Appendix E

Sulfur Dioxide Data Requirements Rule Monitoring Placement Evaluations

Texas Commission on Environmental Quality
2016 Annual Monitoring Network Plan

Appendix E: Sulfur Dioxide Monitoring Placement Evaluations

Introduction

On August 21, 2015, the United States (U.S.) Environmental Protection Agency (EPA) finalized the sulfur dioxide (SO_2) Data Requirements Rule (DRR) for the 2010 one-hour SO_2 primary National Air Ambient Quality Standard (NAAQS). The DRR requires air agencies to characterize current air quality in areas around sources that emit 2,000 tons per year (tpy) or more of SO_2 and that are not located in an area already designated nonattainment. The DRR gives air agencies the option to characterize air quality using either modeling of actual source emissions or using appropriately sited ambient air quality monitors. Air agencies are required to locate the source-oriented SO_2 monitors in locations of expected maximum one-hour concentrations.

Per the DRR requirements, on January 15, 2016, the Texas Commission on Environmental Quality (TCEQ) provided the EPA with a list identifying 25 SO_2 sources meeting the rule's applicability threshold. Of the 25 DRR sources, the TCEQ will deploy source-oriented SO_2 monitors near 14 sources by the January 1, 2017, rule deadline. Due to the close geographical proximity of four out of the 14 sources, a total of 12 monitoring stations are proposed for deployment to characterize ambient air quality surrounding each of the 14 sources. The EPA is expected to finalize area designations for the remaining eleven sources by July 2, 2016. The TCEQ will pursue monitoring station locations as expeditiously as practical for any of the 11 remaining sources designated as nonattainment under the EPA's final action.

The TCEQ focused on complying with the directly-applicable federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring station locations that would appropriately and sufficiently characterize ambient air quality in areas around an SO_2 emissions source. The DRR requirements stipulate that air monitoring stations must be deployed in areas of maximum expected one-hour concentrations in ambient air. This approach included utilizing multiple techniques and guidance provided in the *SO_2 NAAQS* (National Ambinet Air Quality Standards) *Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD). The Monitoring TAD suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD).

The TCEQ considered the modeling analysis, but did not rely solely on it in the prioritization of potential sites. The latitude and longitude of each SO_2 source designated for ambient air monitoring was plotted on a satellite map. Surrounding properties and associated owners were identified using county appraisal district information. The TCEQ then collectively considered the following parameters: predominant wind flow, modeling analyses, property owner agreement, and logistical constraints, such as space, power availability, terrain, grade, and drainage. Failure to meet criteria for any single parameter did not necessarily exclude the location from consideration.

This appendix includes information specific to each source used in locating new source-oriented SO_2 monitors for the purpose of compliance with the DRR.

Appendix E Table of Contents

Monitoring Placement Evaluations Approved by the EPA

Big Spring Carbon Black....3
Calaveras Plant....24
Oxbow Calcining....41
AEP Pirkey Power Plant....58
Welsh Power Plant....99

Draft Monitoring Placement Evaluations Pending EPA approval

Streetman Plant....80
Sandow Steam Electric Station and Sandow 5 Generating Plant....120
Sid Richardson Borger Carbon Black and Orion Borger Carbon Black....137
Oak Grove Steam Electric Station....161
Orion Echo Carbon Black Plant....175
Harrington Generating Station....195
Baytown Refinery....210

Big Spring Carbon Black Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Big Spring Carbon Black (Figure 2)
- Owner: Sid Richardson Carbon Company
- Facility function: chemical manufacturing
- Location: 32.267390, -101.418244, Texas Commission on Environmental Quality (TCEQ) Region 7, Howard County, Texas
- Sulfur Dioxide (SO_2) emissions data: 8,307 tons (2013), 5,947 tons (2014)
- Long-term emissions trend: decreasing, 40 percent (%) decrease from 2004 to 2014
- Emission profile: operational year-round
- Stack height: 51 meters
- SO_2 emission controls: none
- Permit related data: Federal Operating Permit

Existing Air Monitoring Sites

The nearest ambient air quality monitoring sites are detailed in Table 1. No TCEQ ambient air quality monitors are located within 98 kilometers (km) of Big Spring Carbon Black. The existing sites listed in Table 1 are not located to characterize maximum SO_2 source concentrations and are not downwind.

Table 1: Air Monitoring Sites Near Big Spring Carbon Black

Site	Location	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2012–2014)
Odessa Gonzales	98.5 kilometers southwest	No	Not applicable
Odessa-Hays Elementary School	101 kilometers southwest	No	Not applicable

Settings and Surroundings

The rural and suburban area surrounding Big Spring Carbon Black consists of the southwestern tablelands with elevation ranging from 690 to 850 meters as shown in Figure 1. (Griffith et al. 2004) No significant changes to the landscape were noted during the reconnaissance as compared to the Google Earth view shown in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area as detailed in Table 2.

Alon USA LP Big Spring Refinery (Alon), located approximately 1.5 km southwest of Big Spring Carbon Black, has the potential to influence SO_2 concentrations in the Big Spring Carbon Black area under certain meteorological conditions. Alon's SO_2 emissions were reported as 819 tons in 2014. Due to the site's location and the area's predominant southeasterly wind flow, it is anticipated that Alon would only minimally impact SO_2 concentrations around the Big Spring Carbon Black area when winds are from the southwest (approximately 4% of the time according to the Big Spring Airport wind rose data; Figures 3 and 4).

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

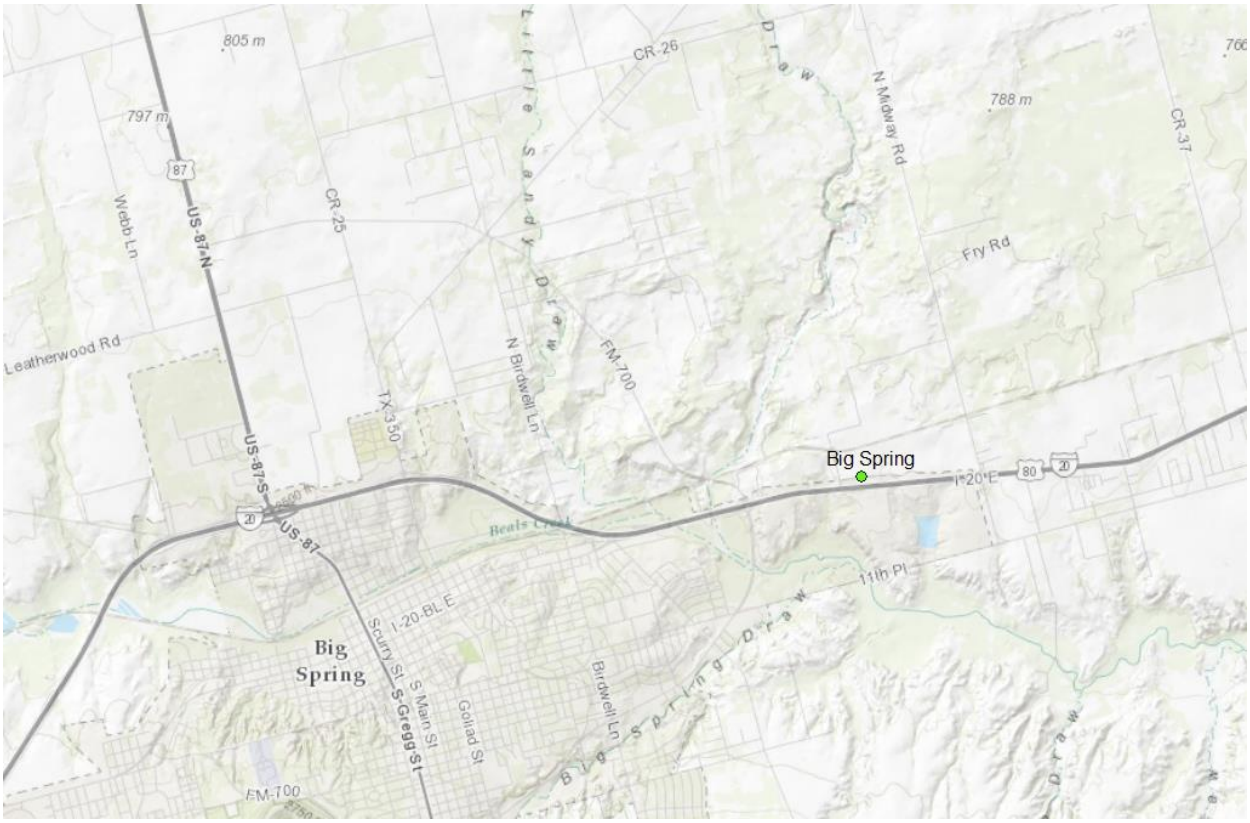

Figure 1: Big Spring Carbon Black Area Elevation Map

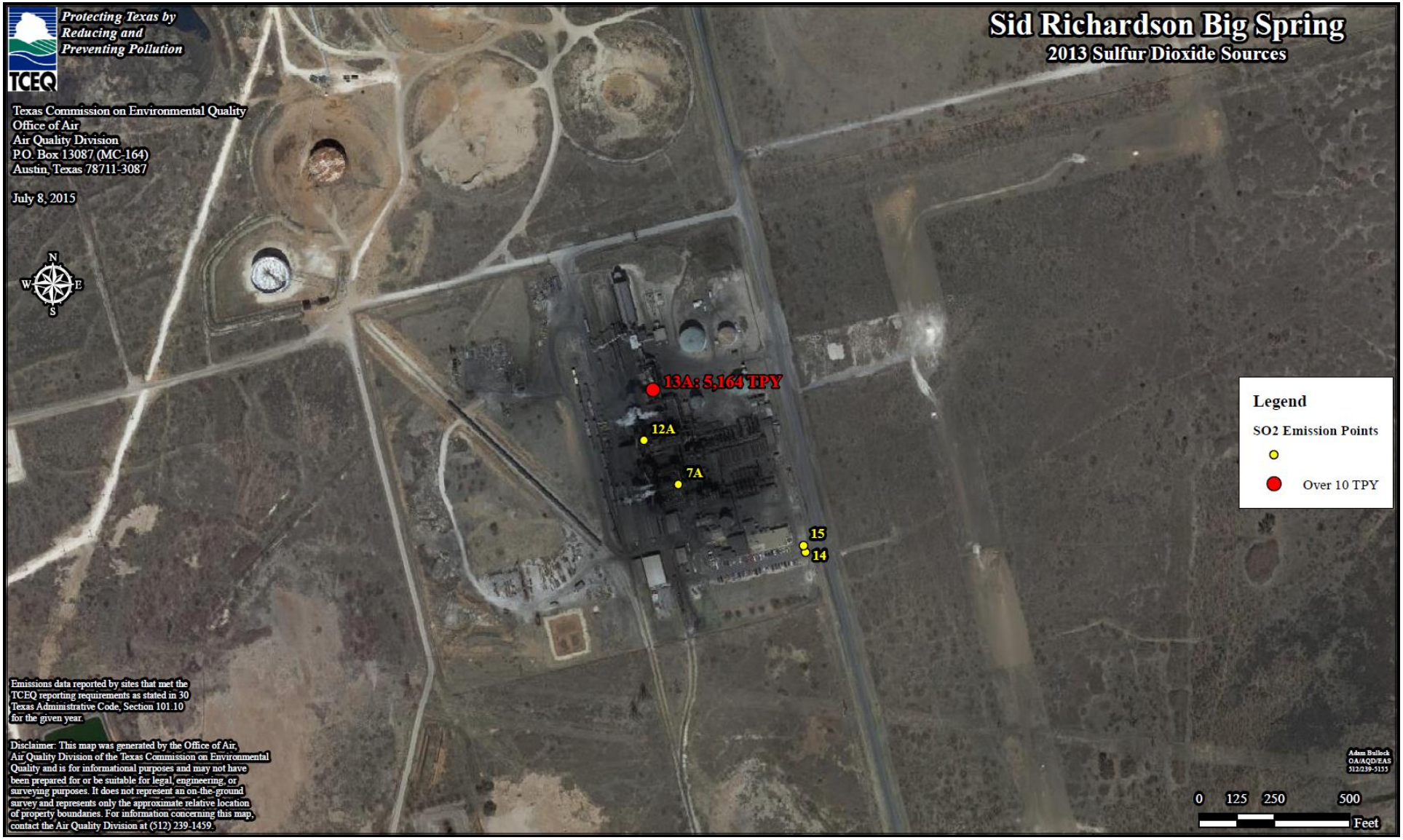

Figure 2: Big Spring Carbon Black Sulfur Dioxide Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Big Spring Airport, located 12 miles southwest of Big Spring Carbon Black. Figure 4 illustrates the 2012-2014 annual average wind speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012-2014 wind data, the dominant wind flow direction is from the south to southeast, approximately 36% of the average area wind flows. Over this three year period, calm winds (0-2 miles per hour) occurred on average 9% of the time and wind speeds averaged 10.3 miles per hour.

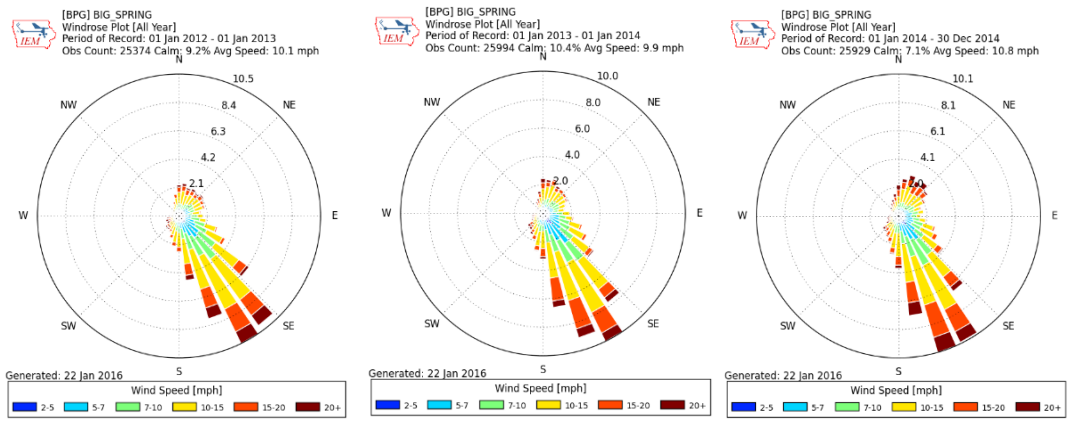

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

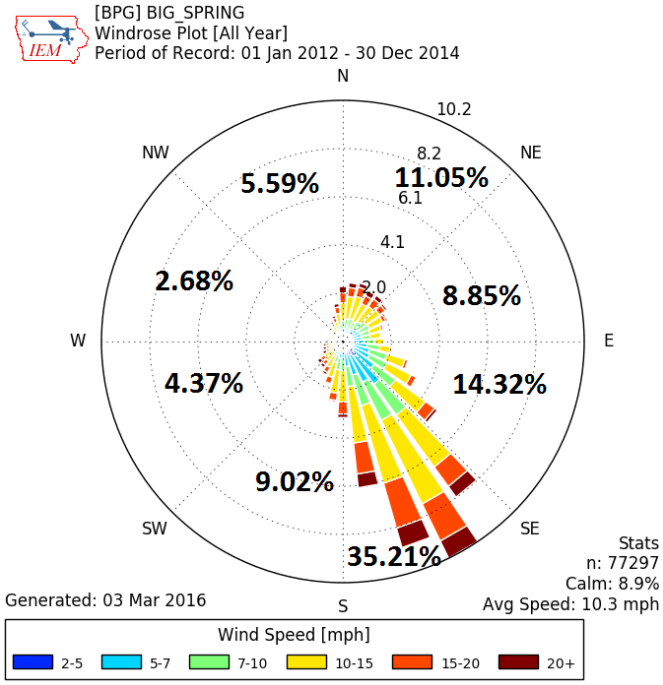

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the one kiln stack was modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a + symbol. Big Spring Carbon Black's permitted property is outlined in black. Based on this analysis, the highest normalized concentrations, greater than 85% of the predicted off-property maximum, are expected within or north, northeast and east of Big Spring Carbon Black's property. The proposed monitor locations identified within Figure 5 (sites 14, 15, and 18) are within areas with predicted normalized concentrations within 50% to 80% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-

property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around the Big Spring Carbon Black facility. Again, the location of the predicted off-property maximum is indicated by a + symbol and Big Spring Carbon Black's permitted property is outlined in black. Using this analysis metric, areas directly to the north, northeast, and east of the Big Spring Carbon Black facility scored greater than 60% and would be expected to see the highest frequency of elevated SO_2 concentrations. The areas directly to the north and northeast are not viable for monitor placement based on site reconnaissance and discussion with property owners.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a λ symbol and Big Spring Carbon Black's permitted property is outlined in black. As with the normalized 99th percentile and normalized frequency metrics, areas directly north and directly east of the Big Spring Carbon Black facility scored greater than 90% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did not yield a viable location for monitor placement.

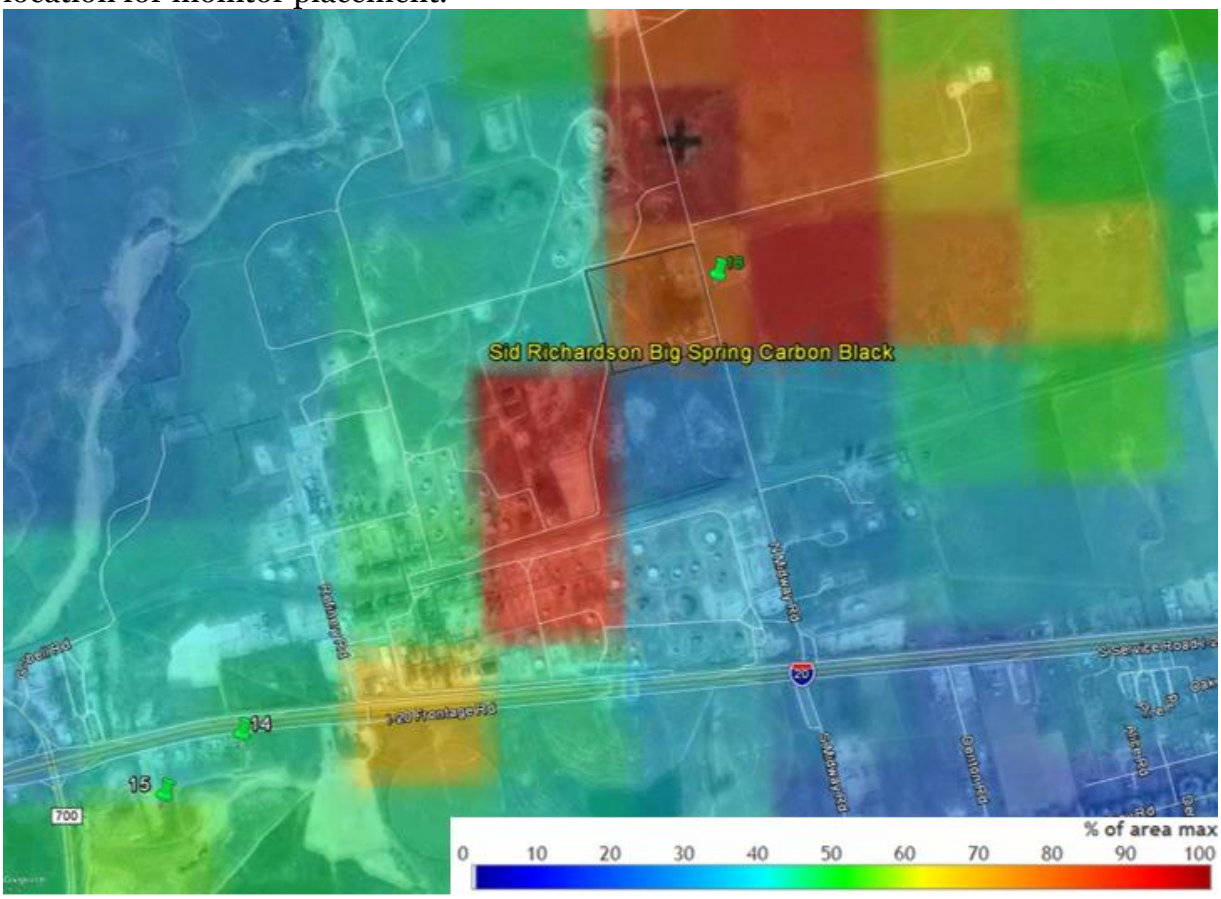

Figure 5: Big Spring Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Locations (14, 15, 18)

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

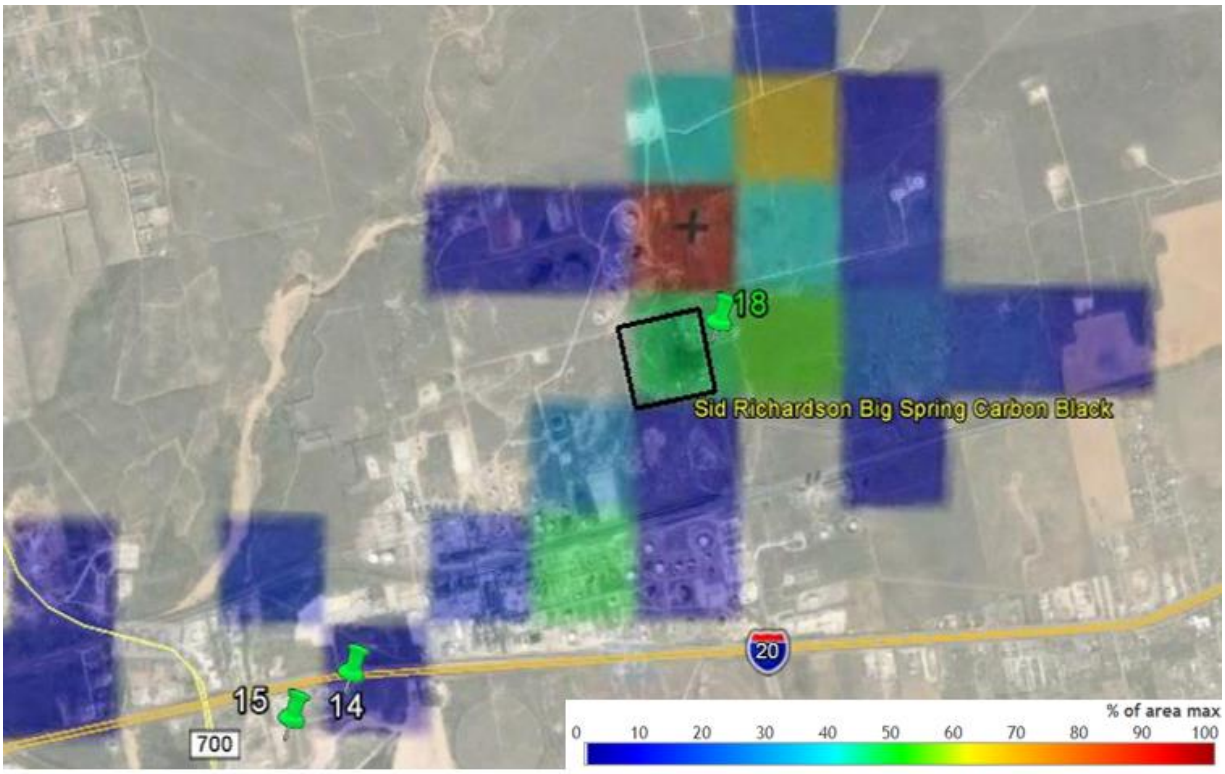

Figure 6: Big Spring Area CAMx Model Predictions, Normalized Frequency, (Number of Days) and Viable Site Locations

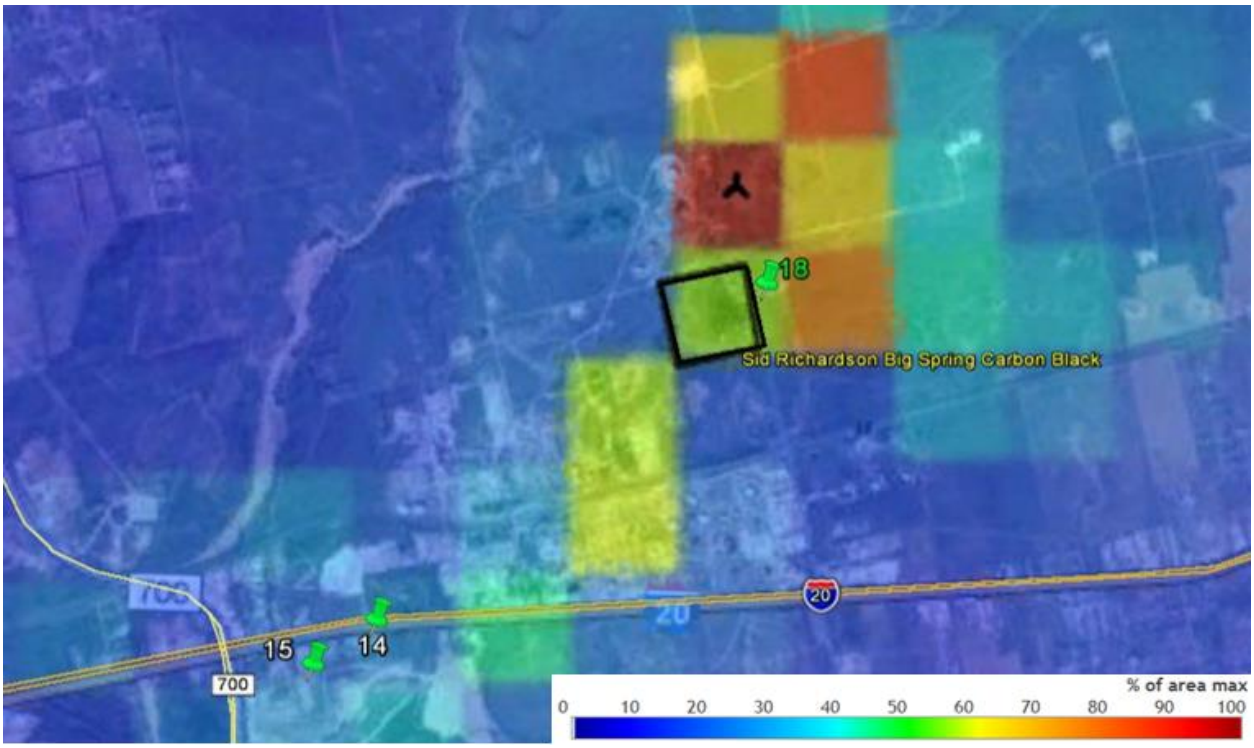

Figure 7: Big Spring Area CAMx Model Predictions Composite Metric and Viable Site Locations

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Big Spring Carbon Black that would characterize the highest SO_2 concentrations from this facility; therefore a new site is required. The TCEQ focused on complying with the federal requirements listed in Section 40 of the Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach includes utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analysis provided in Figures 5, 6, and 7 suggest that maximum SO_2 concentrations are expected to occur north and east of the Big Spring Carbon Black facility. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected within or directly north of Big Spring Carbon Black.

Twenty-three potential sites were identified as shown in Figure 8. Twenty of the identified potential sites (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 19, 20, 21, 22, and 23) are not considered viable and are indicated by red pins in Figure 8. Sites 1, 2, 3, 4, 5, 7, 8, 10, and 11 were in areas with restricted access, such as a locked gate to a private road. Property owners at sites 6, 9, 12, 16, 19, and 20 were unwilling or unresponsive. The property owner of site 16 was actively pursued due to the proximity to maximum off property concentrations, frequency, and composite metrics. After numerous conversations and written communication it was determined that the property owner was not willing to locate a monitoring site anywhere on the property. The outline of each non-viable property is indicated in yellow in Figure 8. While downwind of the source, predicted SO_2 concentrations around site 13 were considerably lower than other potential site locations. Sites 17, 21, 22, and 23 were also in areas with low predicted SO_2 concentrations and were not in preferable downwind locations. As a result these sites are no longer under consideration.

The three sites with satisfactory logistical and siting characteristics and locations anticipated to have peak concentrations include sites 14, 15, and 18, which are indicated by green pins in Figures 5, 6, 7, and 8. These site locations are also identified on the model and satellite image overlay shown in Figures 5, 6, and 7.

- Site 14 is positioned approximately 2.25 km southwest of the Big Spring Carbon Black facility. Although this site is not directly downwind of the source, the site does provide level ground, adequate space, and available power. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 45-50% of the maximum concentrations, so the site would be expected to measure elevated concentrations (likely during periods of calm or northerly winds). The property owner is amenable to a site agreement.
- Site 15 is positioned approximately 2.5 km southwest of the Big Spring Carbon Black facility. Although this site is not directly downwind of the source, the site does provide level ground, adequate space, and available power. The normalized 99th percentile concentration metric analysis predicted concentrations in this area

to be 45-50% of the maximum concentrations, so the site would be expected to measure elevated concentrations (likely during periods of calm or northerly winds). The property owner is amenable to a site agreement.

- Site 18 is positioned directly east of the Big Spring Carbon Black facility and less than 0.5 km south of the off-property maximum concentration (see Figure 7). Although this site is not downwind of the source, the area approximately 150 meters south of the northeast corner property line, offers level ground, adequate space, and available power. This site area is the closest to the source within a radius of 2,500 meters. The northeast edge of this property is not viable due to numerous electrical, buried cable, and road easements restricting site location. The normalized 99th percentile concentration metric analysis predicted area concentrations to be 80-90% of the maximum, therefore the site would be expected to measure peak SO_2 concentrations near the source. A site agreement has been negotiated with the property owner.

Recommendation

Based on current facility operations, available emission data, wind patterns, modeling analysis, and evaluation of surrounding areas during site reconnaissance, site 18 (see Figures 9 and 10) is the only viable site recommended for placement of a new source-oriented ambient SO_2 monitoring station. No other areas withing a 2,500 meter radius were available for consideration. Although this site is not downwind, it is expected to measure peak concentrations during periods of calm wind speeds. While the modeling analysis predicts the highest maximum normalized concentration and composite metric score to be located 0.5 km to the north, a site agreement with the property owner of site 16 is unattainable. Site 18 is the closest location to the source and predicted maximum normalized SO_2 concentrations with available power, adequate space, level ground, and meets all federal siting criteria.

