.5	Yes

4.1 CONCLUSIONS

The air dispersion modeling analysis performed as described in this report shows that the SO_2 emissions from W. A. Parish Station, when added to representative background values result in maximum predicted impacts below the 1-hour SO_2 National Ambient Air Quality Standard and therefore an attainment designation for Fort Bend County is recommended.

FIGURE 4-1: Parish Station 1-hour SO_2 Impact Contours



5.0 REFERENCES

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U.S. Environmental Protection Agency. (USEPA 2014) "Data Requirements Rule for the 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard (NAAQS)," Pre-publication proposed rule, April 17, 2014; and

U.S. Environmental Protection Agency. (USEPA 2014) "Guidance for 1-hour SO_2 Nonattainment Area SIP Submissions," April 23, 2014.