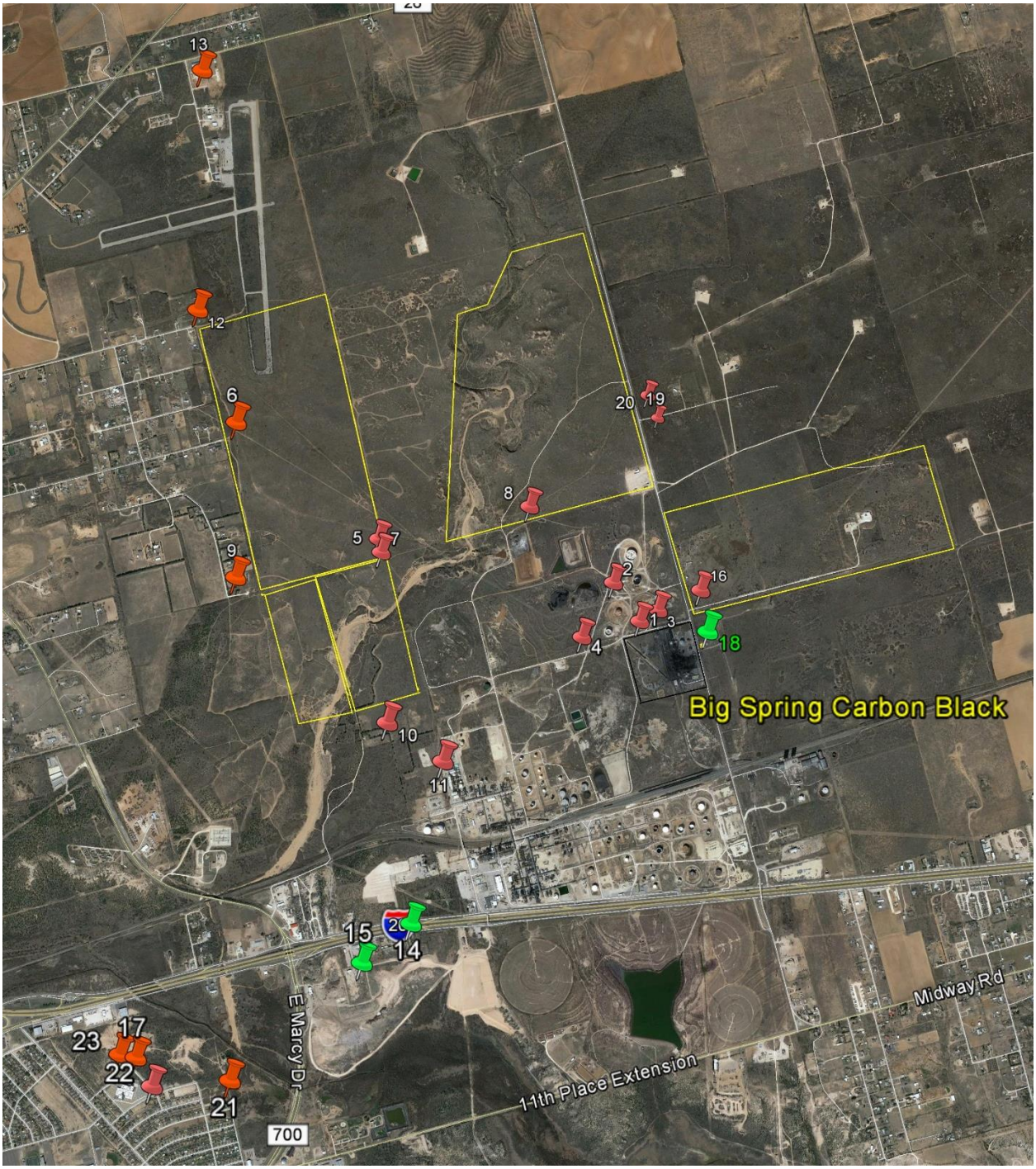

Figure 8: Potential Monitoring Sites for Big Spring Carbon Black

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	Big Spring #1	Big Spring #2	Big Spring #3
Location	32.28067, -101.41135	32.28271, -101.41299	32.28125, -101.41021
Distance from SO_2 Source[2]	292 m	560 m	252 m
Wind Direction	S, SE	S, SE	S, SE
Grade	Not applicable	Not applicable	>2%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (NW)	Yes (N)
Obstructions and Height	Not measured, no site access	Not measured, no site access	Not measured, no site access
Distance from Site to Obstructions	Not applicable	Not applicable	Not applicable
Road/Site Access	No	No	No
Electricity Available <18 m	Not evaluated, no site access	Not evaluated, no site access	Not evaluated, no site access
Pros	Not applicable	Not applicable	Not applicable
Cons	• No site access • Requires special permission and use of private industry road to access site	• No site access • Requires special permission and use of private industry road to access site	• No site access • Requires special permission and use of private industry road to access site • >2% grade
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #4	Big Spring #5	Big Spring #6
Location	32.27989, -101.41493[2]	32.28484, -101.42758[2]	32.29113, -101.43735
Distance from SO_2 Source[2]	608 m	1,883 m	3,020 m
Wind Direction	S, SE	S, SE	S, SE
Grade	Not applicable	Not applicable	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Not measured, no site access	Not measured, no site access	Trees (4-5 m) Ridge (5 m)
Distance from Site to Obstructions	Not applicable	Not applicable	Trees (18 m, 32 m SW, W from dripline) Ridge (132 m SE, E)
Road/Site Access	No	No	No
Electricity Available <18 m	Not evaluated, no site access	Not evaluated, no site access	Yes
Pros	Not applicable	Not applicable	• Level ground • Downwind • Space available • Power available • Easy operator access
Cons	• No site access • Requires special permission and use of private industry road to access site	• No site access • Requires special permission and use of private industry road to access site	• Slight grade in surrounding areas • Declined by property owner
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #7	Big Spring #8	Big Spring #9
Location	32.27989, -101.41493	32.28484, -101.42758	32.28390, -101.43652
Distance from SO_2 Source[2]	2,060 m	1,218 m	2,650 m
Wind Direction	S, SE	S, SE	S, SE
Grade	Not applicable	Not applicable	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Not measured, no site access	Not measured, no site access	Trees (4-8 m) Ridge (5 m)
Distance from Site to Obstructions	Not applicable	Not applicable	Trees (9 m, 38 m, 39 m NW) Ridge (30 m N)
Road/Site Access	No	No	Yes
Electricity Available <18 m	Not evaluated, no site access	Not evaluated, no site access	Yes
Pros	• Not applicable	• Not applicable	• Level ground • Downwind • Space available • Power available • Easy operator access
Cons	• No site access • Requires special permission and use of private road to access site.	• No site access • Requires special permission and use of private road to access site.	• Slight grade in surrounding areas • On unpaved, dirt road; site may not be accessible during heavy rain events • Declined by property owner
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #10	Big Spring #11	Big Spring #12
Location	32.27528, -101.42696	32.27328, -101.42349	32.29732, -101.43947
Distance from SO_2 Source[2]	1,786 m	1,570 m	3,496 m
Wind Direction	S, SE	S, SE	S, SE
Grade	Not applicable	Not applicable	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	No (W)	No (W)	Yes (NW)
Obstructions and Height	Not measured, no site access	Not measured, no site access	Trees (3-7 m) Buildings (4-5 m)
Distance from Site to Obstructions	Not applicable	Not applicable	Trees (45 m NW, E, SE, S from dripline) Buildings (33, 36 m NE)
Road/Site Access	No	No	Yes
Electricity Available <18 m	Not evaluated, no site access	Not evaluated, no site access	Yes
Pros	Not applicable	Not applicable	• Level ground • Downwind • Space available • Power available • Easy operator access • Strong cellular service
Cons	• No site access • Requires special permission and use of private road to access site	• No site access • Requires special permission and use of private road to access site	• Declined by property owner • Planned future development
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #13	Big Spring #14	Big Spring #15
Location	32.31065, -101.43968	32.26497, -101.42531	32.26308, -101.42832
Distance from SO_2 Source[2]	4,500 m	2,251 m	2,599 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	No (SW)	No (SW)
Obstructions and Height	Trees (7 m)	Tree (10 m) Buildings (5 m, 7 m) Tree (8 m)	None
Distance from Site to Obstructions	Trees (30 m SE)	Tree (10 m SW) Building (22 m W, 21 m N) Tree (13 m SE)	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level terrain • Property owner willing • Road base and two sides of fence existing	• Level ground • Site agreement possible • Space available • Power available • Easy operator access	• Level ground • Power available • Site agreement Possible • Space available
Cons	• Low concentration of SO_2 according to modeling analysis	• Low concentration of SO_2 according to modeling analysis • Not downwind	• Low concentration of SO_2 according to modeling analysis • Not downwind
Viable Site (Yes, No, or Preferred)	No	Yes	Yes

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #16	Big Spring #17	Big Spring #18
Location	32.28495, -101.40840	32.25825, -101.44174	32.28004, -101.40716
Distance from SO_2 Source[2]	592 m	3,908 m	160 m
Wind Direction	S, SE	S, SE	S, SE
Grade	Varies	>2%	<1%
Flood Plains	Varies	Possible	No
Mountain/ Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	No (SW)	No (E)
Obstructions and Height	None	Hill (3 m)	None
Distance from Site to Obstructions	None	Building (71 m) Steep grade (18 m)	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Power available • Maximum off-property concentration of SO_2 emissions according to modeling analysis	• Power available • Site agreement possible • Space available	• High concentration and frequency according to modeling analysis • Power Available • Level ground • Signed site agreement
Cons	• Rough terrain • Numerous "No Trespassing" signs • Unresponsive owner	• Low concentration of SO_2 according to modeling analysis • >2% grade	• Not downwind • Will require minor work to level ground and clear brush
Viable Site (Yes, No, or Preferred)	No	No	Preferred

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #19	Big Spring #20	Big Spring #21
Location	32.29177, -101.41015	32.29290, -101.41080	32.25711, -101.43613
Distance from SO_2 Source[2]	1,324 m	1,481 m	3,591 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (N)	No (SW)
Obstructions and Height	None	None	Trees (6 m, 12 m) Building (6 m)
Distance from Site to Obstructions	None	None	Trees (8 m N, 15 m NE, 44 m SW) Building (S 25 m)
Road/Site Access	No	No	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Power available	• Level ground • Power available	• Level ground • Power available • Site agreement possible • Space available
Cons	• Unresponsive property owner • No driveway access • Low concentration of SO_2 according to modeling analysis	• Unresponsive property owner • No driveway access • Low concentration of SO_2 according to modeling analysis	• Low concentration of SO_2 according to modeling analysis • Not downwind
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Big Spring #22	Big Spring #23
Location	32.25684, -101.44078	32.25833, -101.44281
Distance from SO_2 Source[2]	3,901 m	3,984 m
Wind Direction	S, SE	S, SE
Grade	<1%	<1%
Flood Plains	No	No
Mountain/Valley Winds	None	None
Water Body Nearby[2]	No	No
Wind Channeling	None	None
Downwind[2]	No (SW)	No (SW)
Obstructions and Height	Tree (12 m)	Tree (3 m) Building (20 m)
Distance from Site to Obstructions	Tree (44 m NE)	Tree (8 m S) Building (58 m S)
Road/Site Access	Yes	Yes
Electricity Available <18 m	Yes	Yes
Pros	• Level ground • Power available • Space available • Accessible	• Level ground • Power available • Space Available • Accessible
Cons	• Low concentration of SO_2 according to modeling analysis • Not downwind	• Low concentration of SO_2 according to modeling analysis • Not downwind
Viable Site (Yes, No, or Preferred)	No	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
% – percent
N – north
S – south
E – east
W – west
NE – northeast
NW – northwest
SE – southeast
SW – southwest
m – meter
– number
< – less than
> – greater than

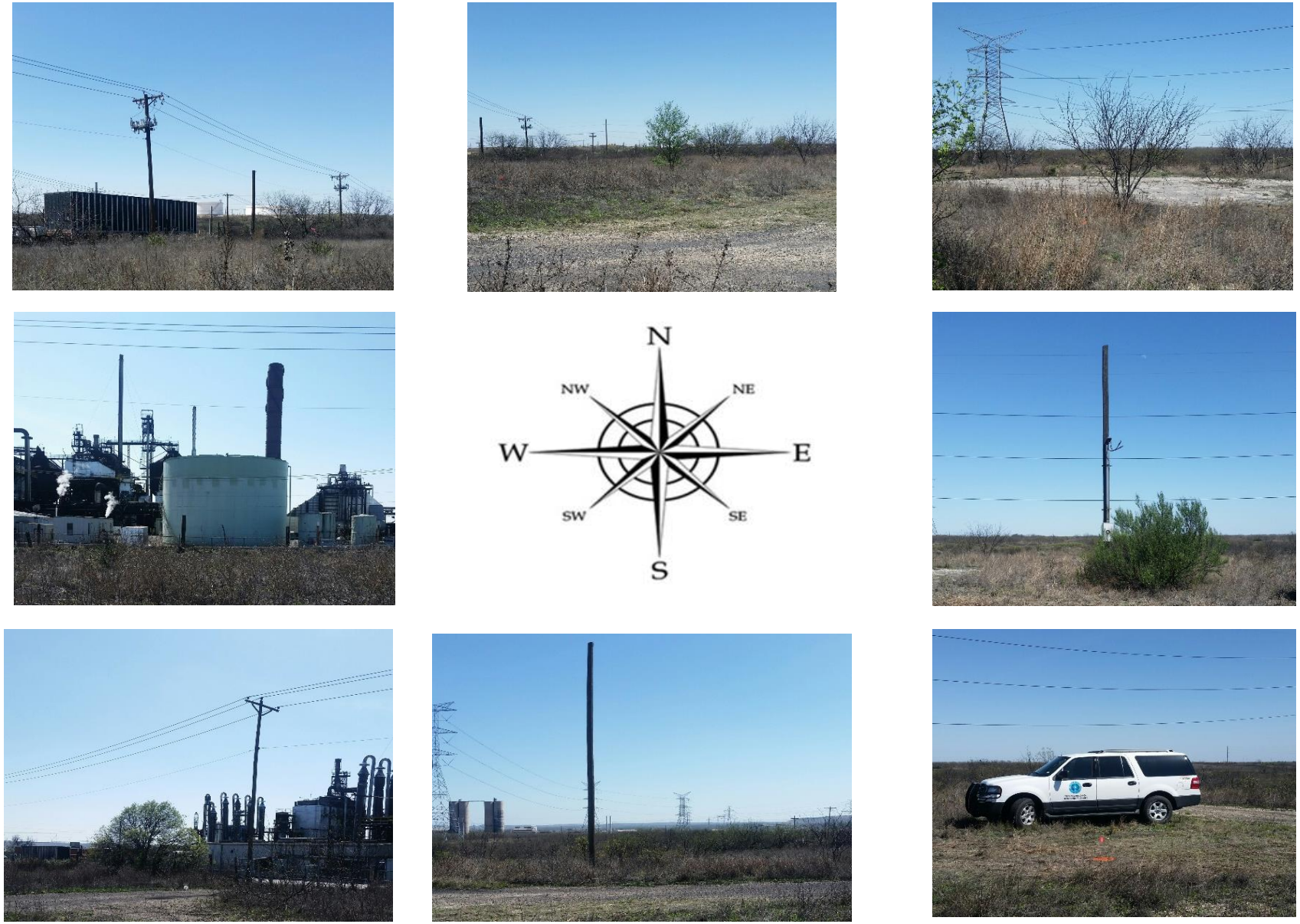

Figure 9: Big Spring Carbon Black #18 Potential Site Cardinal Direction Photos

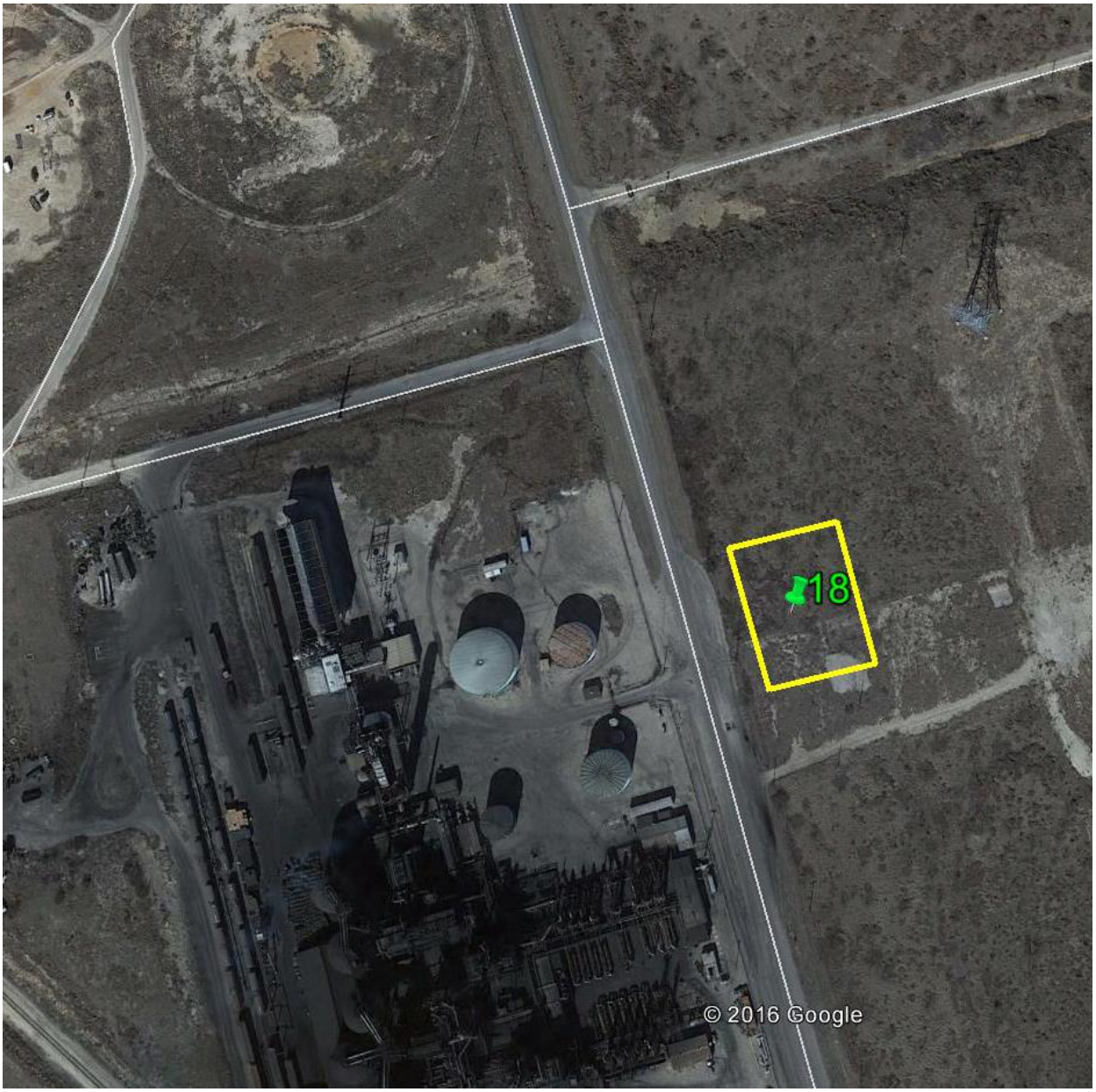

Figure 10: Big Spring Carbon Black #18 Potential Site

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. Ecoregions of Texas. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Calaveras Plant Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Calaveras Plant (Calaveras) (Figure 2)
- Owner: City Public Service (CPS)
- Facility function: electric generation
- Location: 29.308300, -98.321000, TCEQ Region 13, Bexar County, Texas
- SO_2 emissions data: 12,718 tons (2013), 17,133 tons (2014)
- Long-term emissions trend: decreasing, 33% decrease from 2009 to 2014
- Emission profile: operational year-round
- Stack height(s): 2 stacks 102 meters high, which are currently active (shown in Figure 2).
- SO_2 emission controls: 1 limestone scrubber and 1 catalytic reduction each reduce SO_2 emissions by 90%. 1 absorption tower also reduces SO_2 emissions by 80% on a separate stack.
- Permit related data: Prevention of Significant Deterioration(PSD) permit

Existing Air Monitoring Sites

The nearest ambient air quality monitoring sites are detailed in Table 1. All existing SO_2 monitors have design values below the current SO_2 standard of 75 parts per billion (ppb). With the exception of Heritage Middle School, these existing monitoring sites are not located to characterize maximum SO_2 source concentrations and are not downwind. Heritage Middle School site is currently owned and operated by CPS and is in an optimal location.

Table 1: Air Monitoring Sites Near Calaveras Power Plant

Site	Location	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2012–2014)
Gate 58 CPS	1.57 kilometers northwest	No	Not applicable
Gate 9A CPS	2.3 kilometers southwest	No	Not applicable
Gardner Rd. Gas Sub-Station	2.8 kilometers north	No, private monitor on Calaveras property	Not applicable
Calaveras Lake	3.6 kilometers south	Yes, TCEQ	0.64 parts per billion*
Heritage Middle School	4.7 kilometers north	Yes, non-TCEQ private monitor	Not comparable

*design value data does not meet completeness requirements for 2012

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Settings and Surroundings

The rural area surrounding Calaveras consists of interior plains with a low elevation as shown in Figure 1. The terrain is characterized by flat to gently rolling hills, and grasses, forbs, and croplands are the dominant vegetation (Griffith et al. 2004). No significant changes to the landscape were noted during the reconnaissance as compared to the Google Earth view shown in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not characteristic of this area as detailed in Table 2.

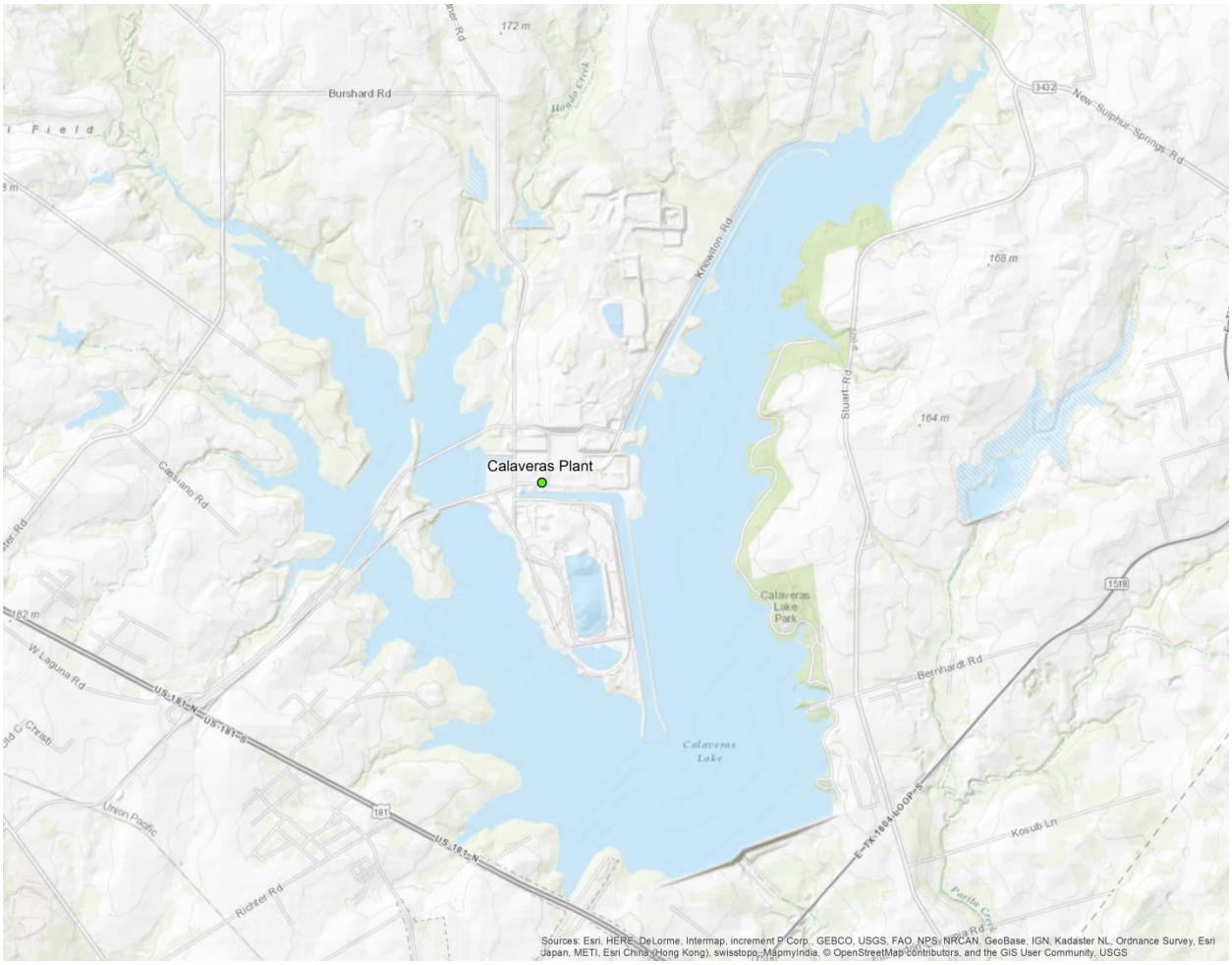

Figure 1: Calaveras Power Plant Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

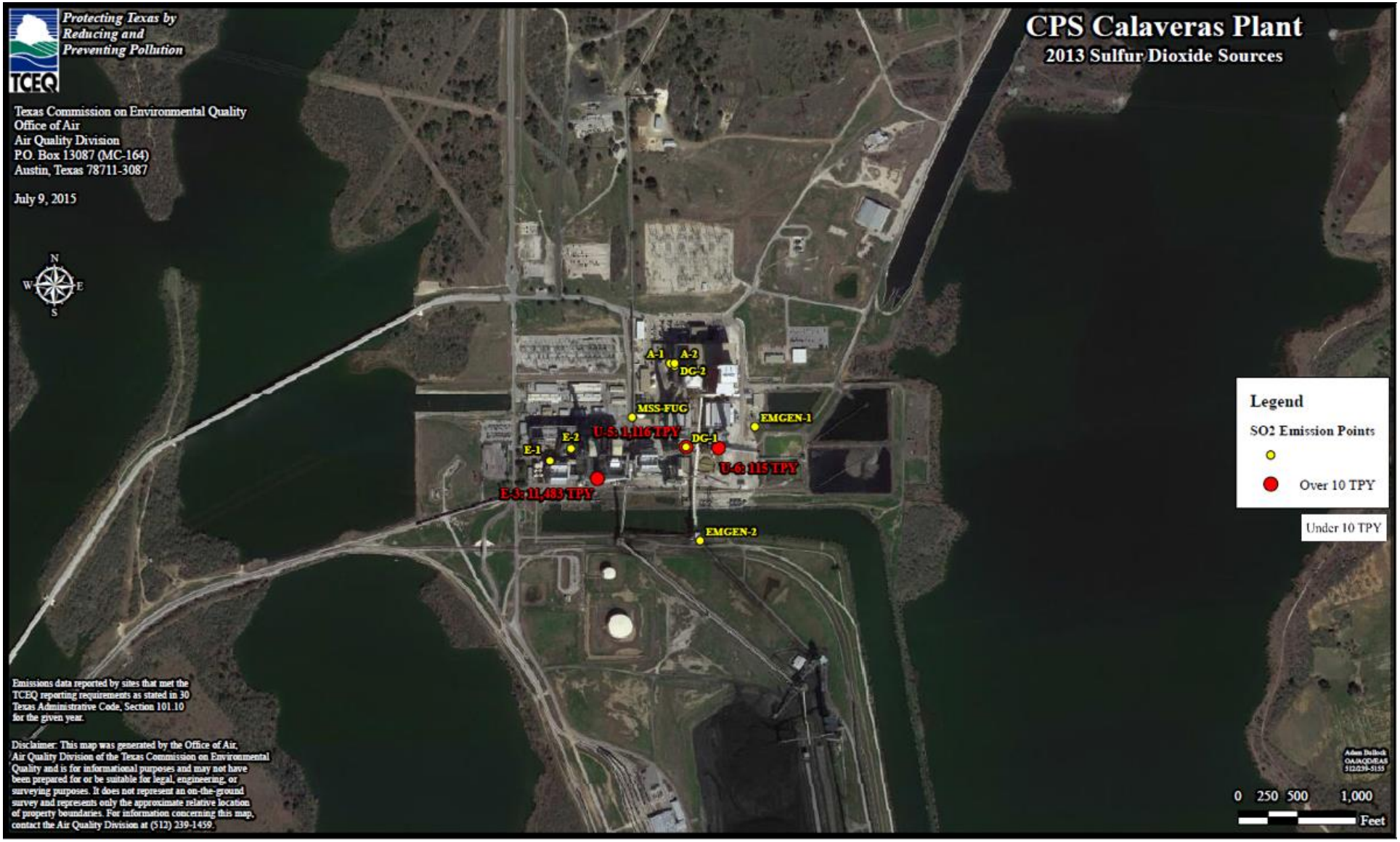

Figure 2: Calaveras Power Plant SO_2 Stacks and Emissions, 2013

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the San Antonio International Airport, located 29 kilometers northwest of Calaveras. Figure 4 illustrates the 2012-2014 annual average wind speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012–2014 wind data, the dominant wind flow direction for the area is south to southeast, with wind flows from the north, northeast, and northwest accounting for only 19% of the average annual wind flows. Over this three year period, calm winds (0-2 miles per hour) occurred on average 13% of the time and wind speeds averaged 8.2 miles per hour (Iowa Environmental Mesonet 2016).

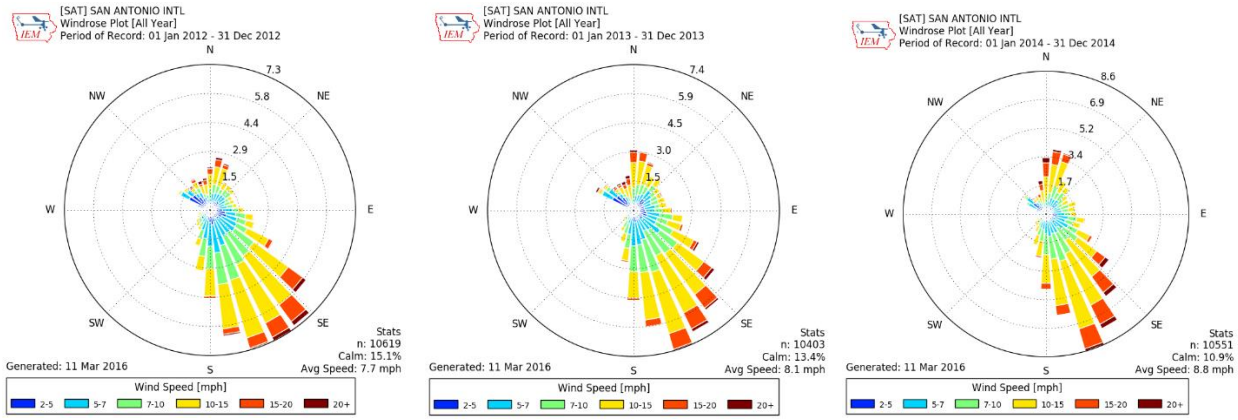

Figure 3: (From left to right) 2012, 2013, and 2014 individual Wind Rose Plots

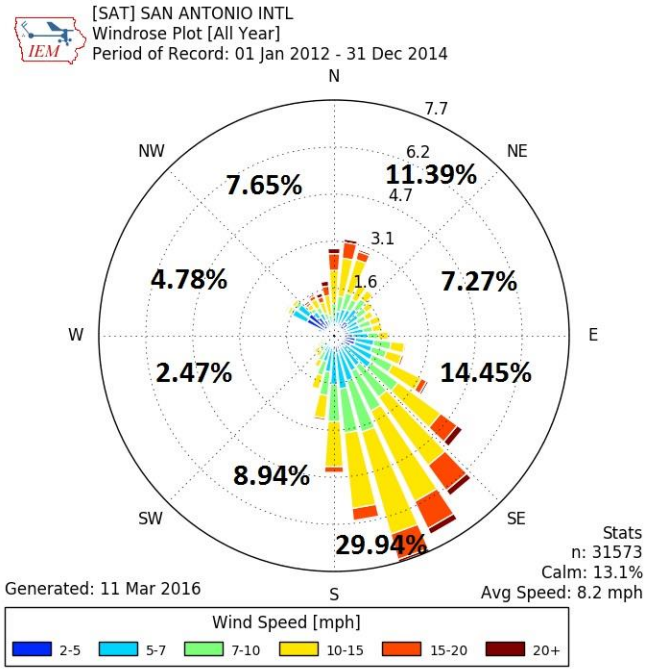

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique for identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72-km by 72-km;
- the two kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12-km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4-km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 graphically presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a black square. Calaveras' permitted property is outlined in blue. Based on this analysis, the highest normalized concentrations, greater than 80% of the predicted off-property maximum, are expected within or immediately surrounding and to the north of Calaveras' property. The proposed monitor locations identified within Figure 5 are within areas with predicted normalized concentrations within 80% to 99% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around the Calaveras facility. Again, the location of the predicted off-

property maximum is indicated by a black square and Calaveras' permitted property is outlined in blue. Using this analysis metric, areas directly to the north and areas directly west of the Calaveras facility scored greater than 80% and would be expected to see the highest frequency of elevated SO_2 concentrations.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum indicated by a black square, the off-property maximum composite metric indicated with λ, and Calaveras' permitted property is outlined in blue. As with the normalized 99th percentile and normalized frequency metrics, areas north and west of the Calaveras facility scored greater than 80% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did yield a viable location for monitor placement.

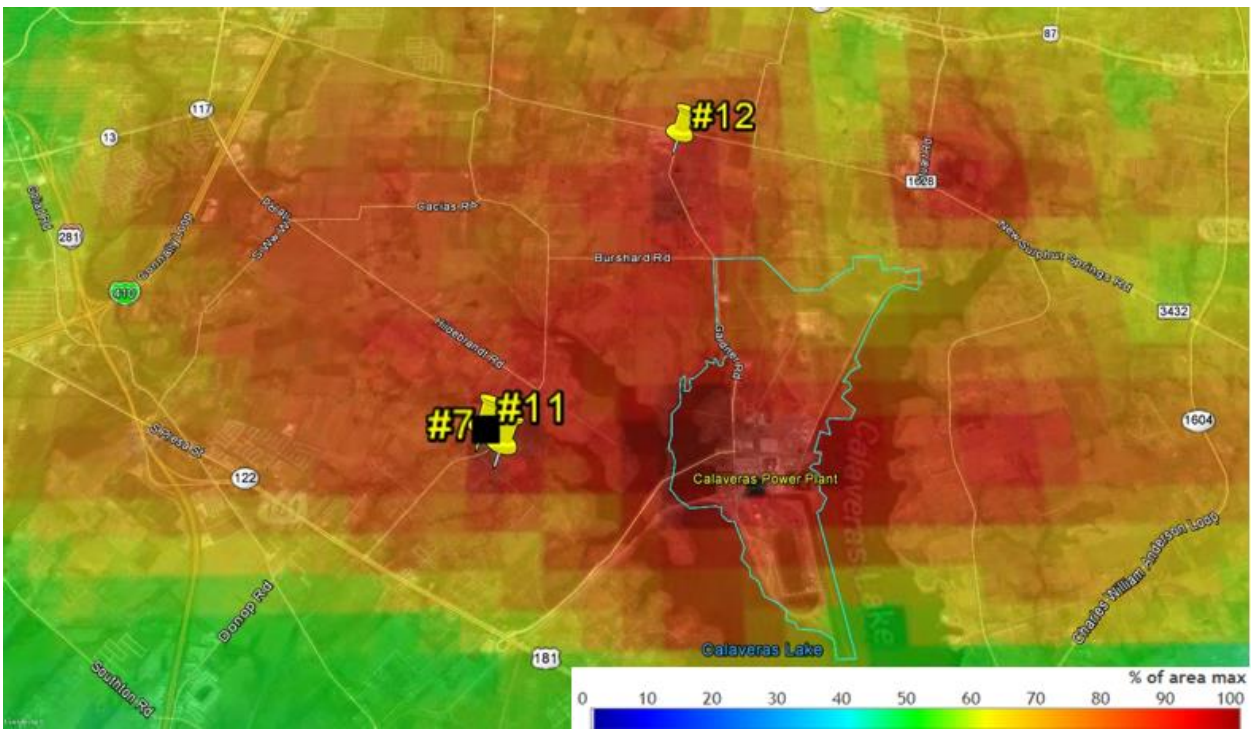

Figure 5: Calaveras Area CAMx Model Predictions Normalized Concentrations and Viable Site Locations

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

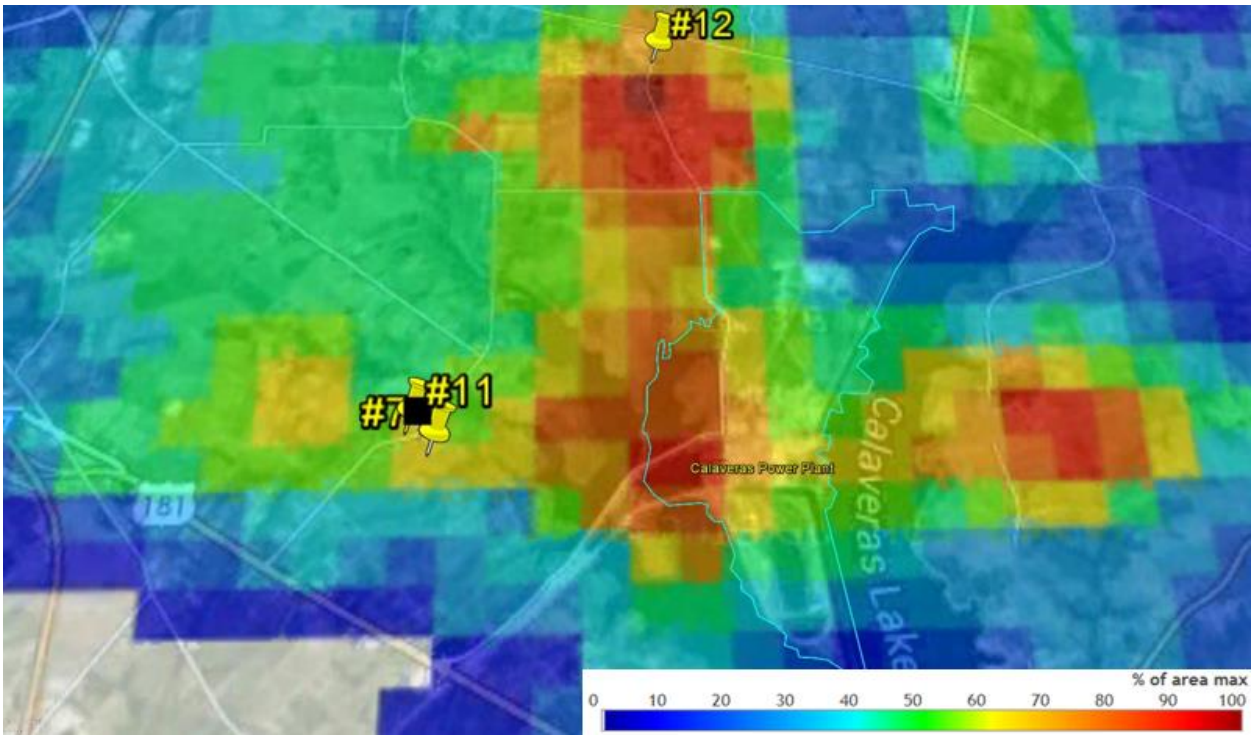

Figure 6: Calaveras Area CAMx Model Predictions Normalized Frequency (number of days) and Viable Site Locations

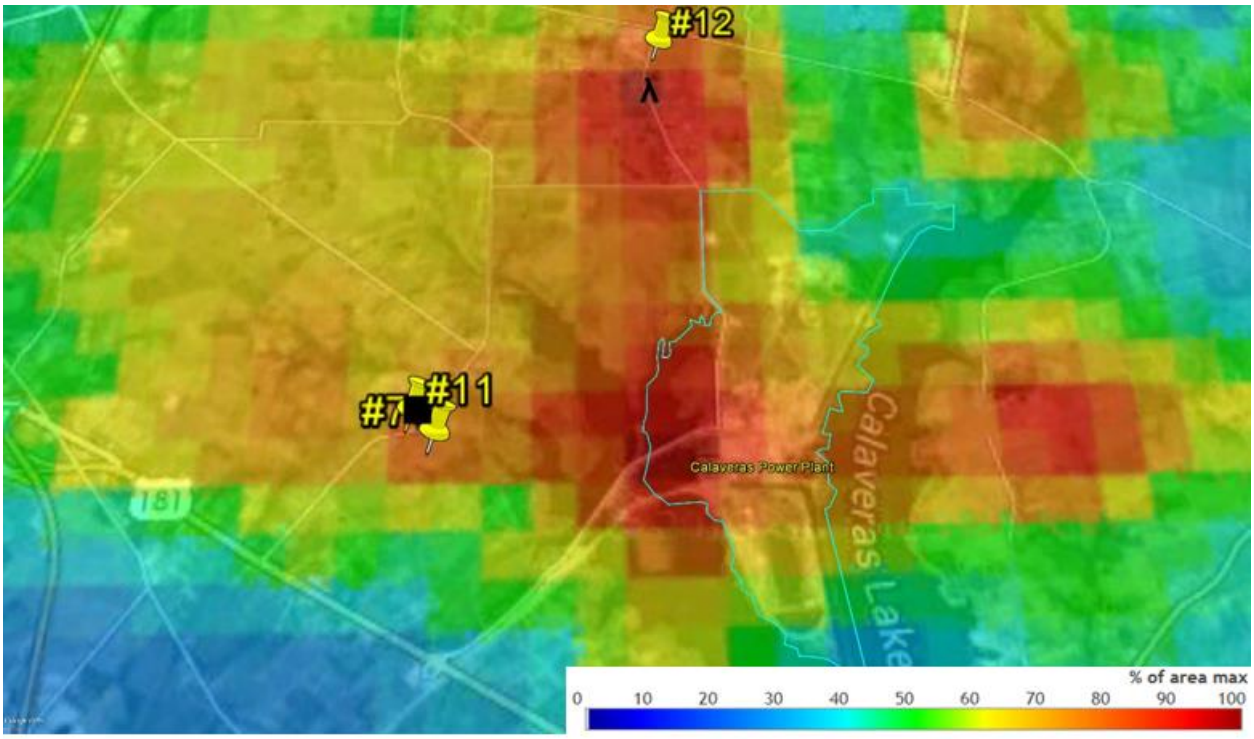

Figure 7: Calaveras Area CAMx Model Predictions Composite Metric and Viable Site Locations

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Selection Criteria and Options

The TCEQ currently does not monitor SO_2 downwind of the Calaveras Power Plant; therefore an additional site is required to characterize maximum concentrations. The TCEQ focused on complying with the federal requirements listed in 40 CFR Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach includes utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analysis provided in Figures 5, 6, and 7 suggest that maximum ground level concentrations are expected to occur north and west of Calaveras.

Fifteen potential sites were identified as shown in Figure 8. Twelve of the identified potential sites (1, 2, 3, 4a, 4b, 4c, 4d, 5, 6, 8, 9, and 10) are not considered viable. Sites 2, 4a, and 4b were declined by the property owner. There was no response from the property owners at Sites 1, 3, and 6. Site 4c does not provide adequate space to locate an air monitor. Sites 4d and 5 have steep terrains that present significant grade issues diminishing their viability as a suitable monitoring site. Site 8 is on City Public Service property and within the restricted, fenced area permitted for the Calaveras Plant. Site 9 is logistically challenging due the presence of a gas pipeline that would hinder site construction activities, such as digging. Site 10 is limited by large trees that would present challenges in meeting federal requirements for minimum distance from an obstruction. Areas north of Site 8 and south of Site 12 along Gardner Road consist of private property homes and agricultural land retained by unresponsive property owners. As a result, these sites are no longer under consideration.

The three sites with satisfactory logistical and siting characteristics and locations anticipated to have peak off-property concentrations include sites 7, 11, and 12. These site locations are also identified on the model and satellite image overlay shown in Figures 5, 6, and 7.

- Site 7 is located approximately 3.5 km west from the Calaveras Plant in a rural community. This site is on level ground, has space and power available, but would involve logistical improvements, such as a new driveway and gate. The site is not directly downwind, but based on TCEQ's monitor placement modeling is located within an area of predicted maximum off-property SO_2 concentrations.
- Site 11 is located 3.7 km west of the Calaveras Plant in a rural community. This site is on level ground, has space and power available, but would involve logistical improvements, such as a new driveway and gate. The site is not directly downwind, but based on TCEQ's monitor placement modeling is located within an area of predicted maximum off-property SO_2 concentrations.
- Site 12 is approximately 4.7 km north of the Calaveras Plant and is approximately 0.4 km directly north from the off-property maximum composite metric indicated with λ noted in Figure 7at an existing monitoring station owned and operated by City Public Service adjacent to Heritage Middle School. Given this location is currently being used as a monitoring site, it satisfies all infrastructure and siting requirements for placement of an SO_2 monitor. A site agreement has been negotiated with the property owner and City Public Service is willing to

convey access to the TCEQ. This potential site is downwind and within an area of predicted a maximum off-property SO_2 concentrations based and a predicted off-property maximum composite metric on TCEQ's modeling.

Recommendation

Based on current plant operations, available emission data, wind patterns, and CAMx model predictions, Site 12 is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. While the modeling analysis results for sites 7, 11, and 12 show similar SO_2 concentrations, Site 12 is also well positioned between the source and an area frequented by the public, providing an advantage over the other viable sites. Site 12 is also the location of the off-property maximum composite metric, an average of the normalized 99th percentile concentration and normalized frequency metrics. Site 12 has an existing monitoring station in place and meets all federal siting criteria. Site 12 is shown in Figures 5, 6, 7, 8, 9, and 10.

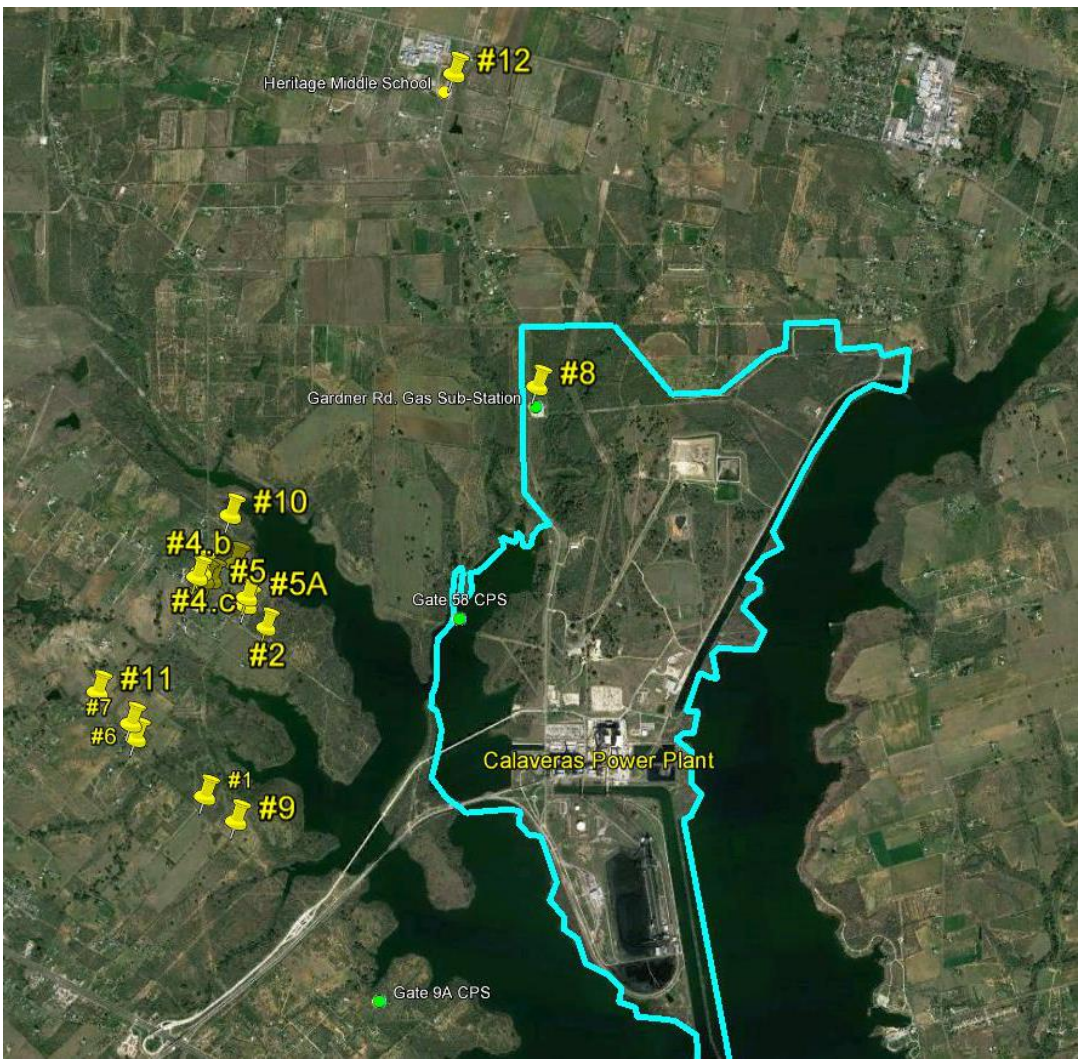

Figure 8: Potential Sites for Calaveras Power Plant

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	Calaveras #1	Calaveras #2	Calaveras #3
Location[2]	29.30476°, -98.35152°	29.31612°, -98.34669°	29.320369°, -98.35104°
Distance from SO_2 Source (meters)[2]	3,075	2,685	3,250
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E); 3.07 kilometers	Yes; reservoir (E); 0.87 kilometers	Yes; reservoir (E); 1.45 kilometers
Wind Channeling	None	None	None
Downwind[2]	No (W)	Yes (NW)	Yes (NW)
Obstructions and Height	Trees (10 m)	Trees (5 m)	Trees (15 m)
Distance from Site to Obstructions	Power substation (20-60 m E/SE) Trees (20-30 m E/SE from dripline)	Power substation (32 m E/SE) Trees (5 m E/SE from dripline)	Power substation (20 m SE)[2] Trees (20 m SE from dripline)[2]
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	Yes	Yes
Pros	• Level ground • Gate in place	• Level ground • Downwind • Power available • Easy access • Few Obstructions	• Level ground • Downwind • Space available • Power available
Cons	• Not directly downwind (W of plant) • Requires a transformer • No response from property owner	• Property owner not agreeable	• No response from property owner
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Calaveras #4a	Calaveras #4b	Calaveras #4c
Location[2]	29.31914°, -98.35145°	29.31364°, -98.35651°	29.319243°, -98.35148°
Distance from SO_2 Source (meters)[2]	3,200	3,535	3,220
Wind Direction	S, SE (dominant);	S, SE (dominant);	S, SE (dominant)
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E); 0.72 kilometers	Yes; reservoir (E); 1.96 kilometers	Yes; reservoir (E); 0.70 kilometers
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	N/A	N/A	Shrubs height (5 m)
Distance from Site to Obstructions	N/A	N/A	Power substation (10 m S) Shrubs (5 m S from dripline)[2]
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	Yes	Yes
Pros	• Level ground • Space available • Optimal site of all 4a, 4b, 4c, and 4d locations • Downwind	• Level ground • Downwind • Power available • Safe access • Open field not used	• Level ground • Power available • Downwind
Cons	• Property owner is not agreeable	• Property owner is not agreeable	• Residential backyard used for recreation • Not enough space • Cable line SE of site
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Calaveras #4d	Calaveras #5	Calaveras #6
Location[2]	29.31926°, -98.35142°	29.31786°, -98.34853°	29.308712, -98.35646
Distance from SO_2 Source (meters)[2]	3,220	2,890	3,560
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	>1%	>1%	<1%
Flood Plains	No	Yes	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E); 0.72 kilometers	Yes; reservoir (E); 0.87 kilometers	Yes; reservoir (E); 0.83 kilometers
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	No (W)
Obstructions and Height	Trees (10 m and 15 m)	Trees (10 m)	Brush (10 m) Tree line (10 m)
Distance from Site to Obstructions	Trees (27m NE, 37m SE from dripline)[2]	Trees (12 m) Trees (10 m in all directions from dripline)[2]	Brush (20 m E, 20m E from dripline)[2] Trees (42m SE, 42m SE from dripline)[2]
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	No	Yes
Pros	• Power available • Downwind	• Downwind	• Good access • Power available
Cons	• Significant slope • Two additional electric poles needed • Ditch at entryway	• Uneven Terrain • Significant slope • Natural Gas Pipeline present on site • No Power available • Flood plains	• Needs Transformer • Not Downwind • No response from property owner
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Calaveras #7	Calaveras #8	Calaveras #9
Location[2]	29.30959°, -98.35745°	29.33215°, -98.32643°	291811, -982058
Distance from SO_2 Source (meters)[2]	3,500	2,555	2,800
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant);
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	No
Water Body Nearby[2]	Yes; reservoir (E); 1.38 kilometers	Yes; reservoir (E); 1.22 kilometers	No
Wind Channeling	None	None	None
Downwind[2]	No (W)	Yes (NW)	No (W)
Obstructions and Height	Trees (20 m)	None	Tree (10 m)
Distance from Site to Obstructions	Trees (20 m N from dripline)[2]	NA	Tree (15 m to S)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	Yes	Yes
Pros	• Close proximity to modeled maxima • Space available • Power available • Safe access • Agreeable property owner	• Level ground • Downwind • Power available • Safe access • Site agreement possible	• Level grade • Close to the source
Cons	• Gate installation required • Not downwind	• On Calaveras property • Natural gas pipeline may hinder installation • Access issues	• Gas pipeline hinders construction of site • A transformer would need to be installed • Property owner not agreeable
Viable Site (yes, no, or preferred)	Yes	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Calaveras #10	Calaveras #11	#12 Heritage Middle School
Location[2]	29.19.21N, -98.211	29.311591°, -98.359697°	29.354663°, -98.334565°
Distance from SO_2 Source (meters)[2]	3,240	3,700	4,700
Wind Direction	S, SE (dominant);	S, SE (dominant);	S, SE (dominant);
Grade	<1%	<1%	<1%
Flood Plains	None	None	No
Mountain/Valley Winds	None	None	No
Water Body Nearby[2]	No	Yes; pond (N) 177 m	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	No (W)	Yes (N)
Obstructions and Height	Trees (10 m, 6 m, and 10 m)	Barn (5 m)	NA
Distance from Site to Obstructions	Trees (35 m to SE); tree (20 m to SE); tree (21 m to E)	Barn (48 m to N)	NA
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	Yes	Yes
Pros	• Downwind • Agreeable property owner	• Flat area • Agreeable property owner • Close proximity to modeled maxima	• Nearest to maximum frequency and maximum composite metric • Current air monitoring site available • Agreeable property owner • Proximity to maximum concentrations • Captures concentrations adjacent to a school • Minimal installation
Cons	• Surrounded by large obstructions	• A gate and driveway would have to be constructed • Not downwind	• None
Viable Site (yes, no, or preferred)	No	Yes	**Recommended**

[1]Based on guidance from March 1, 2011, memorandum from Tyler Fox, EPA Office of Air Quality Planning and Standards, "Additional Clarification Regarding the Application of Appendix W Modeling Guidance for the 1-hr NAAQS." Research Triangle Park, North Carolina 27711.
[2]Based on Google Earth

SO_2 – sulfur dioxide
m - meters
% – percent
< - less than
E – east
N – north
NE – northeast

NW – northwest
SE – southeast
SW – southwest
– number
° – degree
NA – Not applicable

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

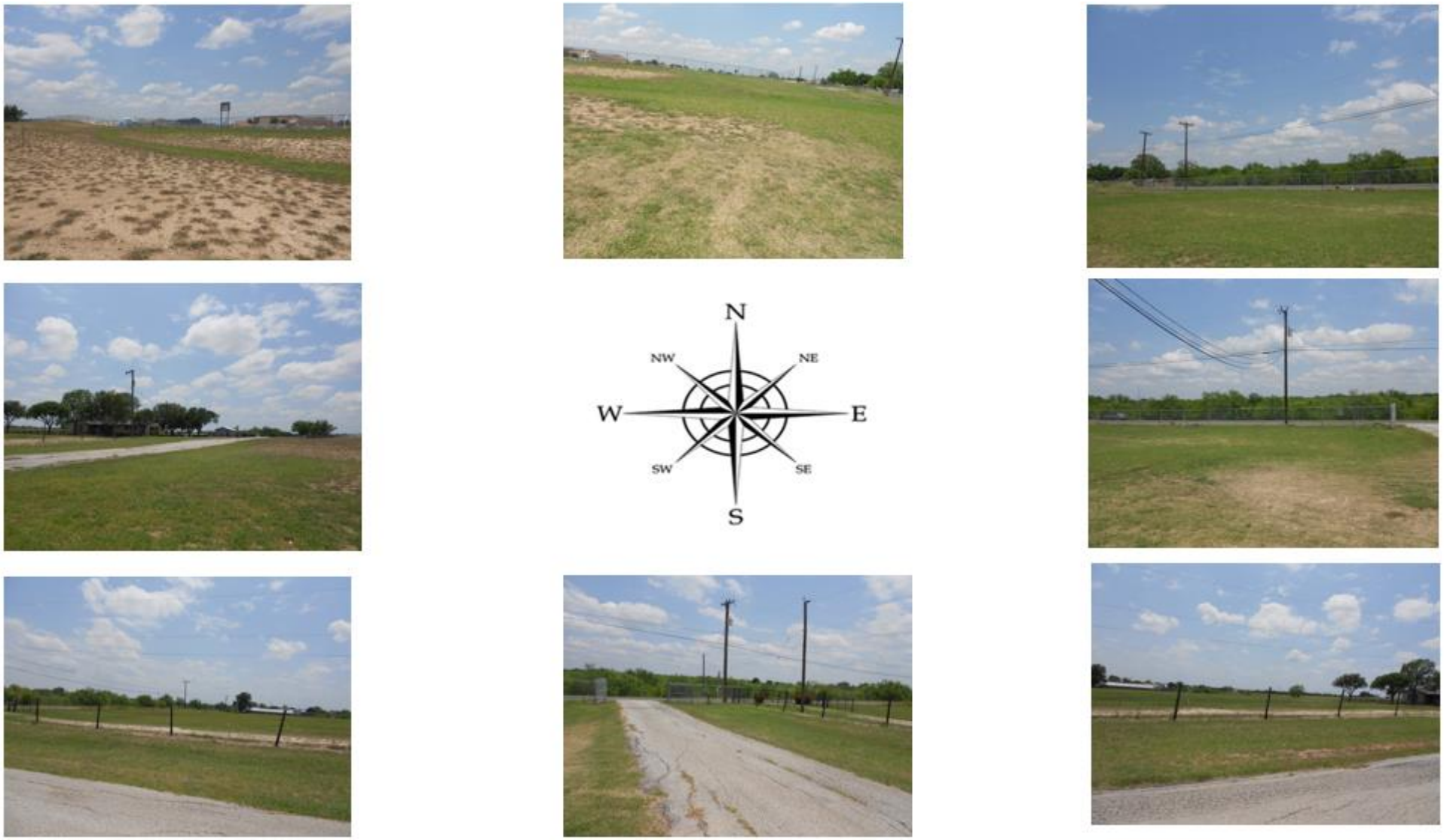

Figure 9: Calaveras #12 Potential Site Cardinal Direction Photos

Figure 10: Calaveras #12 Potential Site References

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Oxbow Calcining Monitor Placement Evaluation

Source Information

- Name: Oxbow Calcining LLC (Oxbow)
- Owner: Oxbow Carbon LLC
- Facility function: petroleum and coal products
- Location: 29.83560°, -93.96300°, Texas Commission on Environmental Quality (TCEQ) Region 10, Jefferson County, Texas
- Sulfur dioxide (SO_2) emissions data: 7,964 tons (2013), 11,319 tons (2014, preliminary data)
- Long-term emissions trend: decreasing, 25 percent (%) decrease from 2003 through 2013
- Emission profile: operational year-round
- Stack height(s): 4 stacks total; one is 38 meters and the other three are 56 meters each (shown in Figure 2)
- SO_2 emission controls: none
- Permit related data: Federal Operating Permit 1493

Existing Air Monitoring Sites

The nearest ambient air quality monitoring sites are detailed in Table 1. All existing SO_2 monitors have design values below the current SO_2 standard of 75 parts per billion (ppb). The existing sites are not located to characterize maximum SO_2 source concentrations and are not downwind.

Table 1: Air Monitoring Sites Located Near Oxbow

Site	Location	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2012-2014)
SETRPC Port Arthur	3.7 kilometers north	Yes (non-TCEQ private monitor)	not comparable
City Service Center Port Arthur	6.9 kilometers north	No	not applicable
Port Arthur West	7.3 kilometers northwest	Yes	51 parts per billion*
Port Arthur Memorial School	11.1 kilometers northeast	No	not applicable
Jefferson County Airport	12.6 kilometers northwest	No	not applicable

*design value data does not meet completeness requirements for 2012

Settings and Surroundings

The rural area surrounding Oxbow consists of flat gulf coastal plains with a sea level elevation as shown in Figure 1. The gulf coast plains are primarily coastal prairies marked by forested vegetation and river channels. (Griffith et al. 2004) River channels run east, west, and south of Oxbow. No significant changes to the landscape were noted during the reconnaissance as compared to the Google Earth view shown in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not characteristic of this area as detailed in Table 2.

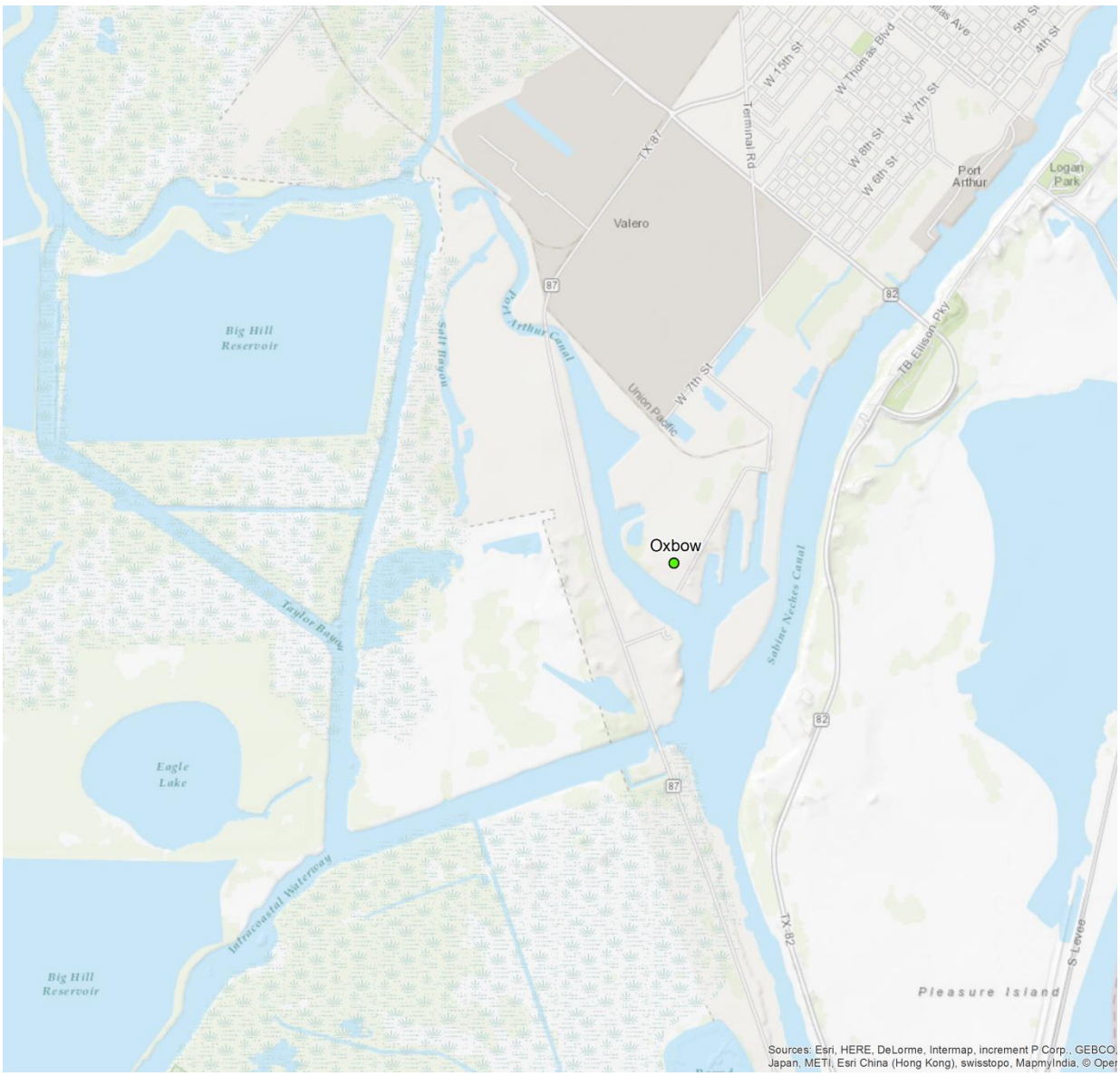

Figure 1: Oxbow Area Elevation Map

Figure 2: Oxbow Calcining Sulfur Dioxide Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Jefferson County Airport, located 13 kilometers north-northwest of Oxbow. Figure 4 illustrates the 2012-2014 annual average wind speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012 – 21014 wind data, the dominant wind flow direction for the area is south to southeast, with wind flows from the north, northeast, and northwest accounting for only 23% of the average annual wind flows. Over this three year period, calm winds (0-2 miles per hour) occurred on average 17% of the time and wind speeds averaged 7.9 miles per hour (Iowa Environmental Mesonet 2016).

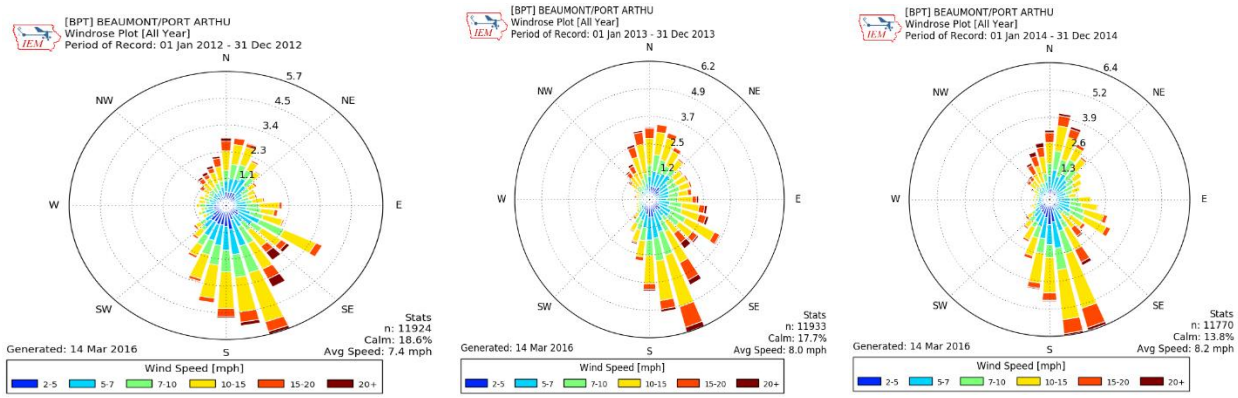

Figure 3: (From left to right) 2012, 2013, and 2014 individual Wind Rose Plots

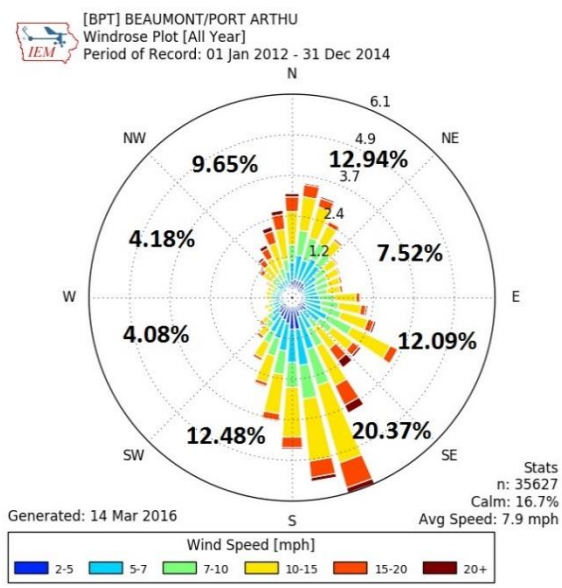

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique for identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72-km by 72-km;
- the four kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12-km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4-km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 graphically presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a black cross. Oxbow's permitted property is outlined in blue. Based on this analysis, the highest normalized concentrations, greater than 70% of the predicted off-property maximum, are expected within or immediately surrounding Oxbow's property. The area immediately surrounding the predicted off-property maximum is a water retention and overflow area not viable for monitor placement based on site reconnaissance and discussions with property owners. However, both of the proposed monitor locations identified within Figure 5 are within areas with predicted normalized concentrations within 70% to 80% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-

property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around the Oxbow facility. Again, the location of the predicted off-property maximum is indicated by a black cross and Oxbow's permitted property is outlined in blue. Using this analysis metric, areas within or directly to the north of the Oxbow facility scored greater than 70% and would be expected to see the highest frequency of elevated SO_2 concentrations. These areas are not viable for monitor placement based on site reconnaissance and discussions with property owners.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum indicated by a black cross and Oxbow's permitted property is outlined in blue. As with the normalized 99th percentile and normalized frequency metrics, areas within and directly north of the Oxbow facility scored greater than 70% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did not yield a viable location for monitor placement.

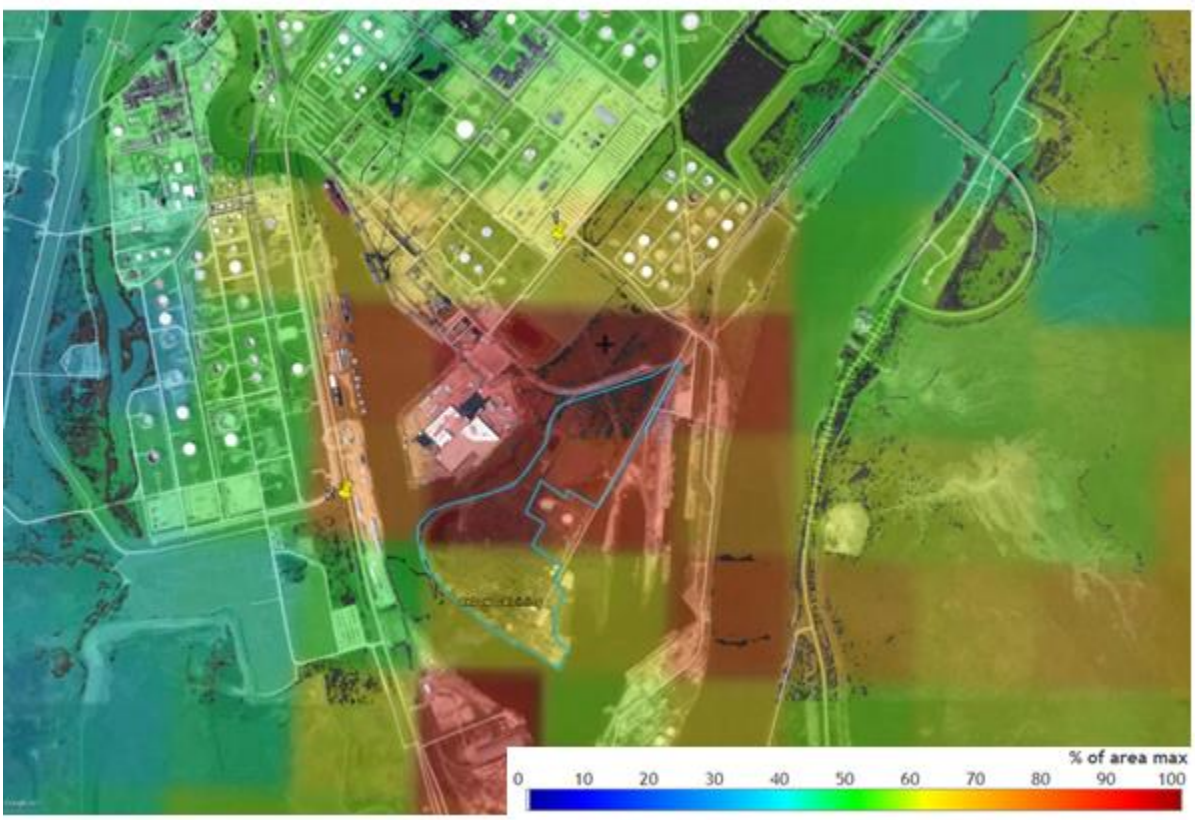

Figure 5: Oxbow Area CAMx Predicted Normalized 99th Percentile Concentrations and Viable Site Locations

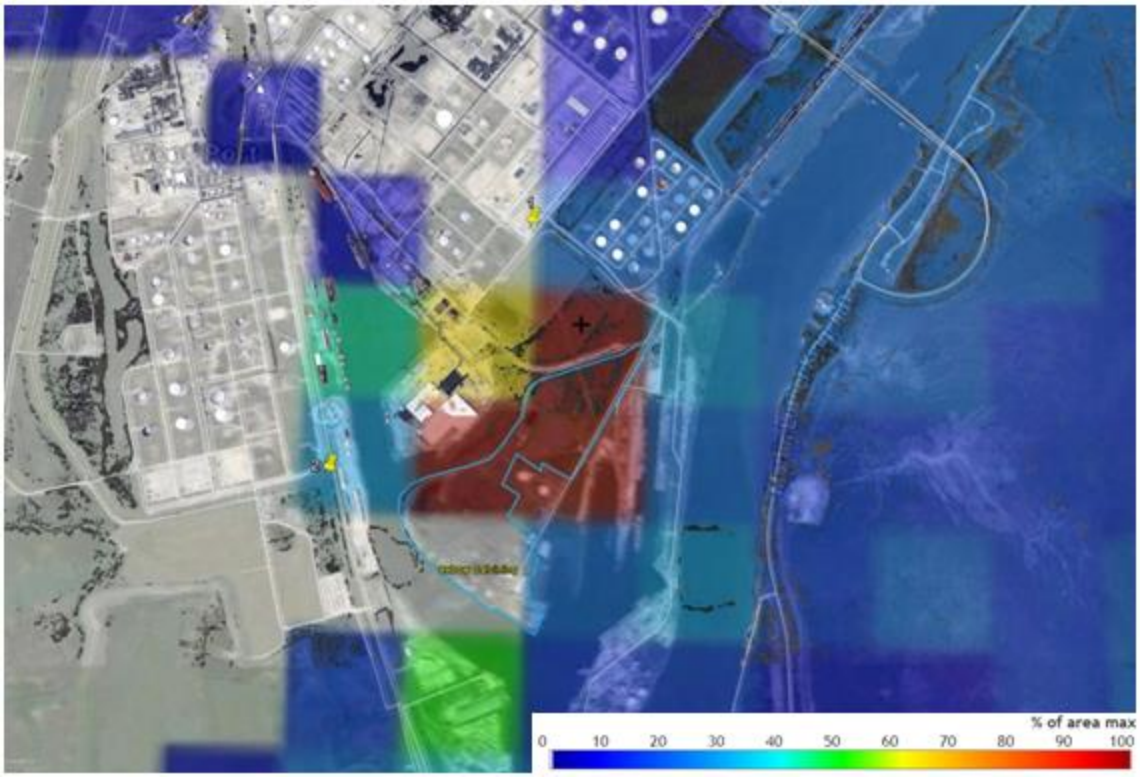

Figure 6: Oxbow Area CAMx Predicted Normalized Frequency (number of days) and Viable Site Locations

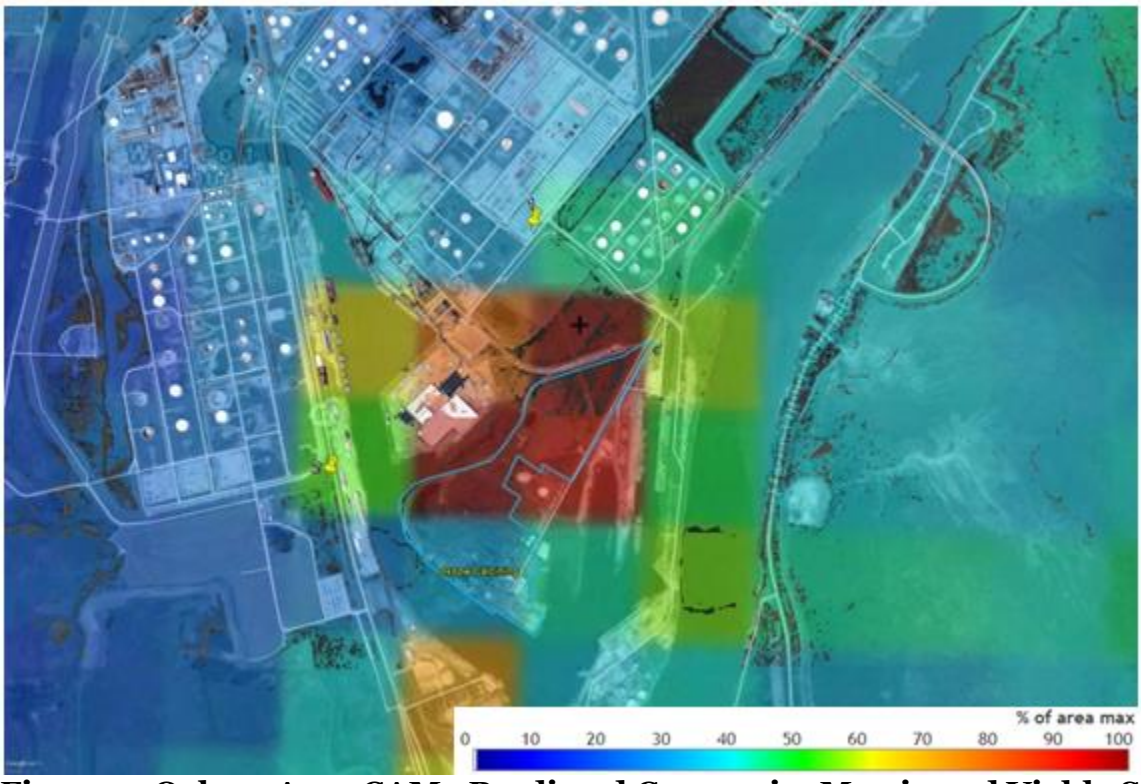

Figure 7: Oxbow Area CAMx Predicted Composite Metric and Viable Site Locations

Site Selection Criteria and Options

The TCEQ does not currently have SO_2 monitors located in the area surrounding Oxbow that would characterize the highest SO_2 concentrations from this facility; therefore a new site is required. The TCEQ focused on complying with the federal requirements listed in 40 CFR Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach includes utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analysis provided in Figures 5, 6, and 7 suggest that maximum SO_2 concentrations are expected to occur north-northeast of Oxbow and slightly south on days with northerly and/or calm winds. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected within or directly north of the Oxbow facility.

Ten potential sites were identified as shown in Figure 8. A logistical summary of all the potential sites is provided in Table 2. Eight of the identified potential sites (sites 3, 4, 5, 6, 7, 8, 9, and 10) are not considered viable. Sites 3 and 6 were excluded due to a lack of electrical availability and logistical issues. Sites 5 and 7 are on land that is currently for sale by the property owner. Sites 3, 4, 8, 9, and 10 are located well outside of the model maxima predicted area. Figure 8 also includes the identification of two parking lots labeled P 1 and P 2. Parking lot number 1 (P 1) is utilized for private facility parking beyond secured access gates. Parking lot number 2 (P 2) is utilized for heavy duty on-road vehicle parking and frequently contains idling vehicles. As a result, these sites are no longer under consideration.

The two sites with satisfactory logistical and siting characteristics and locations anticipated to have peak concentrations include sites 1 and 2. These site locations are also identified on the model and satellite image overlays shown in Figures 5, 6, and 7.

- Site 1 is positioned slightly north of Oxbow and southwest of a neighborhood that includes Abraham Lincoln Middle School and Booker T. Washington Elementary School approximately 3.5 to 4 kilometers from Oxbow. Electricity is available, and obstructions are a sufficient distance from the location to meet siting criteria. A site agreement has been negotiated with the property owner. This potential site is approximately 1.5 km north of Oxbow.
- Site 2 is located northwest of Oxbow in an industrial area, east of a large bayou and west of a marine vessel shipping channel. Electricity is available, and obstructions are a sufficient distance from the location to meet siting criteria. A site agreement has been negotiated with the property owner. This potential site is approximately 1.0 km west of Oxbow.

Recommendation

Based on current plant operations, available emission data, wind patterns, and CAMx model predictions, Site 1 is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. While the modeling analysis results for Sites 1 and 2 are very comparable, Site 1 would be directly downwind of the Oxbow facility and has the benefit of being well positioned between the source and a populated

neighborhood with two schools. Site 1 offers open areas, has available electricity, and meets all federal siting criteria. Site 1 is shown in Figures 5, 6, 7, 8, 9, and 10.

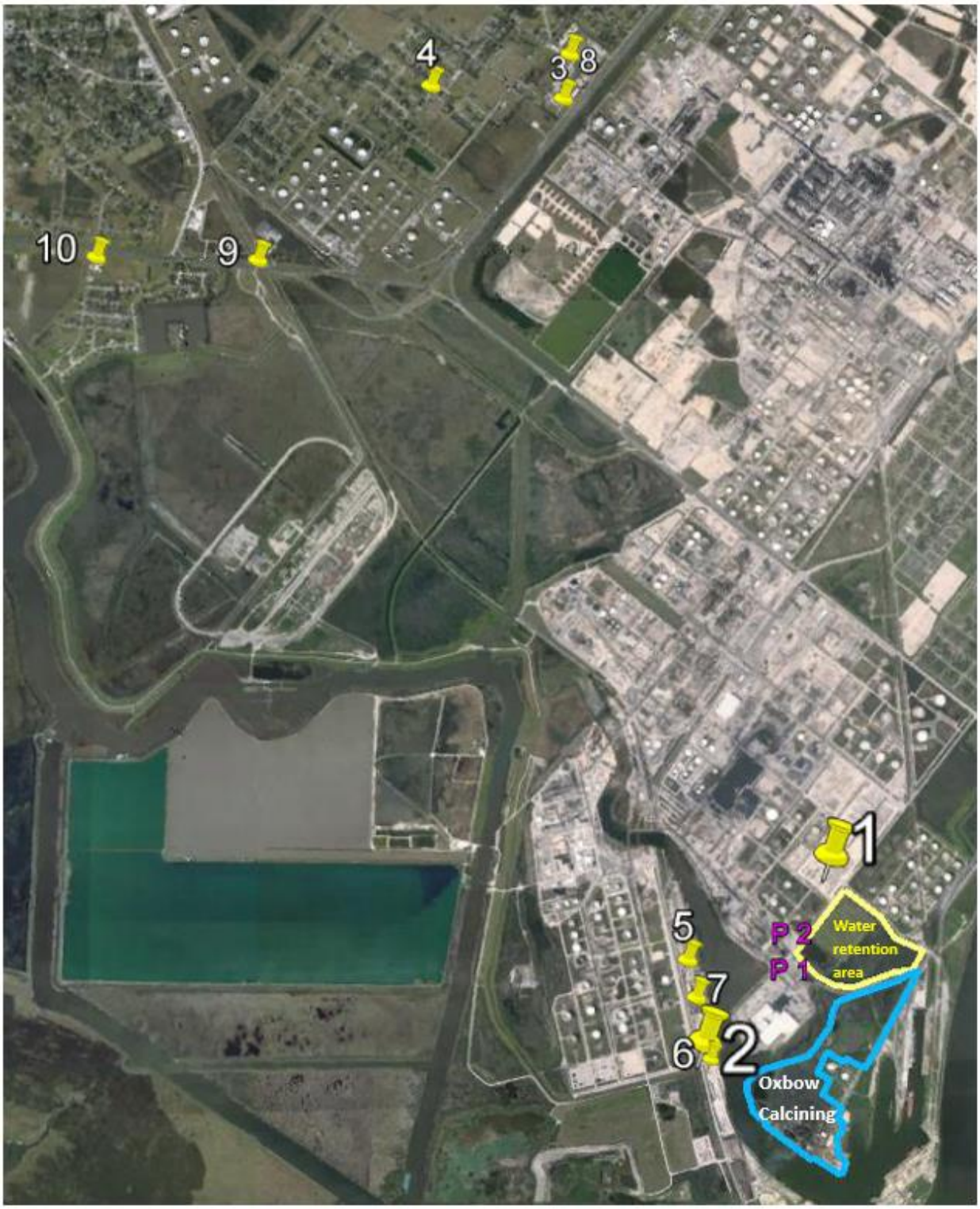

Figure 8: Potential Sulfur Dioxide Monitoring Sites for Oxbow Calcining

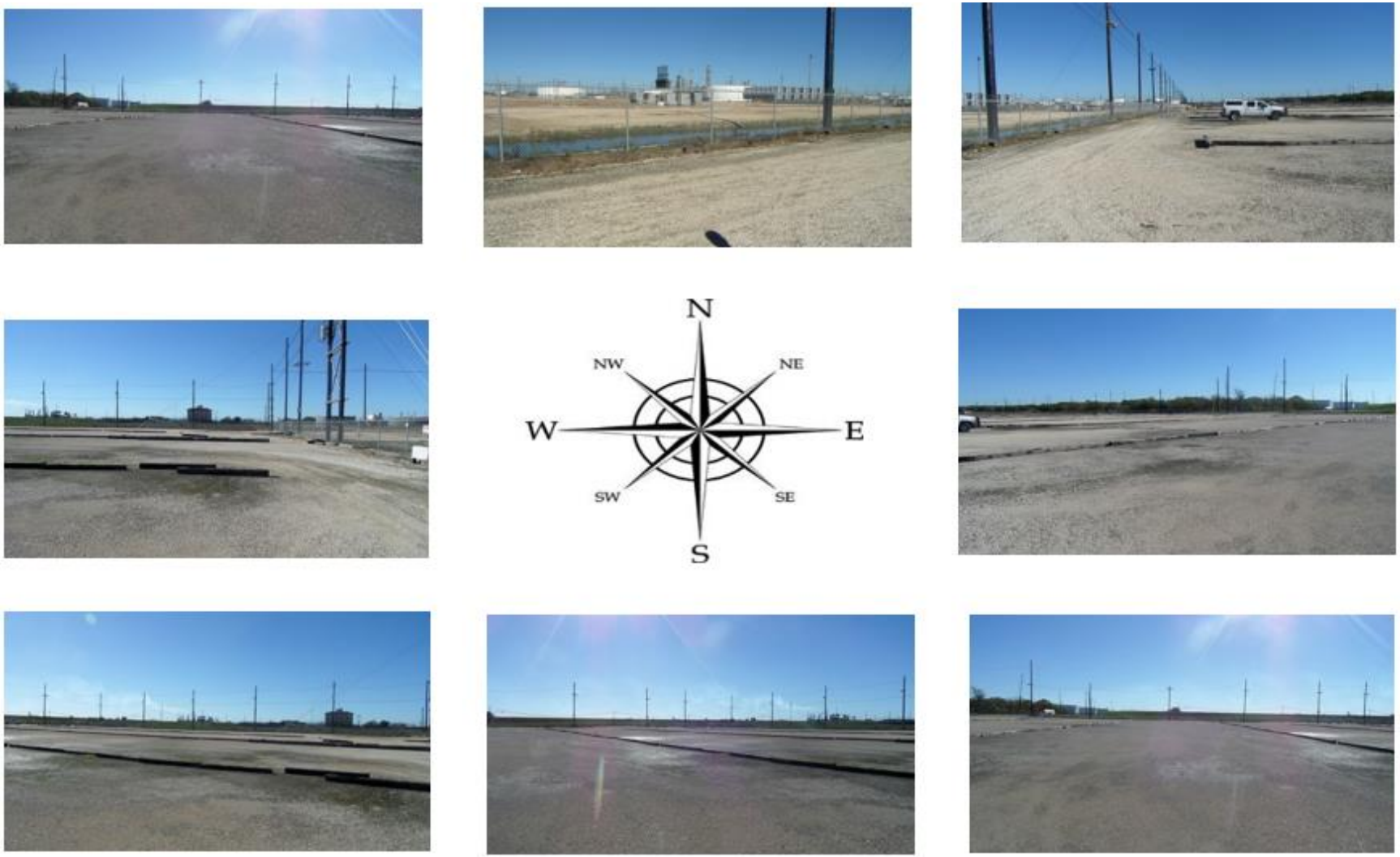

Figure 9: Oxbow #1 Potential Site Cardinal Direction Photos

Figure 10: Oxbow #1 Potential Site

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment

Site Number	Oxbow #1	Oxbow #2	Oxbow #3
Location[2]	29.84575° -93.96348°	29.83887°, -93.97028°	29.89393°, -93.97913°
Distance From SO_2 Source[2]	1,500 meters	800 meters	7,000 meters
Wind Direction	N, NW	N, NW	N, NW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; river (E)	Yes; river (E)	Yes; river (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (NW)	Yes (NW)
Obstructions and Height	None	None	Trees (10 meters)
Distance from Site to Obstructions	Not applicable	Not applicable	Trees (18 meters SE from dripline)[2]
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	Yes	No
Pros	• Downwind • Power available • Space available • Close proximity to source and modeled maxima • Located between the source and a neighborhood with schools • Predicted to receive the most frequent daily maximum concentrations	• Level ground • Power available • Space available • Close proximity to source and modeled maxima	• Level ground • Downwind • Space available • Intergovernmental agreement possible
Cons	• Located east of large truck parking	• Adjacent to area with marine vessel transport • Not downwind	• Far from source • No power available
Viable Site (yes, no, or recommended)	**Recommended**	Yes	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Oxbow #4	Oxbow #5	Oxbow #6
Location[2]	29.89436°, -93.98871°	29.84382°, -93.97142°	29.83891°, -93.97016°
Distance From SO_2 Source[2]	7,030 m	1,240 m	775 m
Wind Direction	N, NW	N, NW	N, NW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; river (E)	Yes; river (E)	Yes; river (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Building (10 m)	Building (8 m)	None
Distance from Site to Obstructions	Building (23 m NE)[2]	Building (60 m E)[2]	Not applicable
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	Yes	Yes	No
Pros	• Downwind • Space available • Level ground	• Downwind • Power available • Close proximity to source • Level ground	• Downwind • Close proximity to source • Level ground
Cons	• Outside modeled maxima	• Property is for sale	• Power may be difficult to acquire
Viable Site (yes, no, or recommended)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Oxbow #7	Oxbow #8	Oxbow #9
Location[2]	29.84188°, -93.97092°	29.89652°, -93.97865°	29.88459°, -93.99966°
Distance From SO_2 Source[2]	1,000 meters	7,050 meters	6,520 meters
Wind Direction	N, NW	N, NW	N, NW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; river (E)	Yes; river (E)	Yes; river (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Building (8 meters)	Not applicable	Not applicable
Distance from Site to Obstructions	Building (60 meters E)[2]	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 meters	No	Yes	Yes
Pros	• Close proximity to source • Downwind	• Downwind	• Downwind
Cons	• Property is for sale • No power available	• Outside modeled maxima	• Outside modeled maxima
Viable Site (yes, no, or recommended)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Oxbow #10
Location[2]	29.88479°, -94.01070°
Distance From SO_2 Source[2]	7,220 meters
Wind Direction	N, NW
Grade	<1%
Flood Plains	No
Mountain/Valley Winds	None
Water Body Nearby[2]	Yes; river (SW)
Downwind[2]	Yes (NW)
Obstructions and Height	Building (7 meters)
Distance from Site to Obstructions	Building (50 meters E)[2]
Road/Site Access	Yes
Electricity Available <18 meters	No
Pros	• Downwind
Cons	• Outside modeled maxima
Viable Site (yes, no, or recommended)	No

[1]Based on guidance from March 1, 2011, memorandum from Tyler Fox, EPA Office of Air Quality Planning and Standards, "Additional Clarification Regarding the Application of Appendix W Modeling Guidance for the 1-hr NAAQS." Research Triangle Park, North Carolina 27711.
[2]Based on Google Earth
SO_2 – sulfur dioxide
% – percent
< - less than
E – east
N – north
NE – northeast
NW – northwest
SE – southeast
SW – southwest
– number
° – degree

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

AEP Pirkey Power Plant Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: AEP Pirkey Power Plant (Pirkey) (Figure 2)
- Owner: Southwestern Electric Power Company
- Facility function: electric generation
- Location: 32.46106, -94.48502, Texas Commission on Environmental Quality (TCEQ) Region 5, Harrison County, Texas
- Sulfur dioxide (SO_2) emissions data: 7,339 tons (2013), 2,916 tons (2014)
- Long-term emissions trend: decreasing, 84 percent (%) decrease from 2004 to 2014
- Emission profile: operational year-round
- Stack height: 160 meters
- SO_2 emission controls: limestone wet-scrubbing, 97% reduction efficiency
- Permit related data: Federal Operating Permit

Existing Air Monitoring Sites

The nearest ambient air quality monitoring sites are detailed in Table 1. No TCEQ ambient air quality monitors are located within 23 kilometers (km) of Pirkey. The existing SO_2 monitor at Longview has a design values below the current SO_2 standard of 75 parts per billion (ppb). The SO_2 monitor at Tyler Airport Relocated is a seasonal non-regulatory monitor. The Tyler Airport Relocated 2015 maximum 1-hour SO_2 concentration was 12.9 ppb. The existing sites listed in Table 1 are not located to characterize maximum SO_2 source concentrations and are not downwind.

Table 1: Air Monitoring Sites Near Pirkey

Site	Location	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013-2015)
Longview	23 kilometers southwest	Yes	46 parts per billion (ppb)
Karnack	38 kilometers northeast	No	Not applicable
Tyler Airport Relocated*	88 kilometers west	Yes	Not applicable

*Tyler Airport Relocated operates a non-regulatory, seasonal SO_2 monitor.

Settings and Surroundings

The rural area surrounding Pirkey consists of interior coastal plains with elevations ranging from approximately 100 to 130 m (as shown in Figure 1). The terrain is considered part of the Piney Woods ecological area and includes some of the most densely forested regions of Texas (Griffith et al. 2004). No significant changes to the landscape were noted during the reconnaissance as compared to the Google Earth view shown in Figures 8 and 9. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area as detailed in Table 2.

Martin Lake Electrical Station (Martin Lake), located approximately 24 km southwest of Pirkey, has the potential to influence SO_2 concentrations in the Pirkey area under certain meteorological conditions. Martin Lake's SO_2 emissions were reported as 53,660 tons in 2014. Due to Pirkey's location, and the area's predominant southeasterly wind flow, it is anticipated that Martin Lake would only minimally impact SO_2 concentrations around the Pirkey area when winds are from the south-southwest (approximately 8% of the time according to the Marshall Airport wind rose data; Figures 3 and 4).

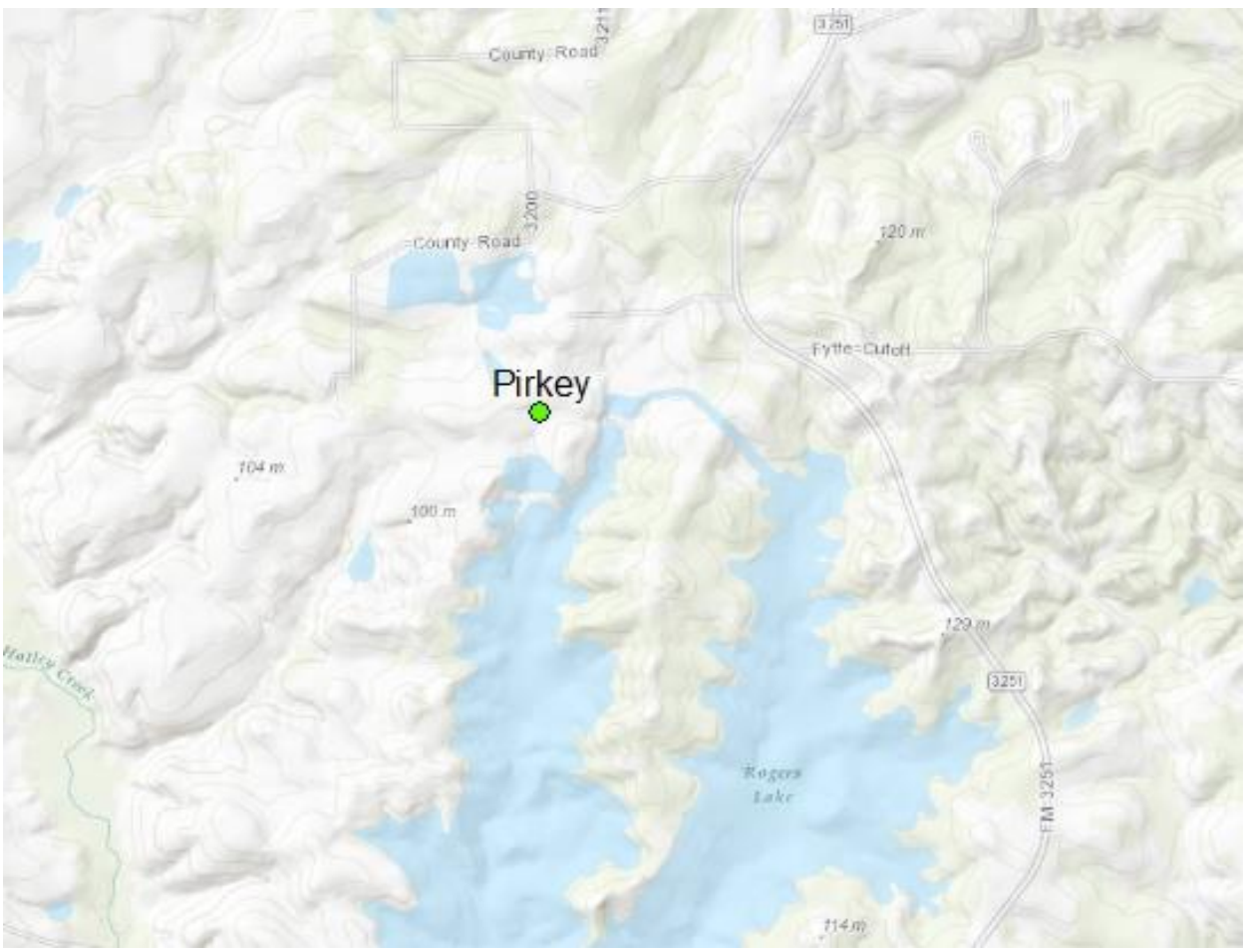

Figure 1: Pirkey Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 2: Pirkey Sulfur Dioxide Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Harrison County Airport in Marshall, Texas, located 18 km northeast of Pirkey. Figure 4 illustrates the 2012-2014 annual average speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012-2014 wind data, the dominant wind flow direction is 135 degrees southeast to 215 degrees south-southwest, approximately 29% of the average area wind flows. Over this three year period, calm winds (0-2 miles per hour) occurred on average 40% of the time and wind speeds averaged 4.3 miles per hour (Iowa Environmental Mesonet 2016).

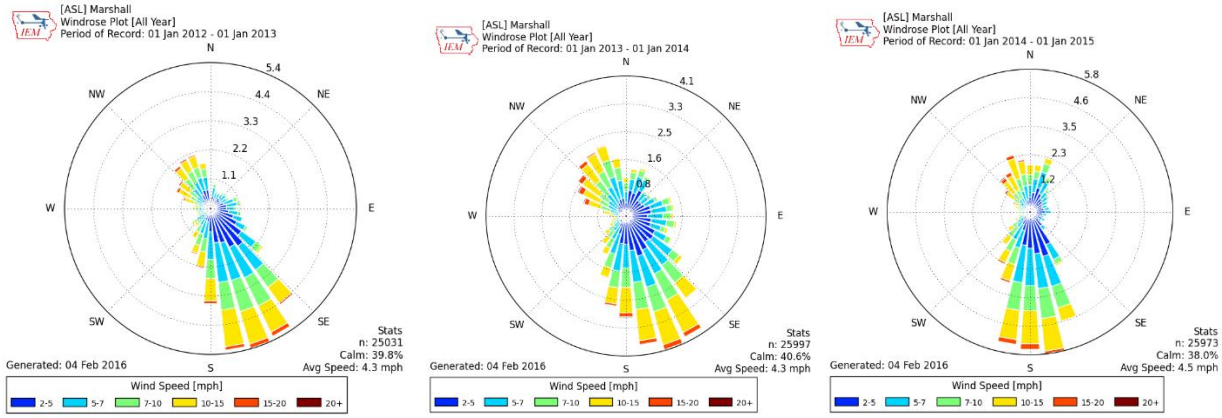

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

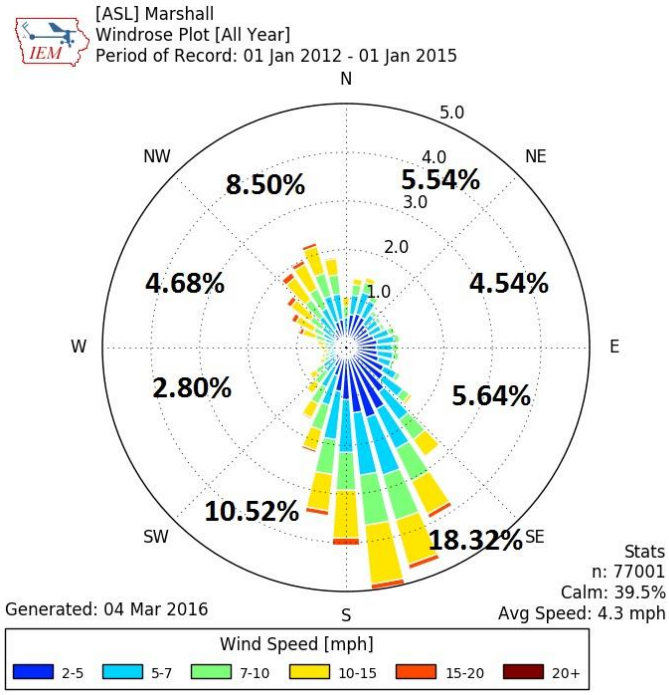

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup includes the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the kiln stack was modeled and tracked as an individual PiG puff;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 graphically presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a + symbol. Pirkey's permitted property is outlined in black. Based on this analysis, the highest normalized concentrations, greater than 85% of the predicted off-property maximum, are expected approximately 18 km to the far north and northwest of Pirkey. The proposed monitor location identified in Figure 5 (site 15) is in an area of 75-80% predicted normalized off-property maximum concentrations.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was

predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around the Pirkey facility. Again, the location of the predicted off-property maximum is indicated by a + symbol and Pirkey's permitted property is outlined in black. Using this analysis metric, areas directly to the north and northwest of Pirkey scored greater than 50% and would be expected to see the highest frequency of elevated SO_2 concentrations.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with λ symbol and Pirkey's permitted property is outlined in black. The area approximately 6 km to the north of Pirkey scored greater than 70% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score, did not yield a viable location for monitor placement.

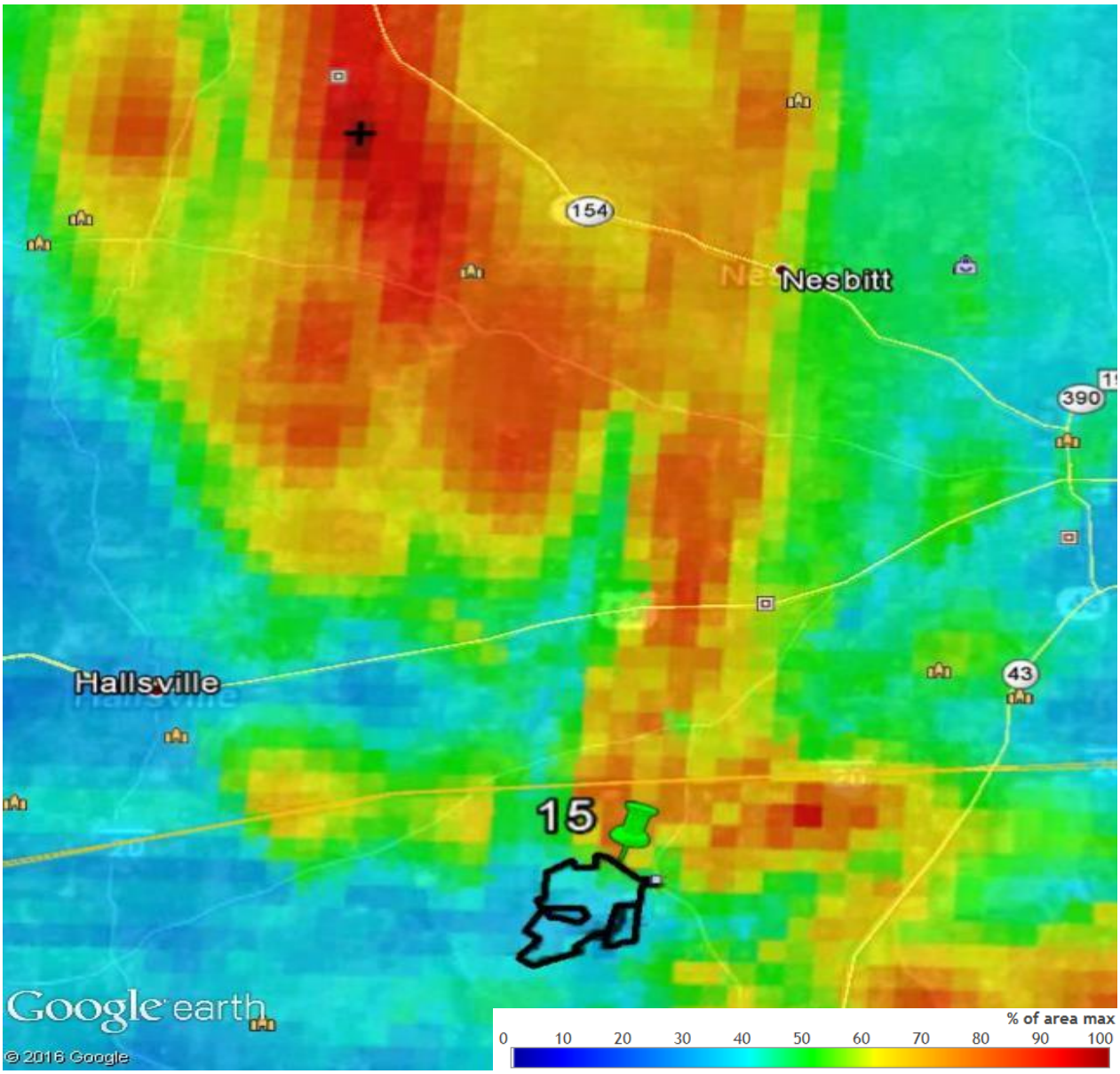

Figure 5: Pirkey Area CAMx Model Predictions Normalized Concentrations, and Viable Site Locations

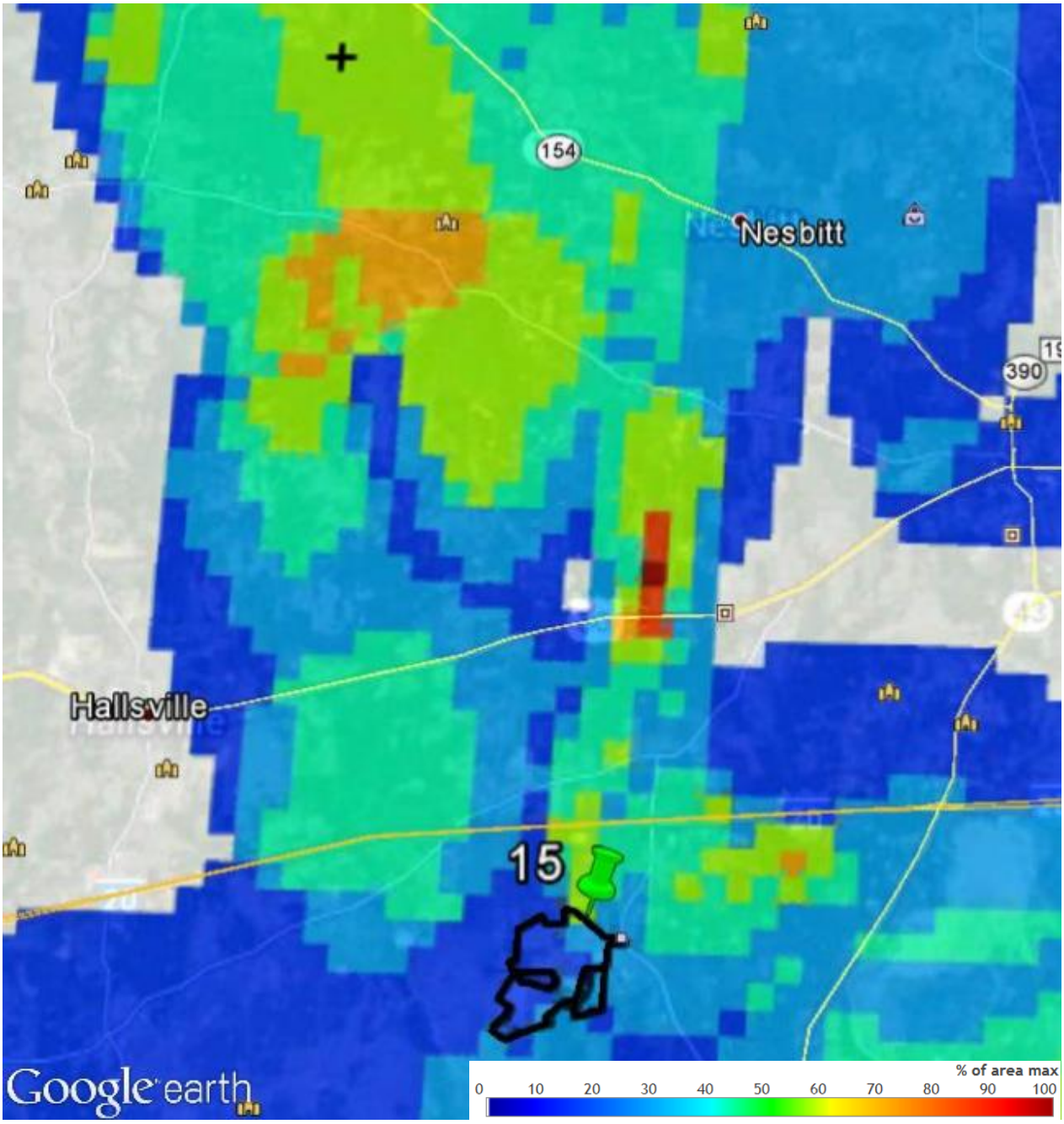

Figure 6: Pirkey Area CAMx Model Predictions, Normalized Frequency (number of days), and Viable Site Locations

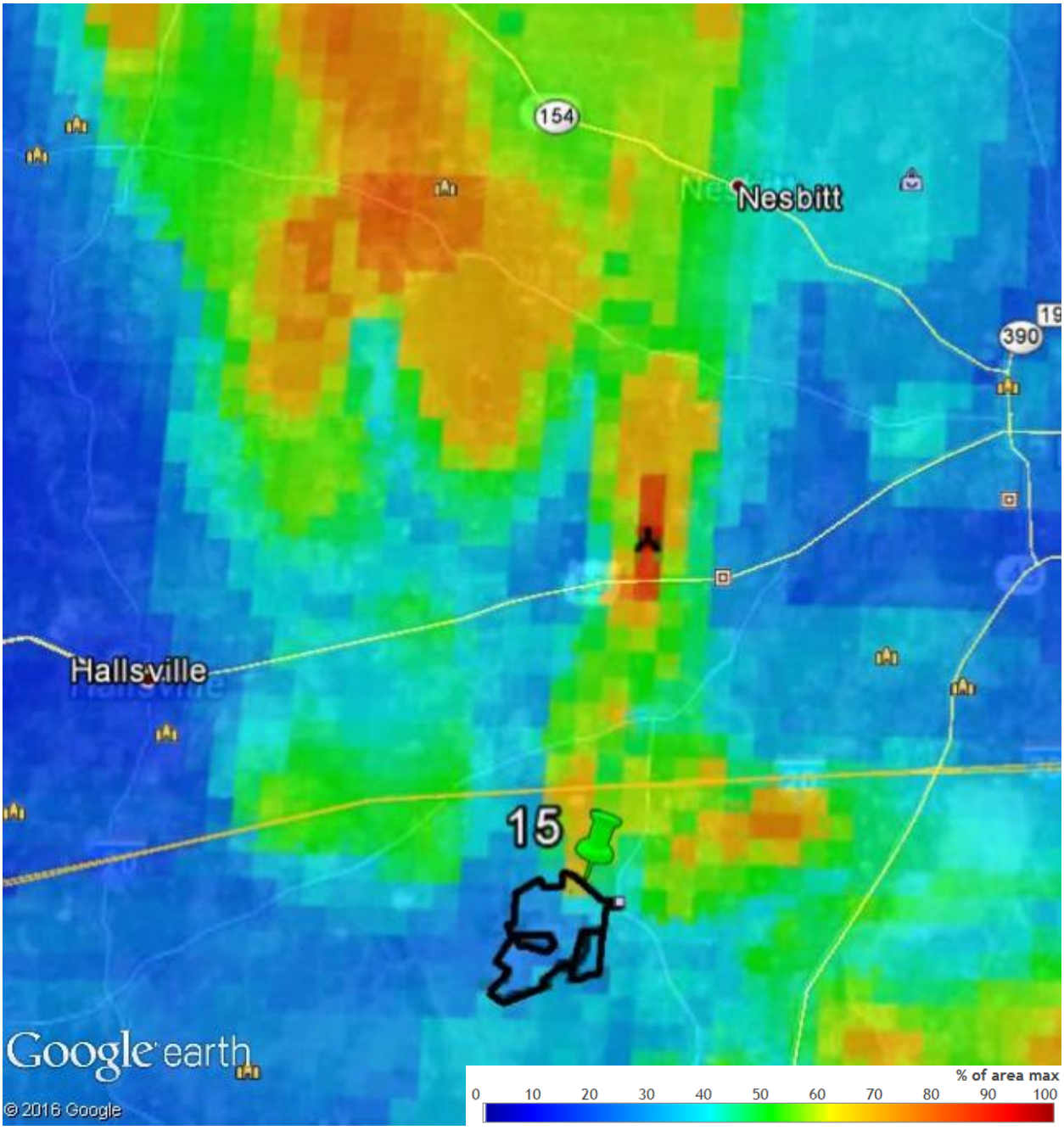

Figure 7: Pirkey Area CAMx Model Predictions Composite Metric and Viable Site Locations

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Pirkey that would characterize the highest SO_2 concentrations from this facility; therefore a new site is required. The TCEQ focused on complying with the federal requirements listed in Section 40 of the Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air qualities in areas around an SO_2 emissions source. This approach includes utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analysis provided in Figures 5, 6, and 7 suggest that maximum SO_2 concentrations are expected to occur north and northwest of Pirkey. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected north of Pirkey.

Twenty potential sites were identified as shown in Figures 8 and 9. A summary of all potential sites is shown in Table 2. Nineteen of the identified potential sites (sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, and 20) are not considered viable and are indicated by red pins in Figures 8 and 9. Property owners at sites 1, 2, 3, 4, 5, 7, 8, 11, 12, 13, 14, 16, 17, 18, 19, and 20 either declined or were unresponsive. Site 6, located 2 km from the source, was in an area where obstructions are not a sufficient distance from the location to meet siting criteria. Site 9, located 3.7 km from the source, contained uneven terrain and is prone to flooding. Site 10, located 4 km from the source was in an area with low predicted SO_2 concentrations according to modeling analysis. As a result, these sites are no longer under consideration.

Site 15 is positioned approximately 1.0 km directly north of Pirkey. This site provides level ground, adequate space, and available power. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 75-80% of maximum concentrations, therefore the site would be expected to measure peak SO_2 concentrations near the source. A site agreement has been negotiated with the property owner.

Recommendation

Based on current facility operations, available emission data, wind patterns, logistics, and modeling analysis, site 15 (Figures 8, 9, 10, and 11) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station and is indicated by a green pin in Figures 5, 6, 7, 8, 9, and 11. While the modeling analysis predicts the highest maximum normalized concentrations and the highest composite metric scores to the north and northwest of the source, access to the property in these areas is unattainable. Site 15 is located in an area with predicted maximum normalized SO_2 concentrations of 75–80%, meets all federal siting criteria, and has available power, space, and level ground.

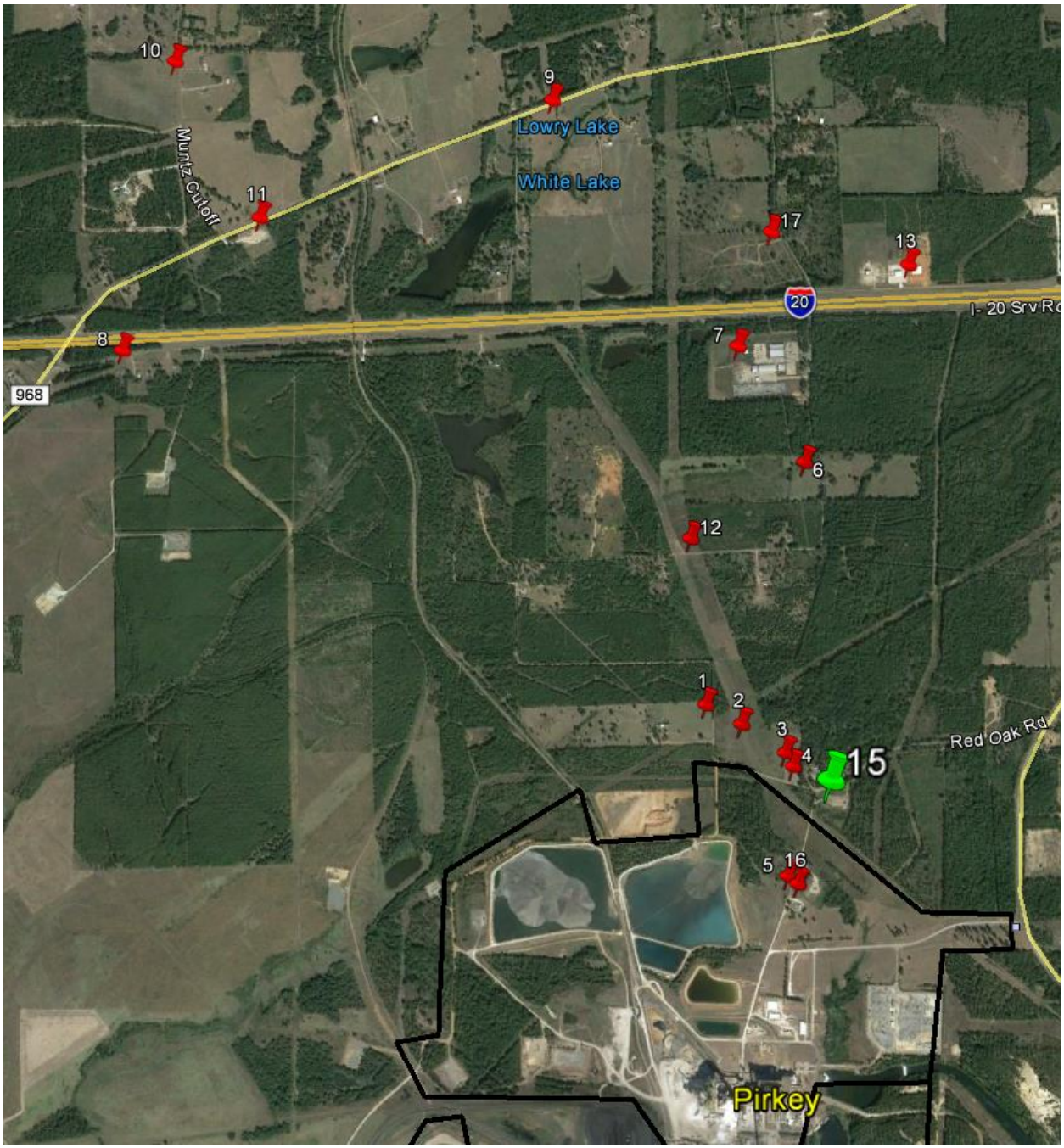

Figure 8: Potential Air Monitoring Sites within 4 km of Pirkey

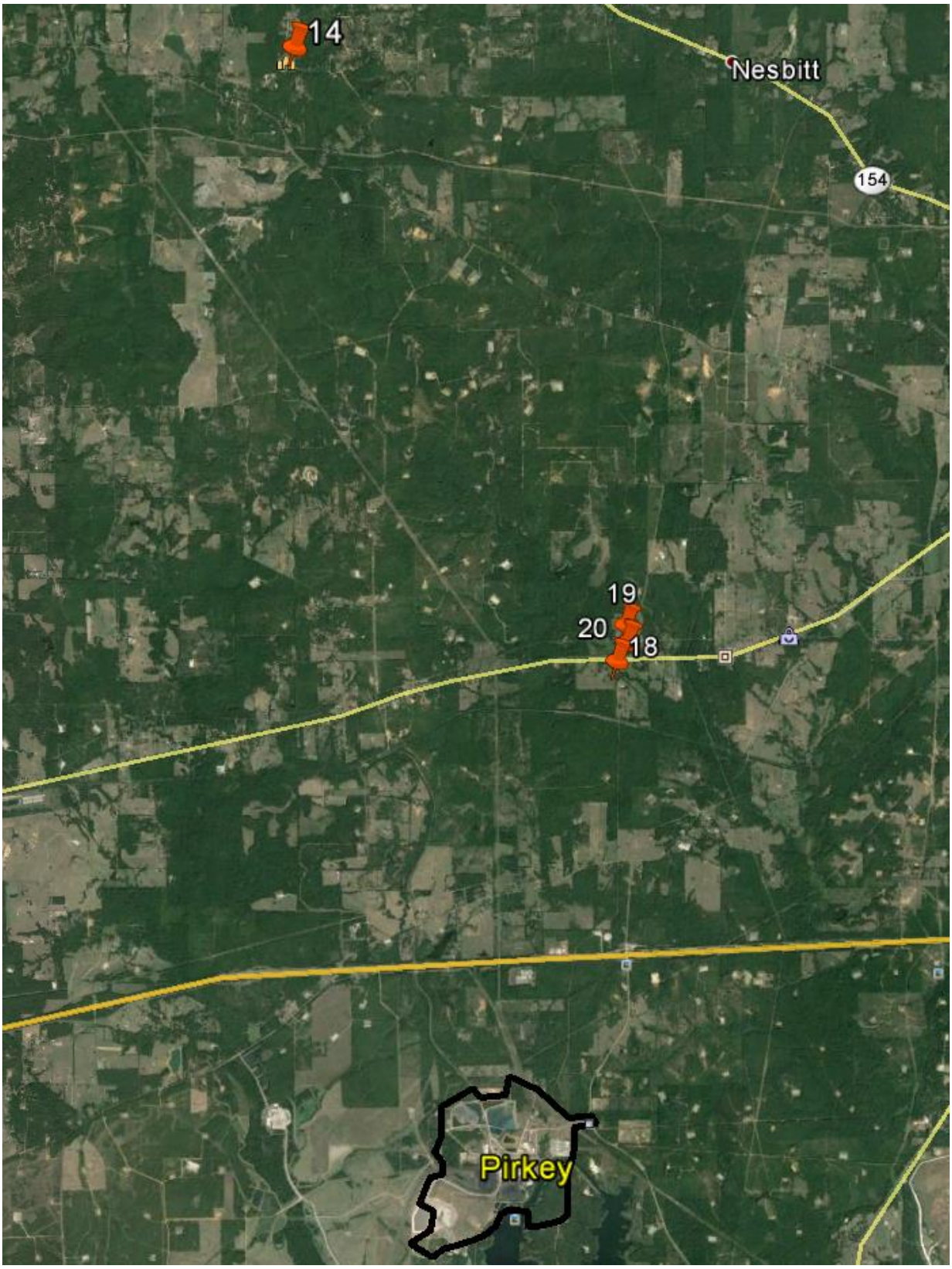

Figure 9: Potential Air Monitoring Sites More Than 4 km from Pirkey

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Air Monitoring Site Assessment[1]

Site Number	Pirkey #1	Pirkey #2	Pirkey #3
Location[2]	32.47321, -94.48573	32.47239, -94.48566	32.47129, -94.48298
Distance from SO_2 Source[2]	1298 m	1265 m	1142 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	Yes	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (N)	Yes (N)
Obstructions and Height	Trees (15 m)	None	None
Distance from Site to Obstructions	Trees (20 m N from dripline)	None	None
Road/Site Access	No	Yes	Yes
Electricity Available <18 m	No	No	Yes
Property Owner	Jerry Michael and Annette McMullen	James Earl Byers	James Earl Byers
Pros	• Level ground • Space available • Downwind	• Level ground • Space available • Downwind	• Level ground • Space available • Power available • Downwind
Cons	• Difficult access • Extra power pole needed • No response from the property owner	• Challenging electrical connection • Property owner declined • Existing flood plain	• Property owner declined
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Pirkey #4	Pirkey #5	Pirkey #6
Location[2]	32.471914, -94.48293	32.47057, -94.48181	32.48070, -94.48164
Distance from SO_2 Source[2]	1100 m	750 m	2183 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	>2%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (N)	Yes (N)
Obstructions and Height	Church (18 m)	None	Trees (20 m and 25 m)
Distance from Site to Obstructions	Church (15 m N)	None	Trees (30 m N from dripline) Trees (30 m W from dripline)
Road/Site Access	Yes	No	No
Electricity Available <18 m	Yes	No	No
Pros	• Level ground • Close to the source • Power available • Downwind	• Close to the source • Downwind • Level ground	• Downwind • Space available
Cons	• Unresponsive property owner	• Property owner declined • No power	• No power • Difficult access • Slight grade in surrounding areas • Numerous obstructions
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Pirkey #7	Pirkey #8	Pirkey #9
Location[2]	32.48517, -94.48203	32.48433, -94.50815	32.49364, -94.48735
Distance from SO_2 Source[2]	2557 m	3383 m	3700 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	>1%
Flood Plains	No	No	Yes
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (NW)	Yes (NW)
Obstructions and Height	Trees (25 m) Building (20 m)	Trees (25 m)	Trees (15 m)
Distance from Site to Obstructions	Trees (20 m N from dripline) Building (35 m S)	Trees (30 m N from dripline Trees (30 m S from dripline)	Trees (20 m E from dripline) Trees (20 m W from dripline)
Road/Site Access	Yes	Yes	No
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Space available • Level ground • Close to source • Downwind	• Level ground • Space available • Power available • Downwind	• Space available • Power available • Downwind
Cons	• Property owner declined	• Unresponsive property owner • Low SO_2 concentrations according to modeling analysis	• Slight grade in surrounding areas • Existing flood plains • Difficult to access
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Pirkey #10	Pirkey #11	Pirkey #12
Location[2]	32.49396, -94.50600	32.48805, -94.50419	32.47840, -94.48701
Distance from SO_2 Source[2]	4200 m	3537 m	1934 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (N)
Obstructions and Height	Trees (20 m)	Trees (20-30 m)	None
Distance from Site to Obstructions	Trees (40 m N from dripline)	Trees (30 m E from dripline) Trees (30 m S from dripline)	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Level ground • Space available • Power available • Downwind	• Level ground • Downwind	• Level ground • Space available • Power available • Downwind
Cons	• Low concentration of SO_2 according to modeling analysis	• No power • Property owner declined	• Close proximity to power lines and other utility markers
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Pirkey #13	Pirkey #14	Pirkey #15
Location[2]	32.48689, -94.47846	32.61527, -94.54527	32.47045, -94.48152
Distance from SO_2 Source[2]	2850 m	15150 m	1000 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NE)	Yes (NW)	Yes (N)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	None	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Level ground • Space available • Power available • Easy access to site • Downwind	• Maximum off-property concentration of SO_2 emissions according to CAMx modeling Downwind • Level ground	• Level ground • Agreeable property owner • Easy access to site • High concentration and frequency according to modeling analysis • Power available • Downwind
Cons	• Property owner declined	• Unresponsive property owner • No power	• None
Viable Site (yes, no, or preferred)	No	No	Preferred

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Pirkey #16	Pirkey #17	Pirkey #18
Location[2]	32.46728, -94.48268	32.48793, -94.48365	32.51969, -94.47123
Distance from SO_2 Source[2]	650 m	2940 m	6770 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (N)	Yes (NE)
Obstructions and Height	Trees (20 m)	None	None
Distance from Site to Obstructions	Trees (55 m N from dripline)	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	No
Pros	• Level ground • Space available • Power available • Easy access to site • Downwind	• High SO_2 concentrations and frequency according to modeling analysis • Downwind • Level ground	• High SO_2 concentrations and frequency according to modeling analysis • Level ground • Downwind
Cons	• Property owner declined	• Unresponsive property owner • No power	• Unresponsive property owner • No power
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Pirkey #19	Pirkey #20
Location[2]	32.52403, -94.47001	32.52193, -94.46981
Distance from SO_2 Source[2]	7220 m	7050 m
Wind Direction	S, SE	S, SE
Grade	>1%	>1%
Flood Plains	No	No
Mountain/Valley Winds	None	None
Water Body Nearby[2]	No	No
Wind Channeling	None	None
Downwind[2]	Yes (NE)	Yes (NE)
Obstructions and Height	None	None
Distance from Site to Obstructions	None	None
Road/Site Access	Yes	Yes
Electricity Available <18 m	No	No
Pros	• High SO_2 concentrations and frequency according to modeling analysis • Level ground • Downwind	• High SO_2 concentrations and frequency according to modeling analysis • Level ground • Downwind
Cons	• Unresponsive property owner • No power	• Unresponsive property owner • No power
Viable Site (yes, no, or preferred)	No	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
% – percent
N – north
E – east
W – west
S - south
NE – northeast
NW – northwest
SE – southeast
SW – southwest
m – meter
– number
< – less than
> - greater than
SO_2 – sulfur dioxide

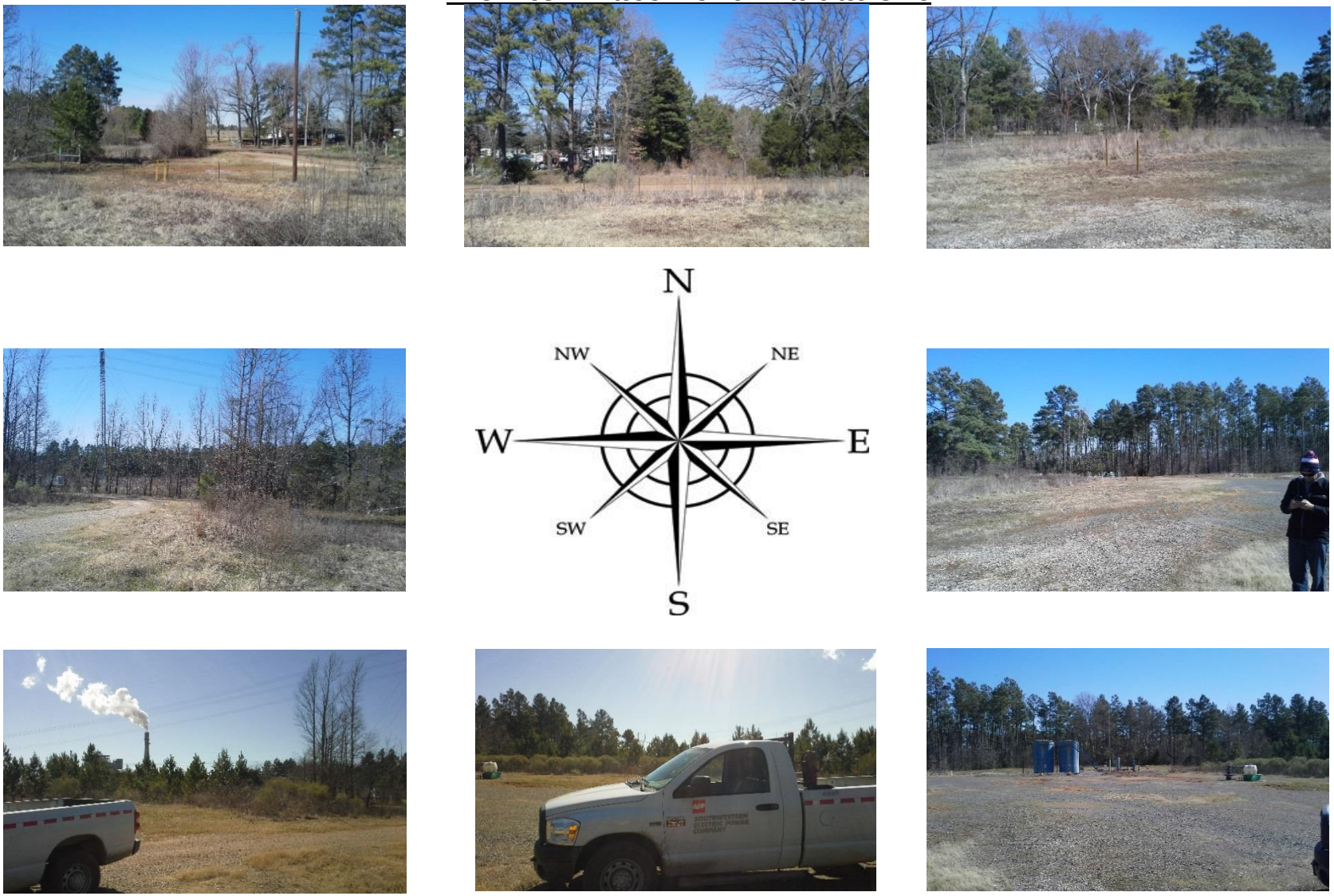

Figure 10: Pirkey #15 Preferred Site Cardinal Direction Photos

Figure 11: Pirkey #15 Preferred Air Monitoring Site

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Streetman Plant Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Streetman Plant (Streetman) (Figure 2)
- Owner: TRNLWS Limited Liability Company (LLC)
- Facility function: lightweight aggregate manufacturing
- Location: 31.91385, -96.34903, Texas Commission on Environmental Quality (TCEQ) Region 4, Navarro County, Texas
- Sulfur dioxide (SO_2) emissions: 3,391 tons (2013), 3,350 tons (2014)
- Long-term emissions trend: Decreasing, 4.6 percent (%) decrease from 2004 through 2014
- Emission profile: operational year-round
- Stack height: 35 meters (m)
- SO_2 emission controls in place: none
- Permit related data: Prevention of Significant Deterioration permit

Existing Air Monitoring Sites

The TCEQ operates four ambient air monitoring sites within a 75 kilometer (km) radius of Streetman. Table 1 details the four closest monitoring sites to Streetman in order of proximity. Maximum SO_2 ground level concentrations can be expected within close proximity to the source. Although all of these locations are currently monitoring SO_2, none of the existing sites are positioned downwind or within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air Monitoring Sites Near Streetman

Site	Distance From Streetman	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013-2015)
Corsicana Airport	14 kilometers north	Yes	39 parts per billion (ppb)
Italy	57 kilometers northwest	Yes	8 ppb
Kaufman	72 kilometers north	Yes	13 ppb
Waco Mazanec	74 kilometers southwest	Yes	7 ppb

Settings and Surroundings

The rural and suburban area surrounding Streetman consists of the Balcones Canyonlands region, with elevations ranging from approximately 111 m to 132 m as shown in Figure 1. Streetman property is bordered by the Richland Chambers Reservoir to the northwest, north, and northeast. The terrain on the northern reservoir shoreline provides limited access and power sources. No significant changes to the landscape were noted during the reconnaissance as compared to the Google Earth view shown in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area.

Big Brown Electric Station (Big Brown), located approximately 30 km southeast of Streetman, has the potential to influence SO_2 concentrations in the Streetman area under certain meteorological conditions. Big Brown's SO_2 emissions were reported as 57,460 tons in 2014. Due to Streetman's location and area wind flows, it is anticipated that Big Brown could impact SO_2 concentrations around the Streetman area when winds are from 100 degrees to 120 degrees southeast (approximately 6% of the time according to the Corsicana Municipal Airport wind rose data).

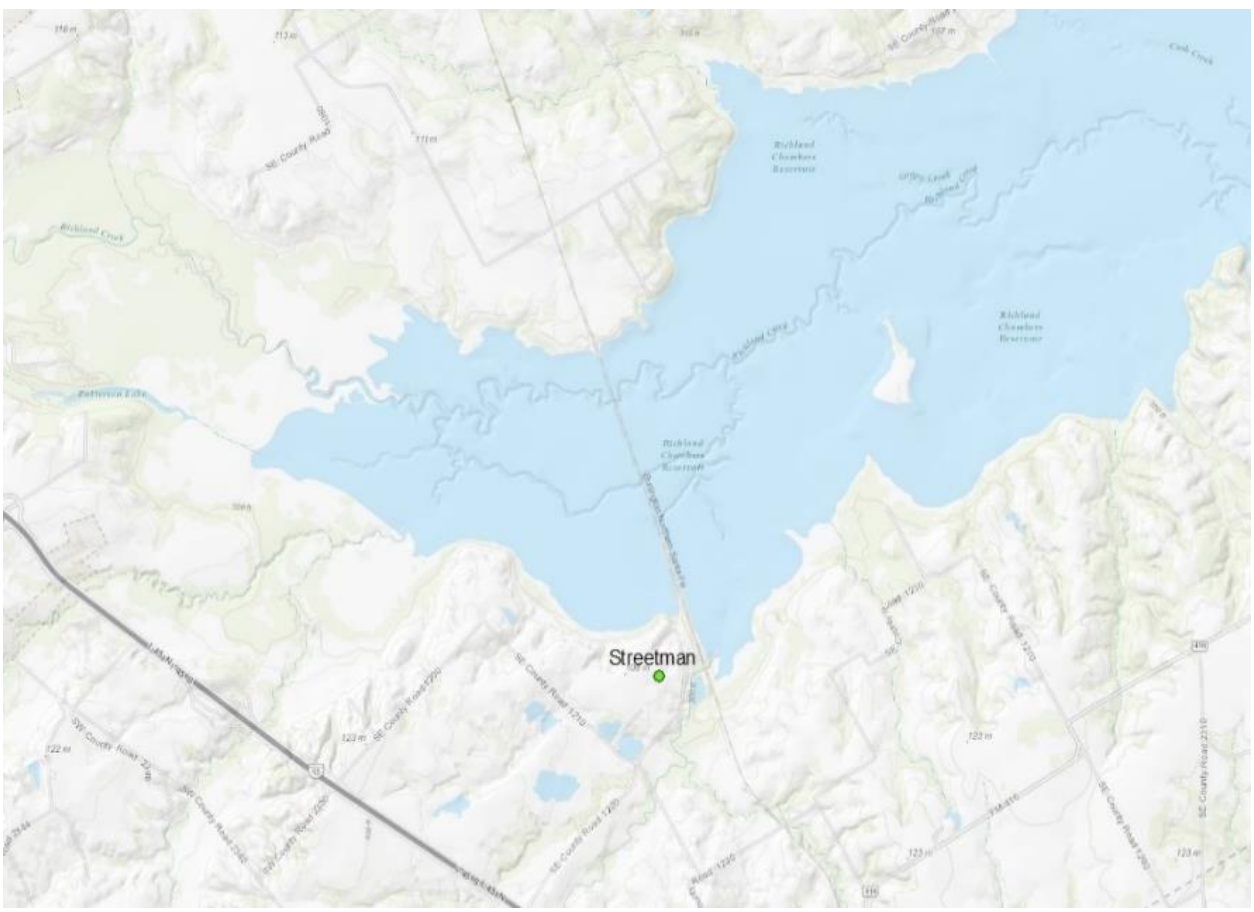

Figure 1: Streetman Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 2: Streetman Plant Sulfur Dioxide (SO_2) Stack and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Corsicana Municipal Airport, located 14 km north of Streetman. Figure 4 illustrates the 2012-2014 annual average speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on the analysis of the 2012-2014 wind data, the dominant wind flow direction is 145 degrees southeast to 205 degrees south-southwest. Approximately 38% of average area wind flows are from the dominant wind flow direction. Over this three year period, calm winds (0-2 miles per hour) occurred 8% of the time, and wind speeds averaged 8.9 miles per hour (Iowa Environmental Mesonet 2016).

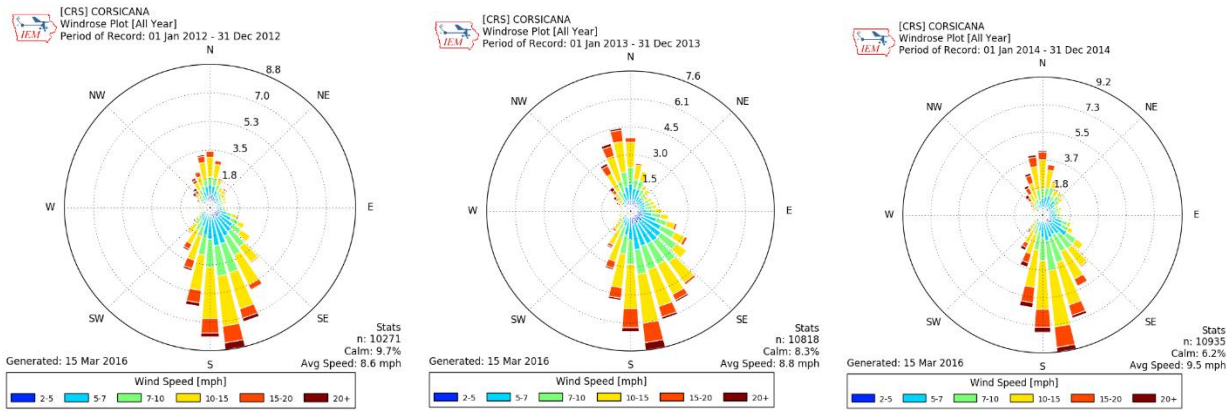

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

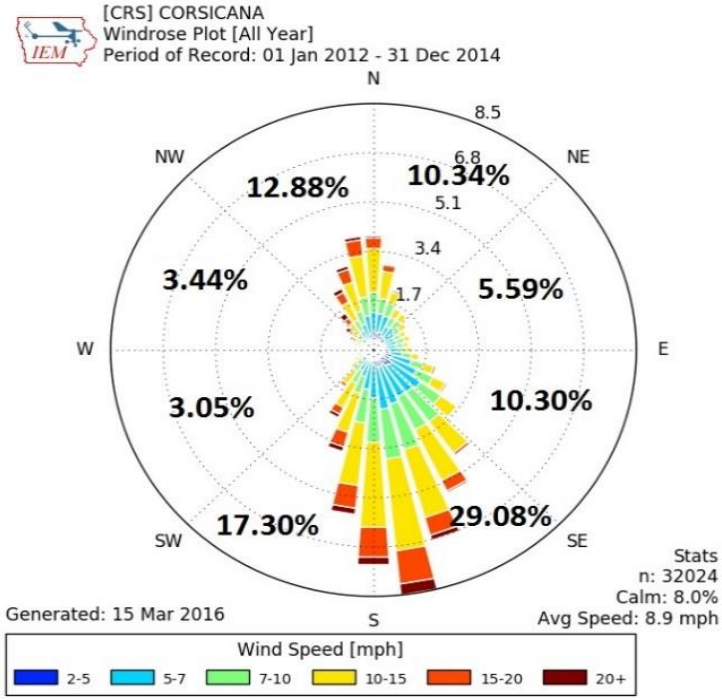

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the one kiln stack was modeled and tracked as an individual PiG puff;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a + symbol. Streetman permitted property is outlined in black. Based on this analysis, the highest normalized concentrations greater than 85% of the predicted off-property maximum are expected to occur in the area within Streetman permitted property and the area 0.3 km north-northeast over the Richland Chambers Reservoir. The proposed monitor location identified in Figure 5 (site 12) is outside the predicted normalized off-property maximum concentrations and 2.25 km southwest of the predicted off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-

property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around Streetman. The location of the predicted off-property maximum is indicated by a + symbol, and Streetman permitted property is outlined in black. Using this analysis metric, areas within Streetman and areas directly to the north, northeast, and east of Streetman scored greater than 60% and would be expected to see the highest frequency of elevated SO_2 concentrations. The area within Streetman property along with areas directly to the north, northeast, and east of Streetman are not viable for monitor placement. The areas immediately to the north and northeast are not viable due to the Richland Chambers Reservoir. The area directly east of the plant is considered not viable, because the property owner declined access to the property.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a λ symbol and Streetman permitted property is outlined in black. As with the normalized 99th percentile and normalized frequency metrics, areas within Streetman property along with areas directly north and northeast of Streetman scored greater than 80% using the composite metric. Similar to areas with a high frequency metric, areas with a high composite metric were not viable due to the Richland Chambers Reservoir.

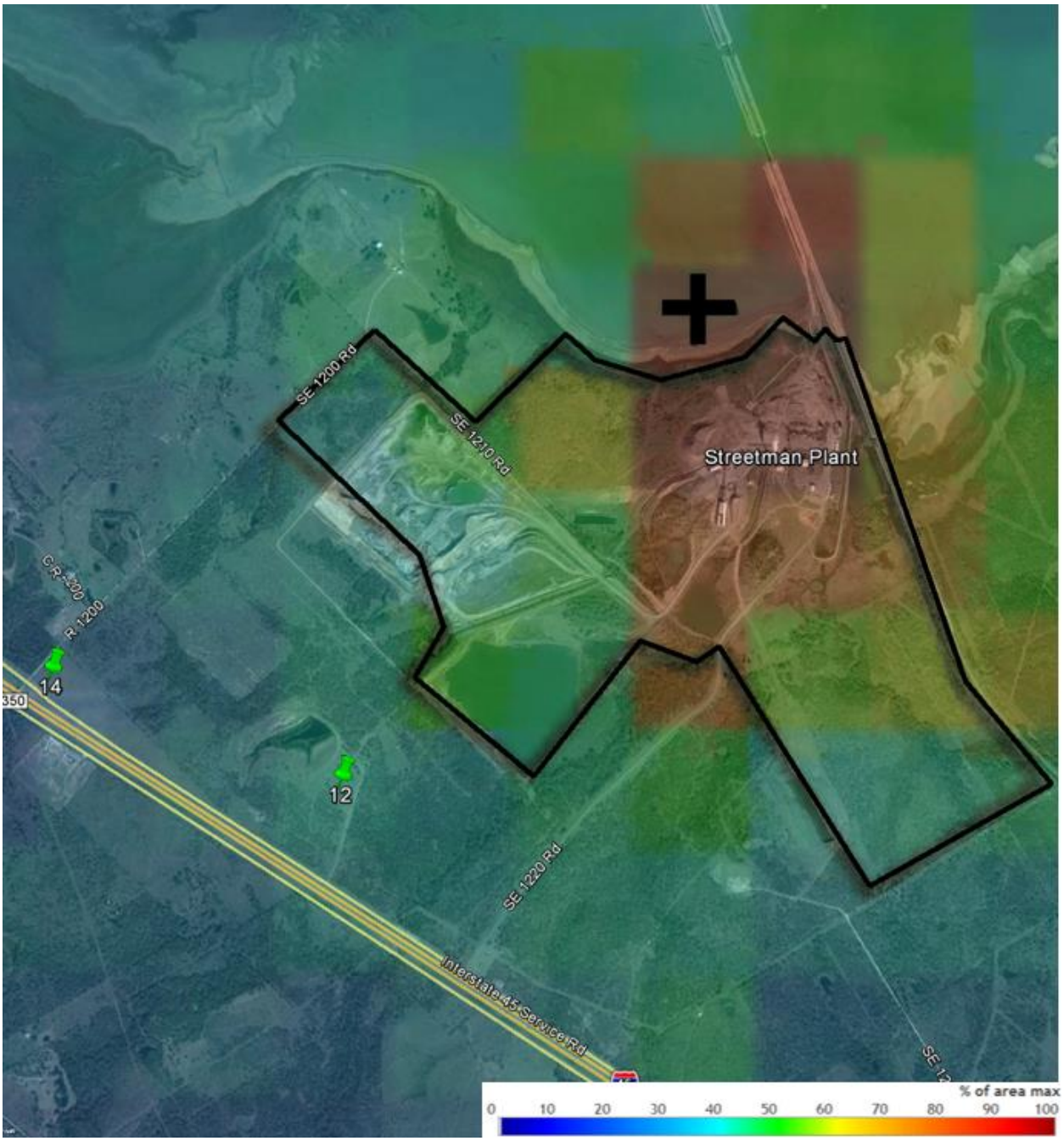

Figure 5: Streetman Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Location

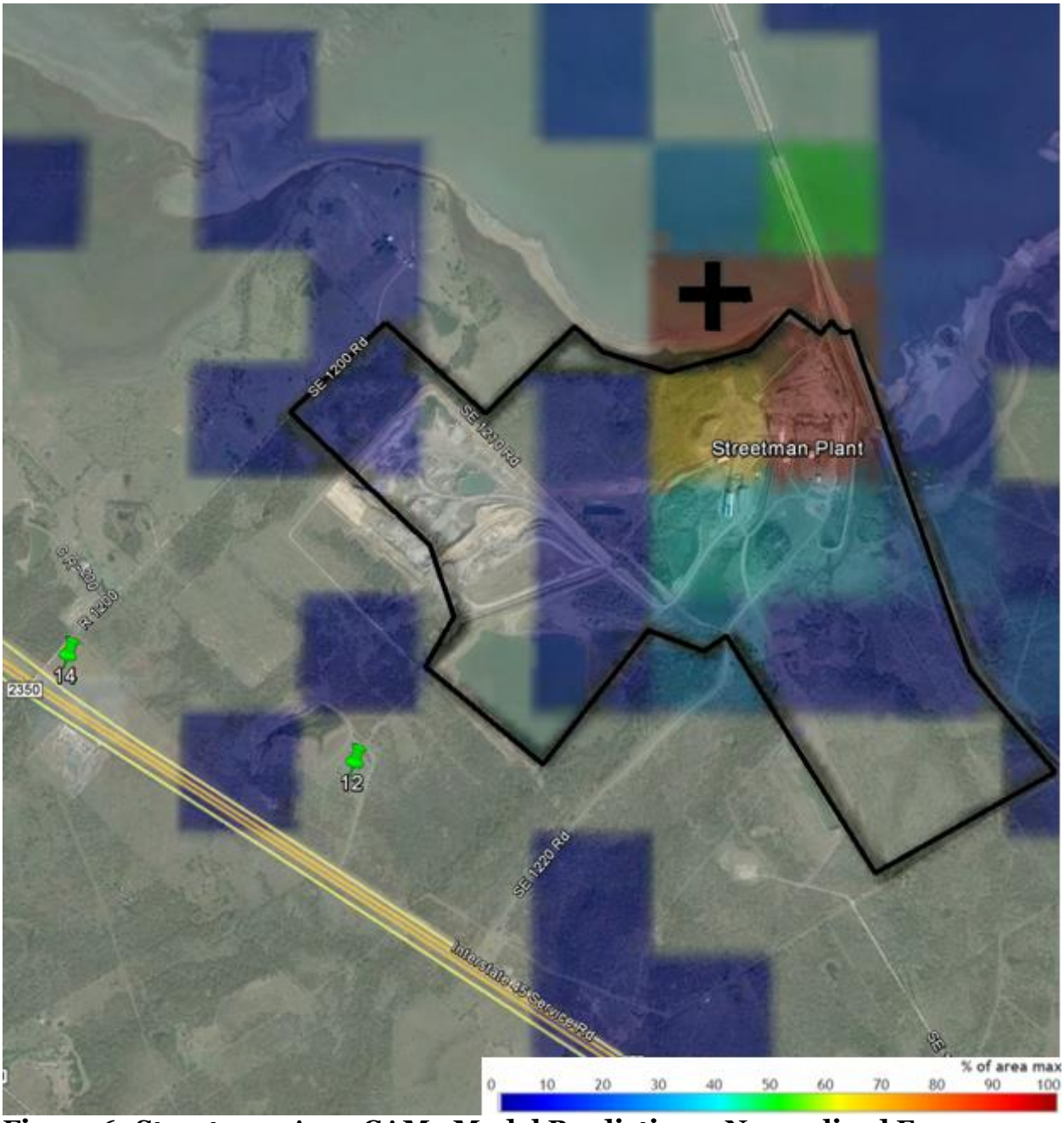

Figure 6: Streetman Area CAMx Model Predictions, Normalized Frequency (Number of Days), and Viable Site Location

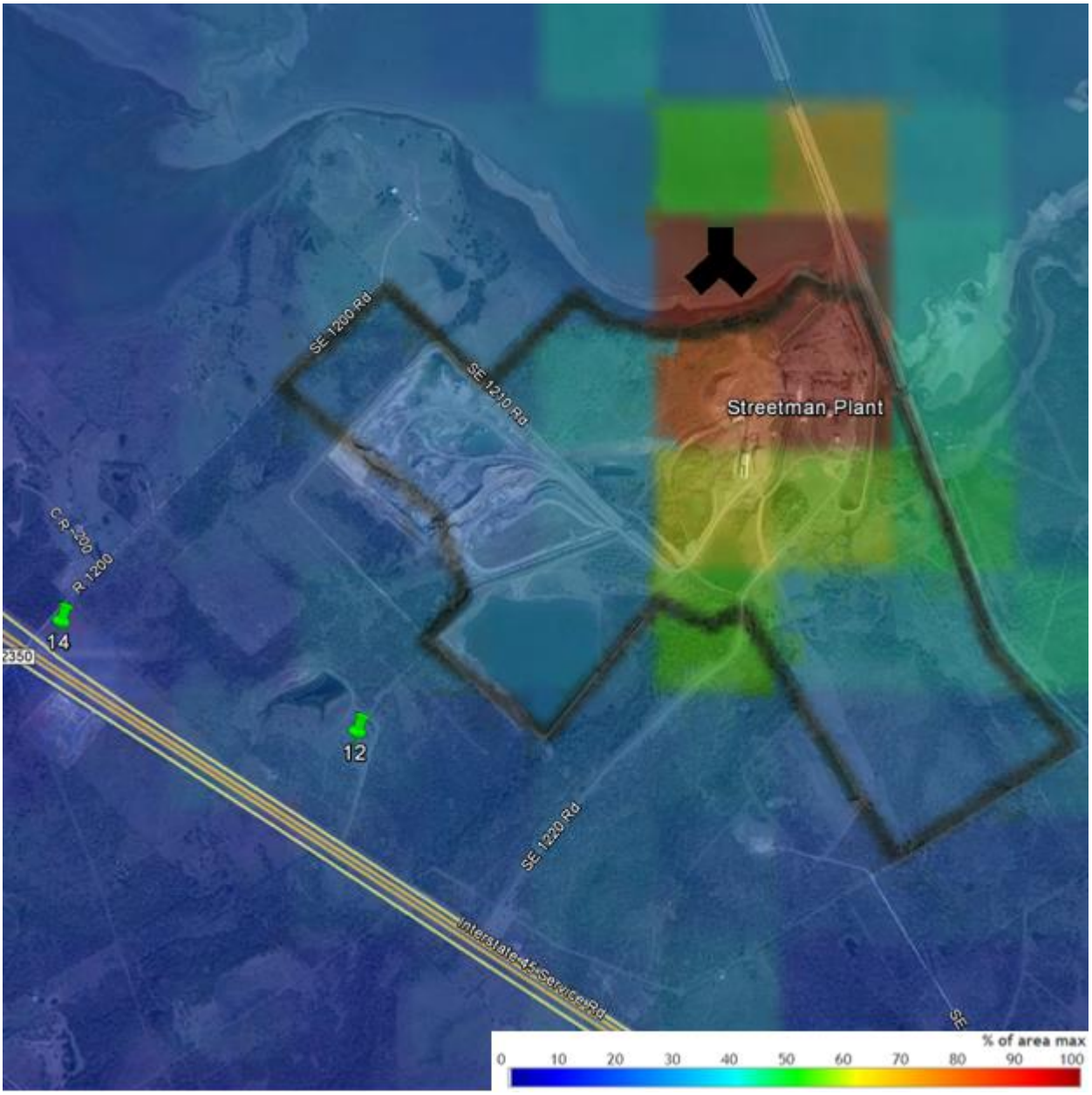

Figure 7: Streetman Area CAMx Model Predictions Composite Metric and Viable Site Location

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Streetman that would be expected to characterize the highest SO_2 concentrations from this facility; therefore a new site is proposed. The TCEQ focused on complying with the federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach included utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 5, 6, and 7 suggests that maximum SO_2 concentrations are expected to occur within the Streetman permitted area and north, northeast, and east of Streetman. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected directly north of Streetman over the Richland Chambers Reservoir. Access to the area directly to the east of the facility was declined by the property owner. The area directly south of the facility was also declined by the property owner and could have interferences from heavy diesel truck traffic.

Fifteen potential sites were identified as shown in Figure 8. A summary of all potential sites is shown in Table 2. Thirteen of the identified potential sites (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, and 15) are not considered viable and are indicated by red pins in Figure 8. Property owners at sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, and 15 either declined or were unresponsive after multiple communication attempts. Non-viable site property lines are outlined with green boundaries.

Site 12 is located approximately 2.25 km southwest of Streetman. This site is downwind of Streetman when winds flow from the north and northwest (approximately 16% of the time). This site provides level ground, adequate space, and available power. A site agreement has been negotiated with the property owner. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 35%-45% of the maximum concentrations. Site 12 is indicated with a green pin in Figures 5, 6, 7, 8, and 10.

Site 14 is located approximately 3.17 km southwest of Streetman. This site is downwind of Streetman when winds flow from the north and northwest (approximately 16% of the time). This site provides level ground, adequate space, and viable power. The property owner is amenable to a site agreement. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 35%-45% of the maximum concentrations. Site 14 is indicated with a green pin in Figures 5, 6, 7, and 8.

Recommendation

Based on property owner cooperation, proximity to the source, current facility operations, available emissions data, wind patterns, and modeling analyses, site 12 (Figures 9 and 10) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. Site 12 is preferred over site 14 due to its closer proximity to the source. While the modeling analyses predict the highest maximum normalized concentration and composite metric score to be located 0.5 km to the north,

this area is located over a water body. Analyzing annual wind flows, site 12 is downwind of Streetman 16% of the time. Site 12 meets all federal siting criteria, has available power, space, level ground, and a signed site agreement.

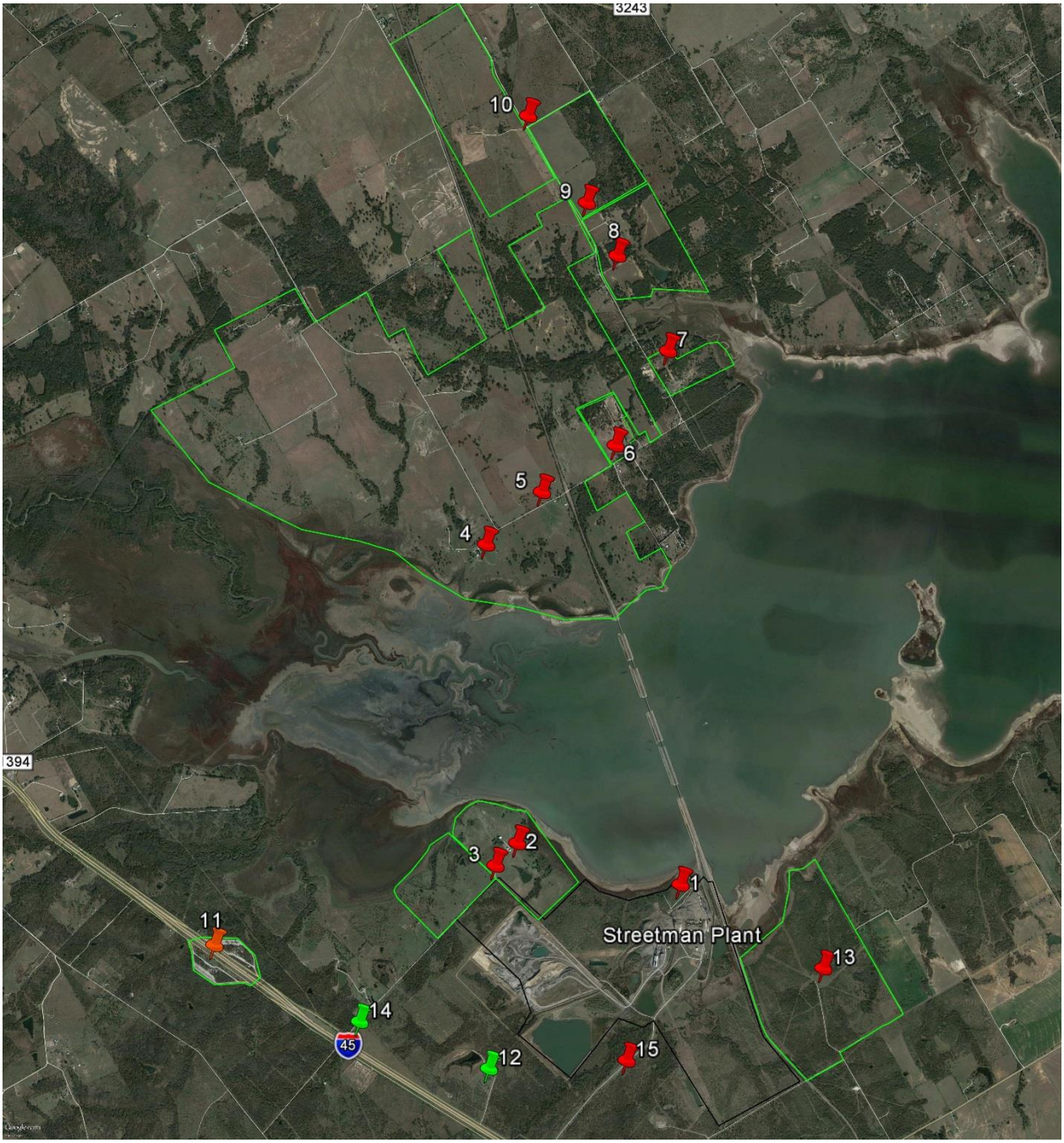

Figure 8: Potential Monitoring Sites for Streetman Plant

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	**Streetman #1**	**Streetman #2**	**Streetman #3**
Location	31.89417, -96.362774	31.91849, -96.367575	31.91844, -96.36790
Distance from SO_2 Source[2]	330 m	1,709 m	1,858 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; reservoir (N)	Yes; reservoir (N)	Yes; reservoir (N)
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (NW)	Yes (NW)
Obstructions and Height	None	None	Trees (10 m)
Distance from Site to Obstructions	None	None	Trees (45 m W to dripline) Trees (30 m S to dripline)
Road/Site Access	No	No	No
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Downwind	• Level ground • Downwind • High concentration and frequency according to modeling analysis	• Level ground • Power available • Space available • Downwind
Cons	• Property owner declined • No access	• Unresponsive property owner • No access	• Property owner declined • No access
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Streetman #4	Streetman #5	Streetman #6
Location	31.948478, -367285	31.95045, -362886	31.95446, -96.35584
Distance from SO_2 Source[2]	4,020 m	4,388 m	4,604 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; reservoir (S)	Yes; reservoir (S)	Yes; reservoir (S)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (N)	Yes (N)
Obstructions and Height	None	None	Trees (10 m)
Distance from Site to Obstructions	None	None	Trees (20 m W to dripline) Trees (20 m NW to dripline)
Road/Site Access	Yes	No	Yes
Electricity Available <18 m	Yes	Yes	No
Pros	• Level ground • Downwind	• Level ground • Downwind	• Level ground • Space available • Downwind
Cons	• Property owner declined	• Property owner declined	• No power • Property owner declined
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Streetman #7	Streetman #8	Streetman #9
Location	31.96239, -96.351707	31.96966, -96.35631	31.97580, -96.35952
Distance from SO_2 Source[2]	5,590 m	6,526 m	7,025 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	>1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; reservoir (SE)	None	None
Wind Channeling	None	None	None
Downwind[2]	Yes (NE)	Yes (N)	Yes (N)
Obstructions and Height	Trees (15-20 m)	Trees (12 m)	None
Distance from Site to Obstructions	Trees (40 m SE to dripline) Trees (40 m W to dripline)	Trees (20 m SW to dripline)	None
Road/Site Access	No	No	No
Electricity Available <18 m	No	No	Yes
Pros	• Level ground • Downwind	• Level ground • Space available • Downwind	• Space available • Downwind
Cons	• No power • Unresponsive property owner • No access	• Unresponsive property owner • No power • No access	• Slight grade in surrounding area • Unresponsive property owner • No access
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Streetman #10	Streetman #11	Streetman #12
Location	31.98266, -96.36470	31.91122, -96.39605	31.54752, -96.22548
Distance from SO_2 Source[2]	7,779 m	4,440 m	2,250 m
Wind Direction	S, SE	S, SE	S, SE
Elevation/Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	Yes (NNE)	No (W)	No (SW)
Obstructions and Height	Trees (10 m)	None	None
Distance from Site to Obstructions	Trees (20 m SE to dripline)	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	No	No	Yes
Pros	• Level ground • Space available • Downwind	• Level ground • Space available	• Level ground • Space available • Power available • Close proximity to facility • Agreeable property owner
Cons	• No power • Unresponsive property owner	• Not downwind • No power • Declined by property owner	• Not downwind
Viable Site (yes, no, or preferred)	No	No	Preferred

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Streetman #13	Streetman #14	Streetman #15
Location	31.54346, -96.20553	31.90510, -96.38168	31.90169, -96.35473
Distance from SO_2 Source[2]	1,399 m	3,172 m	1,376 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	No (E)	No (SE)	No (S)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	None	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	No
Pros	• Level ground • Power available	• Level ground • Power available	• Level ground • Close proximity to facility
Cons	• Not downwind • Declined by property owner	• Not downwind	• Not downwind • Possible interferences from diesel trucks • Declined by property owner
Viable Site (Yes, No, or Recommended)	No	Yes	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
m – meter
% – percent
N – north
S – south
E – east
W – west
NNE – north-northeast
NE – northeast
NW – northwest
SE – southeast
SW – southwest
– number
< – less than
> – greater than
SO_2 – sulfur dioxide

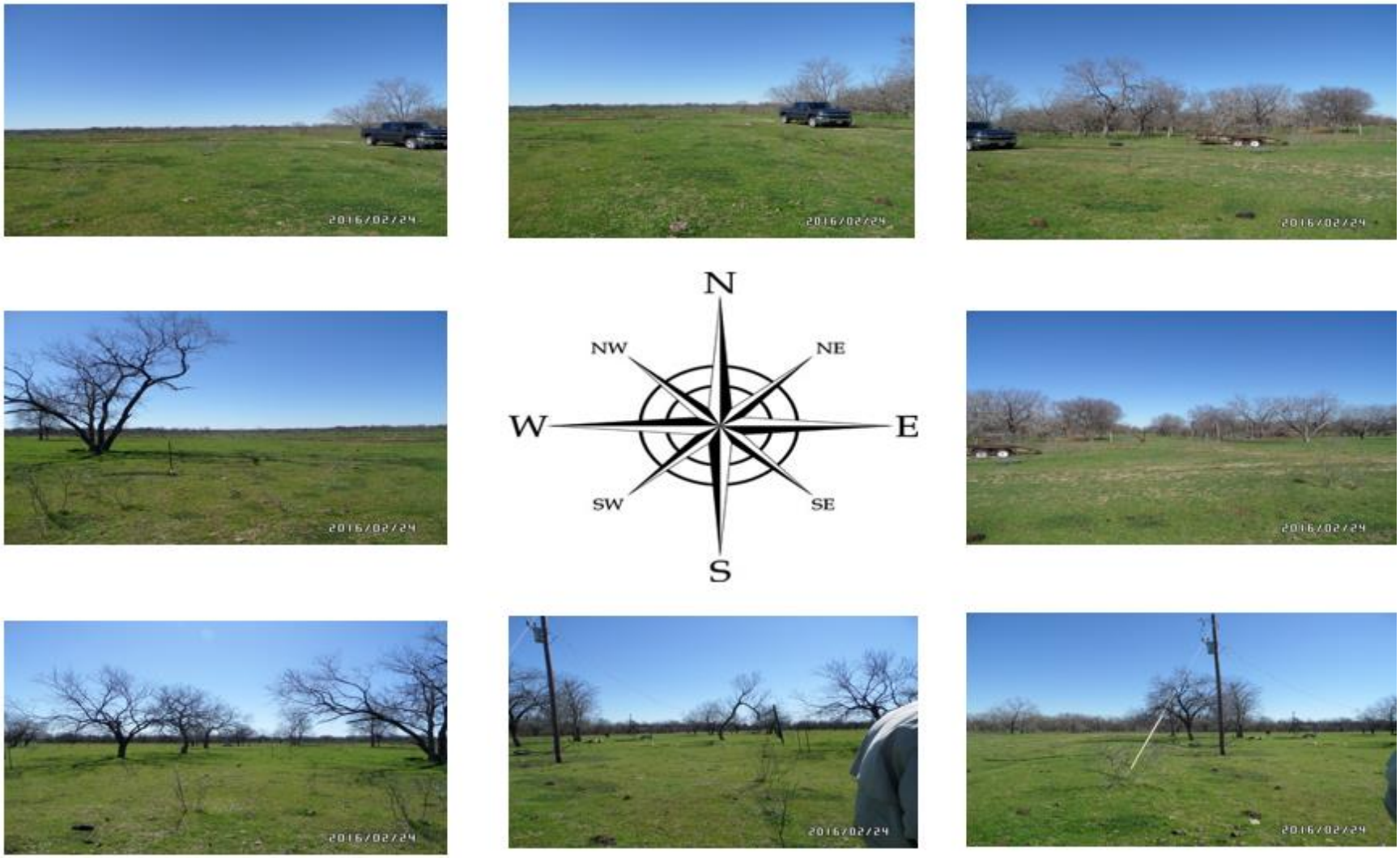

Figure 9: Streetman #12 Potential Site Cardinal Direction Photos

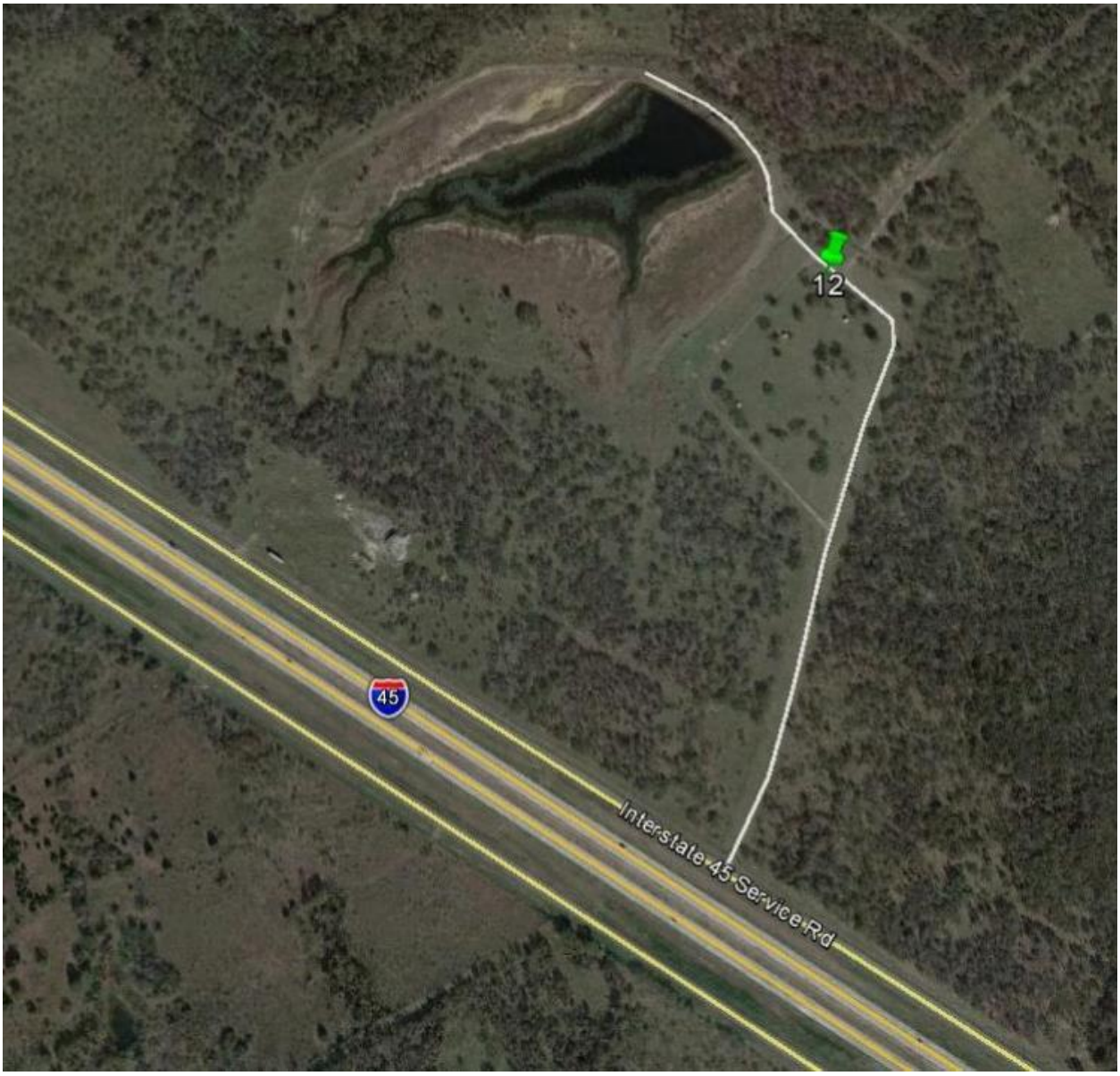

Figure 10: Streetman #12 Preferred Air Monitoring Site

References

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Welsh Power Plant Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Welsh Power Plant (Welsh) (Figure 2)
- Owner: Southwestern Electric Power Company
- Facility function: electric generation
- Location: 33.05500, -94.83944, Texas Commission on Environmental Quality (TCEQ) Region 5, Titus County, Texas
- Sulfur dioxide (SO_2) emissions data: 19,720 tons (2013), 18,225 tons (2014)
- Long-term emissions trend: decreasing, 47 percent (%) decrease from 2004 to 2014
- Emission profile: operational year-round
- Stack heights: stacks 1, 2, and 3, each 92 meters (m), were decommissioned in late 2015; new 159 m stack was installed in 2015
- SO_2 emission controls: none
- Permit related data: Prevention of Significant Deterioration permit

Existing Air Monitoring Sites

The TCEQ operates four ambient air monitoring sites within a 100 kilometer (km) radius of Welsh. Table 1 details the four closest monitoring sites to Welsh in order of proximity. Maximum SO_2 ground level concentrations can be expected within close proximity to the source. Although two of these locations (Longview and Tyler Airport Relocated) are currently monitoring SO_2, none of the existing sites are positioned downwind or within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air Monitoring Sites near Welsh

Site	Location	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013–2015)
Texarkana	71 kilometers northeast	No	Not applicable
Longview	76 kilometers south	Yes	46 parts per billion
Karnack	77 kilometers southeast	No	Not applicable
Tyler Airport Relocated*	95 kilometers southwest	Yes	Not applicable

*Tyler Airport Relocated operates a non-regulatory, seasonal SO_2 monitor.

Settings and Surroundings

The rural area surrounding Welsh consists of interior coastal plains with elevations ranging from approximately 100 to 130 m as shown in Figure 1. (Griffith et al. 2004) The terrain is considered part of the Piney Woods ecological area and includes some of the most densely forested regions of Texas. The area contains the Welsh Reservoir water body, surrounded by dense vegetation, and limited power sources. No significant changes to the landscape were noted during the reconnaissance as compared to the Google Earth view in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area.

Monticello Steam Electric Station (Monticello), located approximately 19 km northwest of Welsh, has the potential to influence SO_2 concentrations in the Welsh area under certain meteorological conditions. Monticello's SO_2 emissions were reported as 20,515 tons in 2014. Due to the site's location and the area's predominant southeasterly wind flow, it is anticipated that Monticello could impact SO_2 concentrations around the Welsh area when winds are from the northwest (approximately 8% of the time according to Mount Pleasant Airport wind rose data; Figures 3 and 4).

Figure 1: Welsh Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

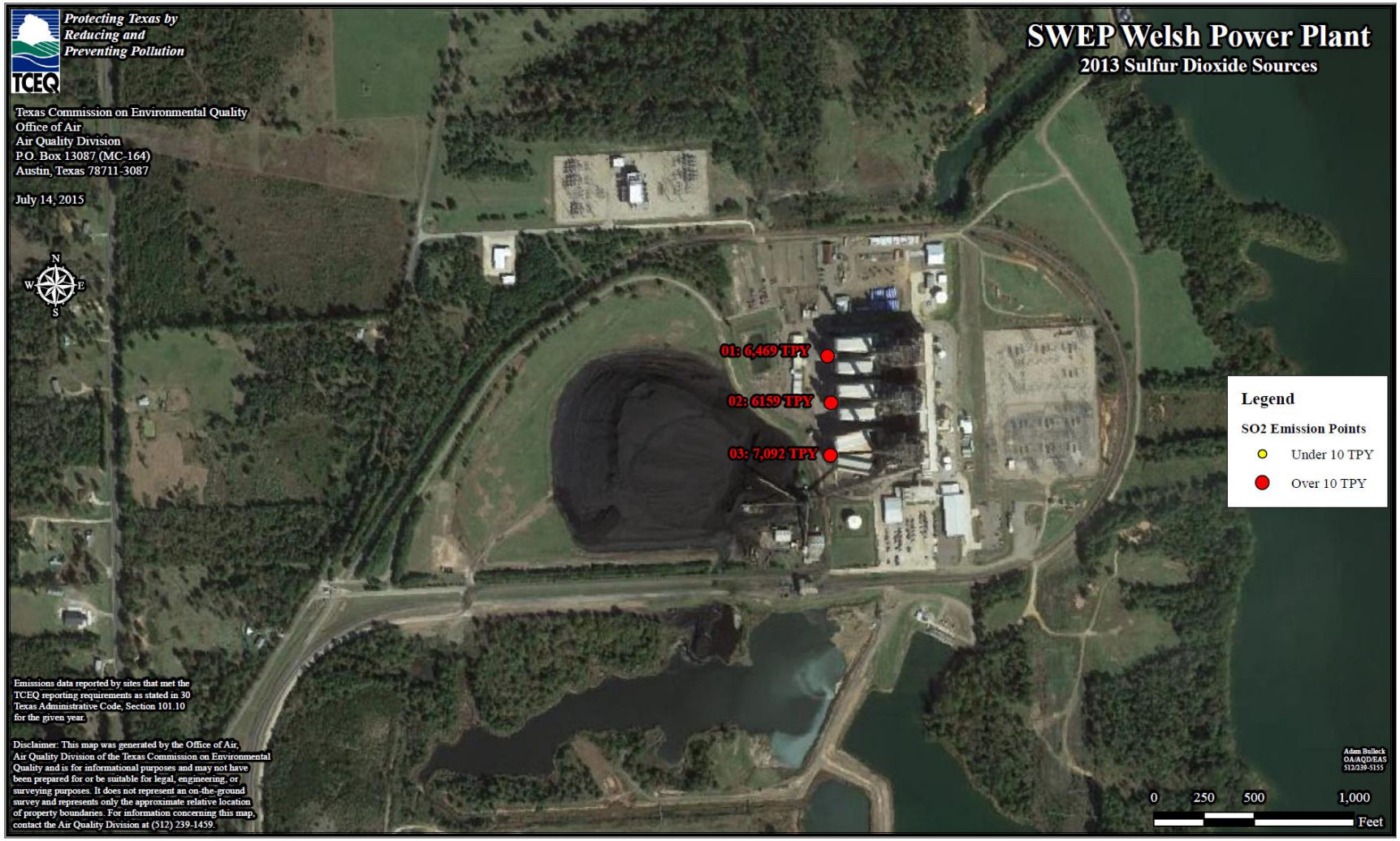

Figure 2: Welsh Power Plant Sulfur Dioxide Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at Mount Pleasant Airport, located 13 km northwest of Welsh. Figure 4 illustrates the 2012-2014 annual average speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012-2014 wind data, the dominant wind flow direction is 110 degrees southeast to 180 degrees south. Approximately 30% of average annual wind flows are from the dominant wind flow direction. Over this three year period, calm winds (0-2 miles per hour) occurred 27% of the time and wind speeds averaged 5.8 miles per hour. (Iowa Environmental Mesonet 2016).

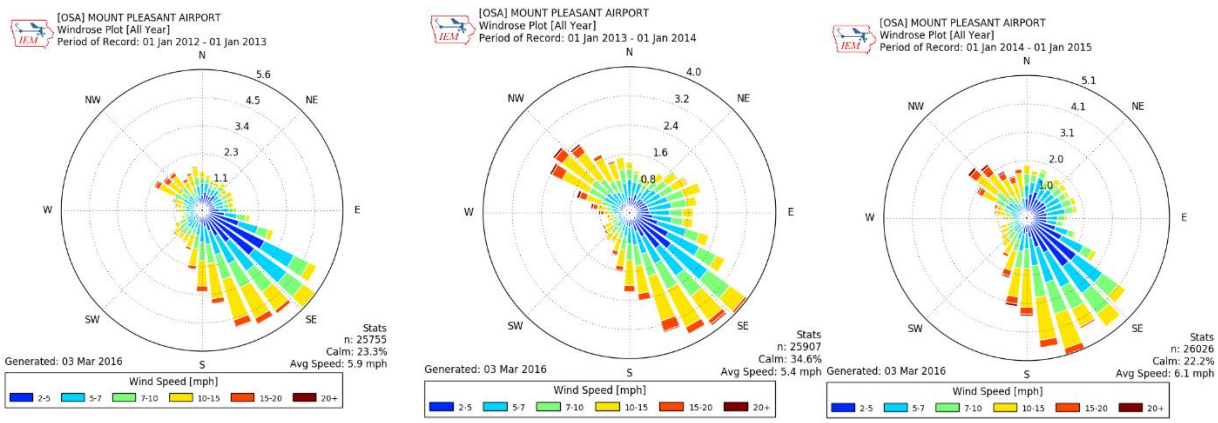

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

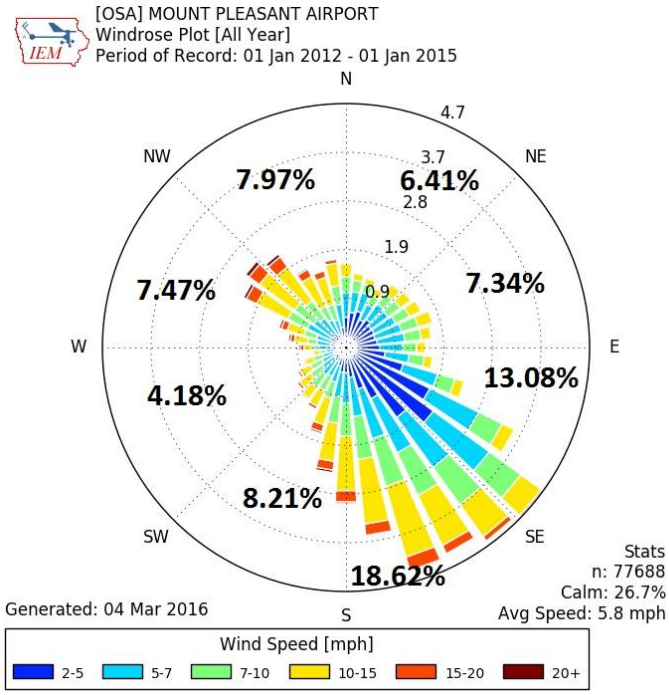

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup includes the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-m PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the four kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 graphically presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a + symbol. Welsh permitted property is outlined in black. Based on this analysis, the highest normalized concentrations, greater than 85% of the predicted off-property maximum, are expected to occur in the area approximately 2 km to the north of Welsh over the Welsh Reservoir water body. The proposed monitor locations identified in Figure 5 (sites 14 and 15) are in areas of 75%-85% predicted normalized off-property maximum concentrations. Site 14 is located 0.75 km northwest of the predicted off-property maximum, while site 15 is located 1.16 km northeast of the predicted off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property

maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around Welsh. Again, the location of the predicted off-property maximum is indicated by a + symbol and Welsh's permitted property is outlined in black. Using this analysis metric, areas directly to the north and areas directly northwest of Welsh scored greater than 80% and would be expected to see the highest frequency of elevated SO_2 concentrations. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest normalized frequency score did not yield a viable location for monitor placement.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the off-property maximum composite metric indicated with λ, and Welsh's permitted property is outlined in black. As with the normalized 99th percentile and normalized frequency metrics, areas approximately 2 km north of Welsh scored greater than 80% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did not yield a viable location for monitor placement.

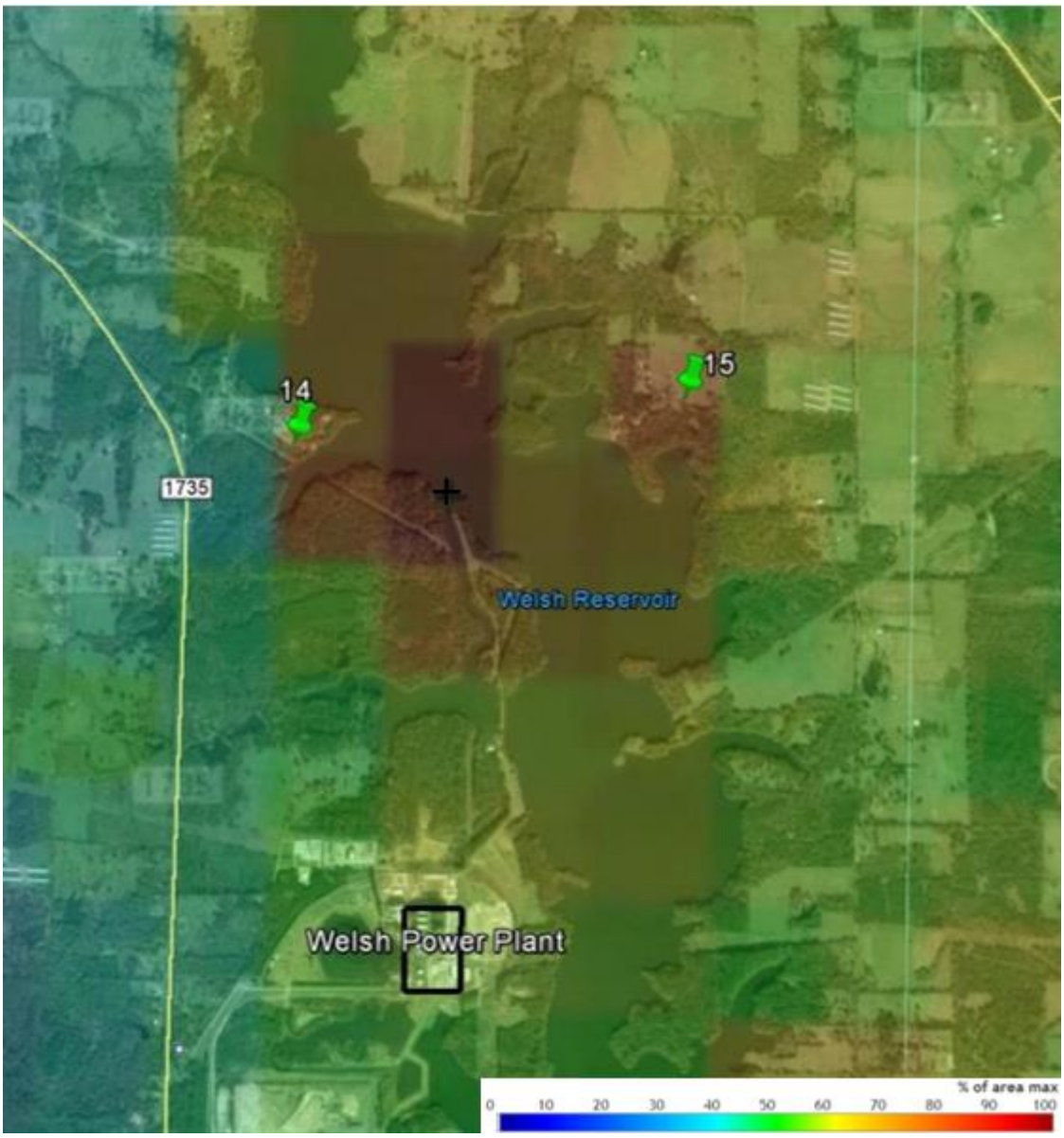

Figure 5: Welsh Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Locations

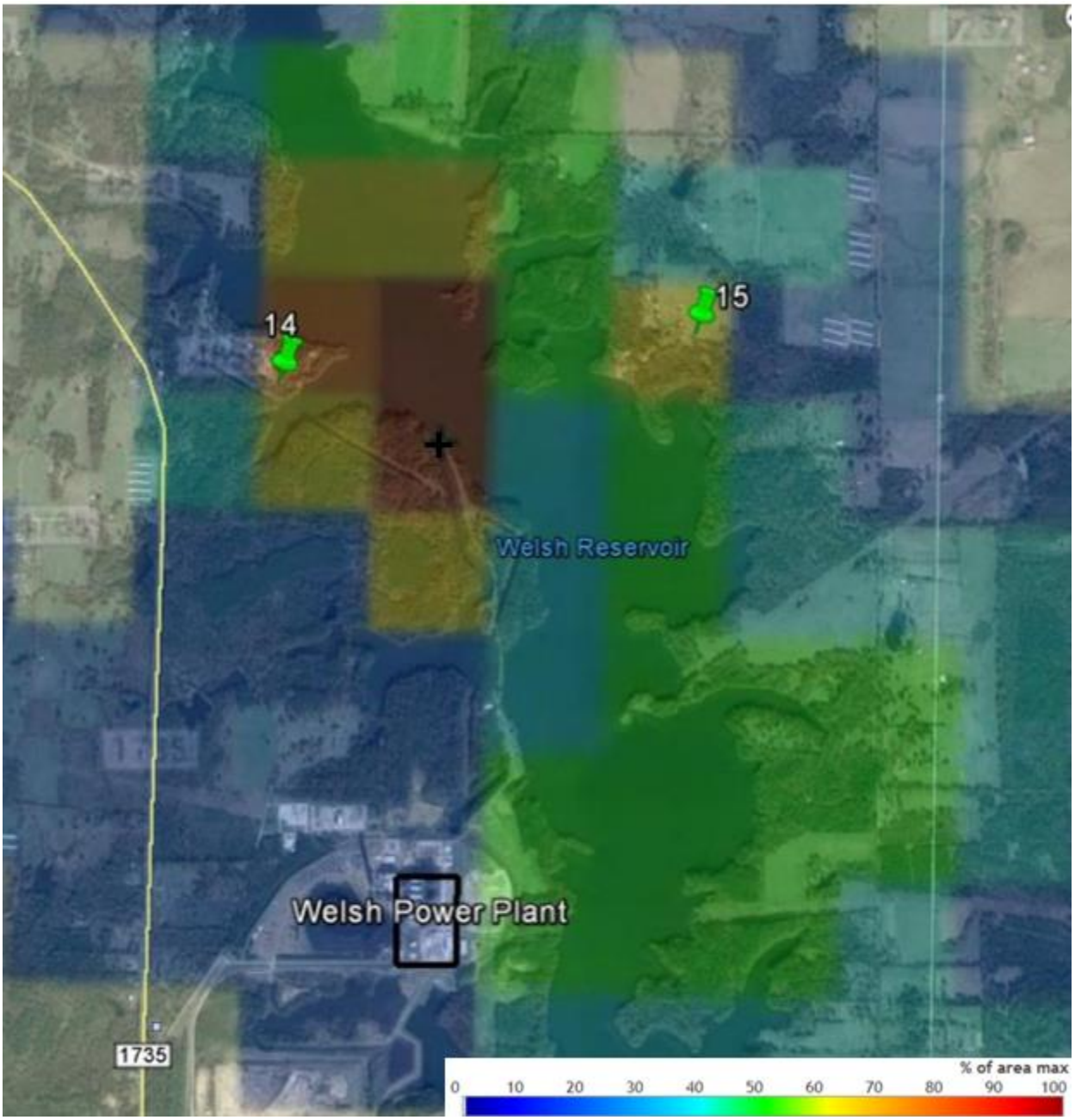

Figure 6: Welsh CAMx Model Predictions, Normalized Frequency, (Number of Days), and Viable Site Locations

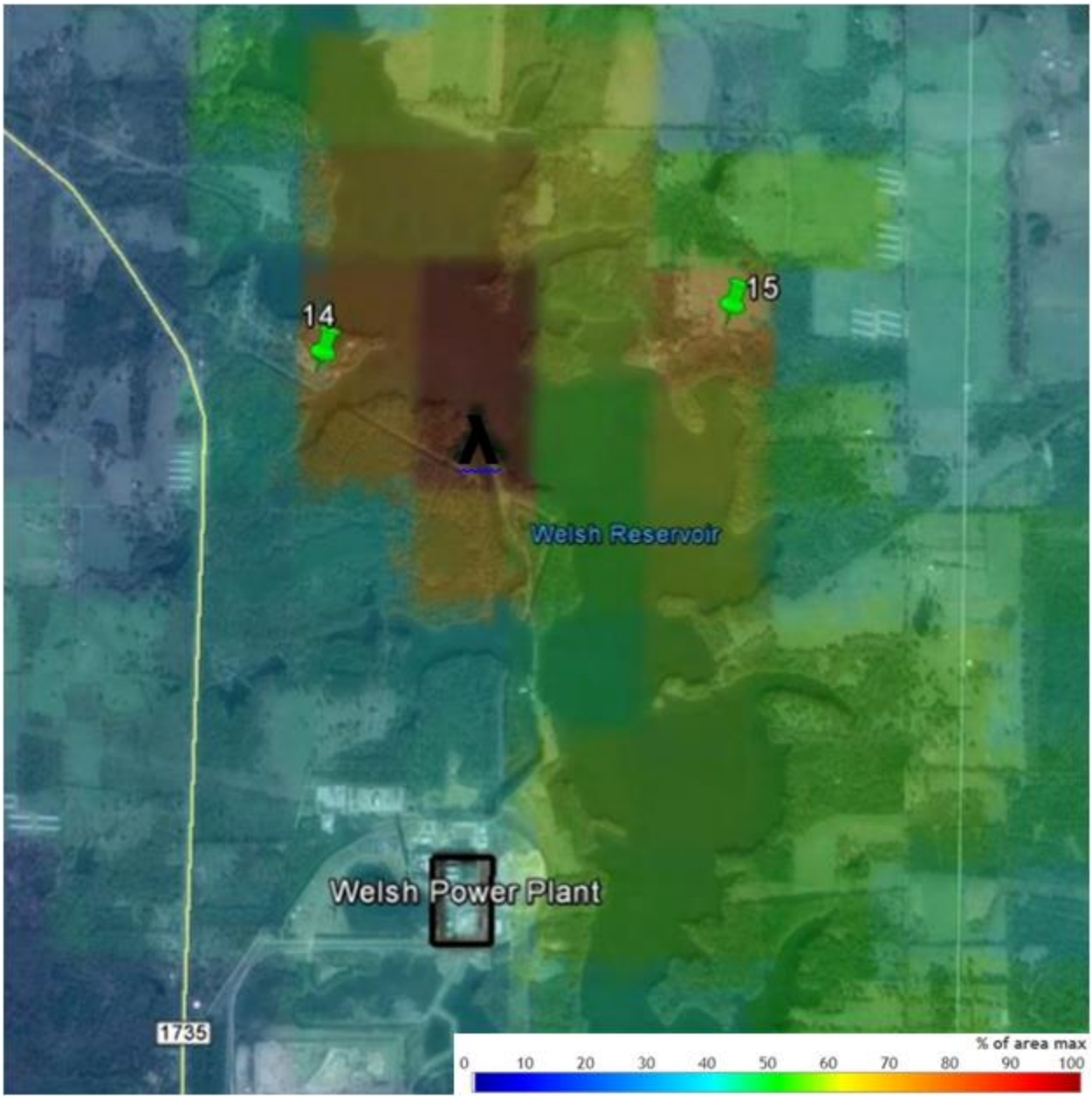

Figure 7: Welsh Area CAMx Model Predictions Composite Metric and Viable Site Locations

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Welsh that would be expected to characterize the highest SO_2 concentrations from this facility; therefore a new site is proposed. The TCEQ focused on complying with the federal requirements listed in Section 40 of the Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach includes utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 5, 6, and 7 suggest that maximum SO_2 concentrations are expected to occur north of Welsh. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected north of Welsh.

Nineteen potential sites were identified as shown in Figure 8. Seventeen of the identified potential sites (1, 2, 3, 3A, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, and 18) are not considered viable and are indicated by red pins in Figure 8. Property owners at sites 2, 7, 10, 11, and 12 either declined or were unresponsive. Sites 3A, 13, and 16 had a large number of obstructions or were prone to flooding. Sites 1, 3, 4, 5, 6, 8, 9, 17, and 18 were in areas with low predicted SO_2 concentrations according to modeling analysis. The property north of site 2 and south of site 14 exhibited logistical hindrances including heavy vegetation common in the Piney Woods, a large water body, and a lack of access, and power sources. As a result, these sites and area are not suitable for placement of a monitor.

The two sites with satisfactory logistical and siting characteristics, located in areas anticipated to have peak concentrations, are sites 14 and 15. These site locations are identified on the model and satellite image overlays shown in Figures 5, 6, 7, and 8 indicated with a green pin.

- Site 14 is positioned approximately 2.2 km northwest of Welsh on the west side of the water body. This site is directly downwind of the source, provides level ground, adequate space, and available power, as shown in Figure 9. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 75%-80% of the maximum concentrations. An air monitoring site at this location would be expected to monitor peak SO_2 concentrations based on the dominant wind patterns and model analysis predictions. A site agreement has been negotiated with the property owner.
- Site 15 is positioned approximately 2.7 km northeast of Welsh on the east side of the water body. Although it is not directly downwind, this site is on level ground, has space, and power available. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 75-80% of the maximum concentrations; therefore, an air monitoring site at this location would be expected to monitor peak SO_2 concentrations. The property owner is amenable to a site agreement.

Recommendation

Based on current facility operations, available emissions data, wind patterns, and modeling analysis, site 14 (see Figures 9 and 10) is the recommended location for placement of a new source oriented ambient SO_2 monitoring station and is shown in Figures 5, 6, 7, 8, and 10. Site 14 is positioned directly downwind, on the same side of the Welsh Reservoir, and is expected to monitor a greater frequency of maximum concentrations than site 15. While the modeling analysis predicts the highest maximum normalized concentration and composite metric scores to the north of the source, a site agreement in this area is not viable due to the terrain and water body. Site 14 is located in an area with predicted maximum normalized SO_2 concentrations of 75%–80%, meets all federal siting criteria, and has available power and level ground.

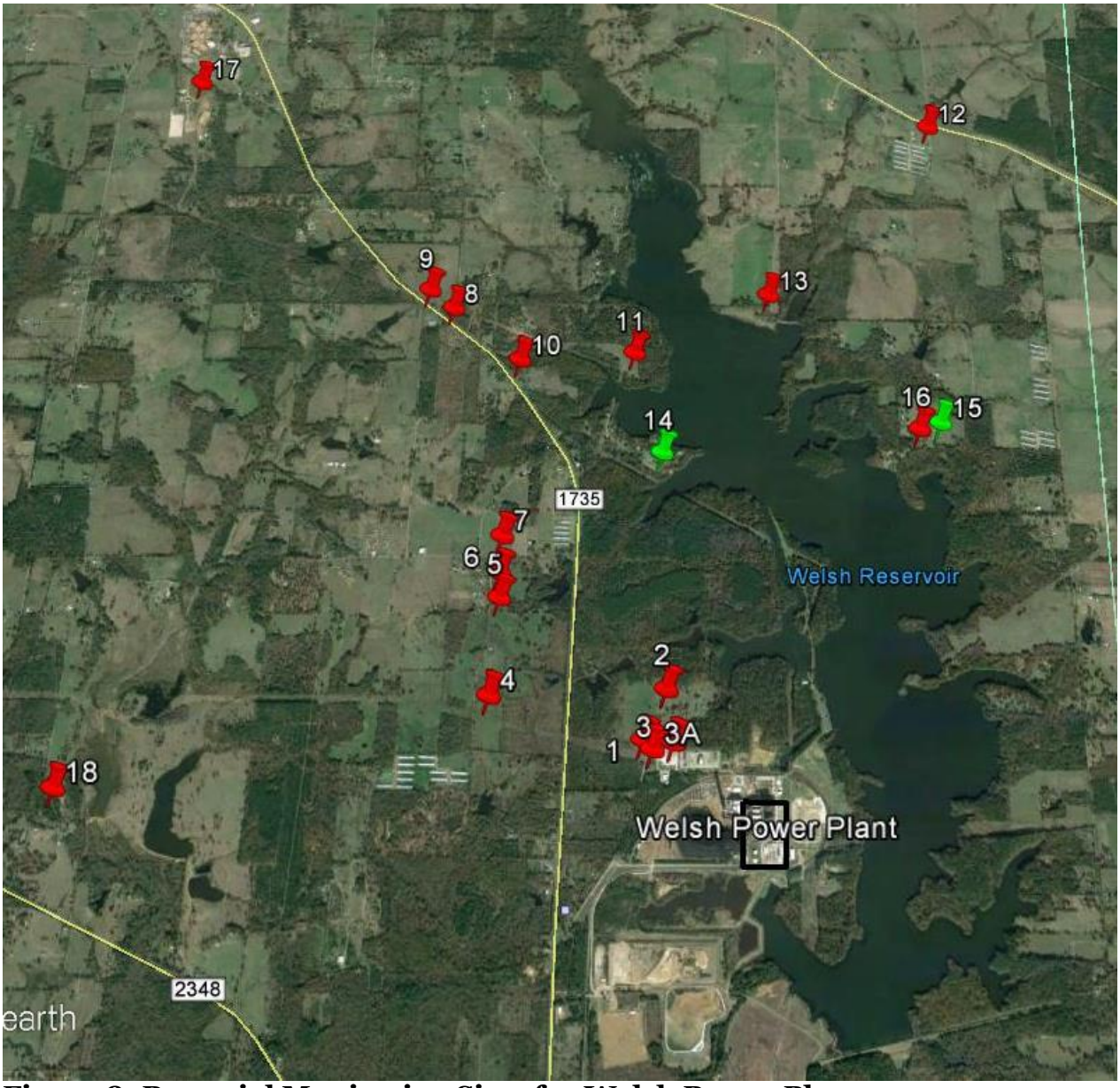

Figure 8: Potential Monitoring Sites for Welsh Power Plant

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	**Welsh #1**	**Welsh #2**	**Welsh #3**
Location[2]	33.05855, -94.84753	33.06118, -94.84673	33.05818, -94.84609
Distance from SO_2 Source[2]	582 m	909 m	428 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E)	Yes; reservoir (E)	Yes; reservoir (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Trees (15 m)	Trees (25 m)	Power substation (10 m), trees (20 m)
Distance from Site to Obstructions	Trees (20 m NE)	Trees (52 m E to dripline) Trees (56 m SE to dripline)	Power substation (20 m SE) Trees (10 m N to dripline)
Road/Site Access	Yes	Yes	No
Electricity Available <18 m	No	Yes	Yes
Pros	• Level ground • Space available • Downwind	• Level ground • Downwind • Power available • Space available	• Level ground • Downwind • Close to source • Power available • Space available
Cons	• No power • Too close to facility	• Property owner declined	• Low SO_2 concentrations according to modeling analysis
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Welsh #3A	Welsh #4	Welsh #5
Location[2]	33.05783, -94.84740	33.06071, -94.85780	33.06614, -94.85742
Distance from SO_2 Source[2]	522 m	1,776 m	2,041 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	Yes	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E)	Yes; reservoir (E)	Yes; reservoir (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Trees (30 m)	None	Trees (10-20 m)
Distance from Site to Obstructions	Trees (20 m N to dripline) Trees (9 m E to dripline) Trees (9 m S to dripline)	None	Trees (55 m NW to dripline) Trees (30 m NE to dripline) Trees (70 m S to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Close to source • Downwind • Level ground	• Level ground • Space available • Downwind	• Level ground • Downwind • Space available • Power available
Cons	• Numerous obstructions • Flood prone	• No power • Low SO_2 concentrations according to modeling analysis	• Site access would require extensive engineering due to a high berm • Low SO_2 concentrations according to modeling analysis
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Welsh #6	Welsh #7	Welsh #8
Location[2]	33.06758, -94.85738	33.06974, -94.85744	33.08403, -94.86159
Distance from SO_2 Source[2]	2,150 m	2,300 m	3,806 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E)	Yes; reservoir (E)	Yes; reservoir (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	None	None	Trees (30 m)
Distance from Site to Obstructions	None	None	Trees (20-50 m all directions to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	No	Yes	Yes
Pros	• Level ground • Space available • Downwind	• Level ground • Downwind • Space available • Power available	• Level ground • Downwind • Power available
Cons	• No power • Low SO_2 concentrations according to modeling analysis.	• Unresponsive property owner • Low SO_2 concentrations according to modeling analysis	• Numerous obstructions • Low SO_2 concentrations according to modeling analysis
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Welsh #9	Welsh #10	Welsh #11
Location[2]	33.08527, -94.86334	33.08067, -94.85698	33.08142, -94.84899
Distance from SO_2 Source[2]	4,015 m	3,180 m	3,022 m
Wind Direction	S, SE	S, SE	S, SE
Grade	>5%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (E)	Yes; reservoir (E)	Yes; reservoir (E)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	None	Trees (15 m)	Trees (25 m) House (15 m)
Distance from Site to Obstructions	None	Trees (15 m N to dripline) Trees (15 m E to dripline) Trees (15 m W to dripline)	Trees (51 m NW to dripline) House (25 m SW)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Power available	• Level ground • Downwind • Space available • Power available	• Level ground • Downwind • Space available • Power available
Cons	• Unlevel terrain • Low SO_2 concentrations according to modeling analysis	• Numerous obstructions • Unresponsive Property owner	• Unresponsive property owner
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Welsh #12	Welsh #13	Welsh #14
Location[2]	33.09678, -94.82739	33.08495, -94.83948	33.07481, -94.84691
Distance from SO_2 Source[2]	4,884 m	3,300 m	2,290 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	>1%	<1%
Flood Plains	No	Yes	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	No	Yes; reservoir (S)	Yes; reservoir (E)
Wind Channeling	None	None	None
Downwind[2]	No (NE)	Yes (N)	Yes (NW)
Obstructions and Height	None	None	Trees (12-14 m)
Distance from Site to Obstructions	None	None	Trees (17 m NW to dripline) Trees (18 m NE to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Level ground • Space available • Easy access • Power available	• Easy access • Downwind	• Level ground • Downwind • Power available • Space Available • Agreeable property owner • Located on the same reservoir side as facility
Cons	• Not downwind • Property owner declined	• No Power • Difficult access • Flood prone • Slight grade in surrounding area	• None
Viable Site (Yes, No, or Preferred)	No	No	Preferred

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Welsh #15	Welsh #16	Welsh #17
Location[2]	33.07664, -94.82795	33.07626, -94.82940	33.10694, -94.89578
Distance from SO_2 Source[2]	2,600 m	2,450 m	6,380 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Nearby[2]	Yes; reservoir (W)	Yes; reservoir (W)	No
Wind Channeling	None	None	None
Downwind[2]	No (NE)	No (NE)	Yes (NW)
Obstructions and Height	None	Trees (14 m)	None
Distance from Site to Obstructions	None	Trees (23 m NE to dripline) Trees (24 m NW to dripline) Trees (26 m S to dripline)	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Space available • Power available • High concentration and frequency according to modeling analysis • Level ground	• Power available • Level ground	• Agreeable property owner • Space available • Downwind • Level ground • Power available
Cons	• Not downwind • Located on the west reservoir side	• Numerous obstructions • Not downwind	• Low SO_2 concentrations according to modeling analysis
Viable Site (Yes, No, or Preferred)	Yes	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	**Welsh #18**
Location[2]	33.05584, -94.88454
Distance from SO_2 Source[2]	4,130 m
Wind Direction	S, SE
Grade	<1%
Flood Plains	No
Mountain/Valley Winds	None
Water Body Nearby[2]	No
Wind Channeling	None
Downwind[2]	No (W)
Obstructions and Height	Trees (15 m)
Distance from Site to Obstructions	Trees (25 m SW to dripline) Trees (30 m NE to dripline) Trees (25 m S to dripline)
Road/Site Access	Yes
Electricity Available <18 m	Yes
Pros	• Level ground
Cons	• Not downwind • No power
Viable Site (Yes, No, or Preferred)	No

[1]Based on guidance from March 1,
2011, memorandum from Tyler Fox, EPA Office of Air Quality Planning and Standards, "Additional Clarification Regarding the Application of Appendix W Modeling Guidance for the 1-hr
NAAQS." Research Triangle Park, North Carolina 27711.
[2]Based on Google Earth
E – east
m – meter
N – north
NE – northeast
NW – northwest
S – south
SE – southeast
SO_2 – sulfer dioxide
SW – southwest
W – west
> – greater than
< – less than
– number
% – percent

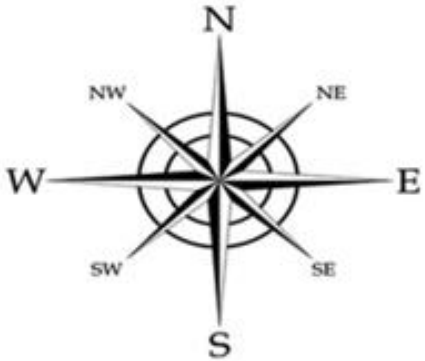

Figure 9: Welsh #14 Potential Site Cardinal Direction Photos

Figure 10: Welsh #14 Preferred Air Monitoring Site

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Sandow Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

Two separately permitted facilities with sulfur dioxide (SO_2) emissions greater than 2,000 tons per year are located on contiguous property in Milam County, Texas. The facilities are officially referred to as the Sandow 5 Generating Plant and the Sandow Steam Electric Station and are approximately 250 meters (m) apart from each other (Figure 1). All subsequent discussions reference the two sources collectively as "Sandow."

Source 1

- Name: Sandow 5 Generating Plant (Figure 2)
- Owner: Luminant Generation Company, LLC
- Facility function: electric generation
- Location: 30.56725, -97.06101, Texas Commission on Environmental Quality (TCEQ) Region 9, Milam County, Texas
- SO_2 emissions data: 2,406 tons (2013), 2,260 tons (2014)
- Long-term emissions trend: increasing, 51 percent (%) increase from 2010 to 2014
- Emission profile: operational year-round
- Stack height(s): two stacks 102 m high, currently active
- SO_2 emission controls: miscellaneous methods of control reduce SO_2 emissions by 95% on two limestone injection boilers, polishing scrubbers also reduce SO_2 emissions by 3% on a circulating fluidized bed boiler
- Permit related data: Federal Operating Permit

Source 2

- Name: Sandow Steam Electric Station (Figure 3)
- Owner: Luminant Generation Company, LLC
- Facility function: electric generation
- Location: 30.56603, -97.06331, TCEQ Region 9, Milam County, Texas
- SO_2 emissions data: 19,761 tons (2013), 21,943 tons (2014)
- Long-term emissions trend: increasing, 34% increase from 2010 to 2014
- Emission profile: operational year-round
- Stack height: one stack 121 m high, currently active
- SO_2 emission controls: limestone wet-scrubbing, reduces SO_2 emissions by 76.6% on main boiler stack
- Permit related data: Federal Operating Permit

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Existing Air Monitoring Sites

There are four existing air monitoring stations within a 75 kilometer (km) radius of Sandow. Two ambient air monitoring sites are monitored by TCEQ (Austin Northwest, Austin Webberville Rd) and two are operated by Capital Area Council of Governments (CAPCOG). Table 1 details the four closest monitoring sites in order of proximity. Maximum SO_2 ground level concentrations can be expected within close proximity to the source. Although three of these locations are currently monitoring SO_2, none of the existing sites are positioned downwind or within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air Monitoring Sites Near Sandow

Site	Distance from Sandow	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013-2015)
CAPCOG Hutto College Street	46 km west	Yes*	Not applicable
CAPCOG Lake Georgetown	65 km northwest	Yes*	Not applicable
Austin Northwest	70 km southwest	Yes	5 parts per billion
Austin Webberville Road	71 km southwest	No	Not applicable

CAPCOG – Capital Area Council of Governments
km – kilometers
* – not regulatory SO_2 monitors

Settings and Surroundings

The primarily rural area surrounding Sandow consists of the blackland prairie, which is characterized by flat to gently rolling hills, grasses, forbs, and croplands (Griffith et al. 2004). The elevation ranges from 150 to 171 meters as shown in Figure 1. No significant changes to the landscape were noted during the reconnaissance as compared to the satellite view shown in Figure 9. Due to a general lack of geographical obstructions and thick elevated vegetation, wind patterns are highly consistent across the Central Texas area. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area.

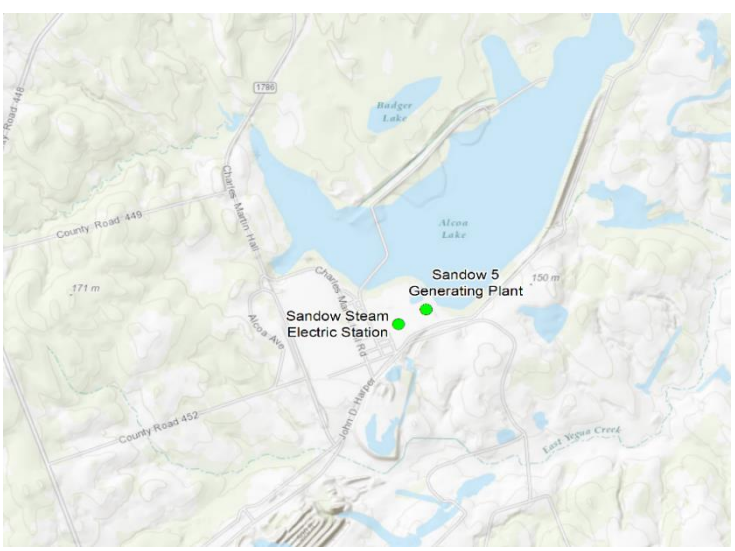

Figure 1: Sandow Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 2: Sandow 5 Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 3: Sandow Steam Electric Station Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

Meteorological Data

Figure 4 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Cameron Airport, located 35 km northeast of Sandow. Figure 5 illustrates the 2012-2014 annual average wind speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on the analysis of the 2012-2014 wind data, the dominant wind flow direction is 150 degrees south-southeast to 215 degrees south-southwest. Approximately 48% of the average area wind flows move from these directions. Over this three year period, calm winds (0-2 miles per hour) occurred on average 16.5% of the time, and wind speeds averaged 7.2 miles per hour (Iowa Environmental Mesonet 2016).

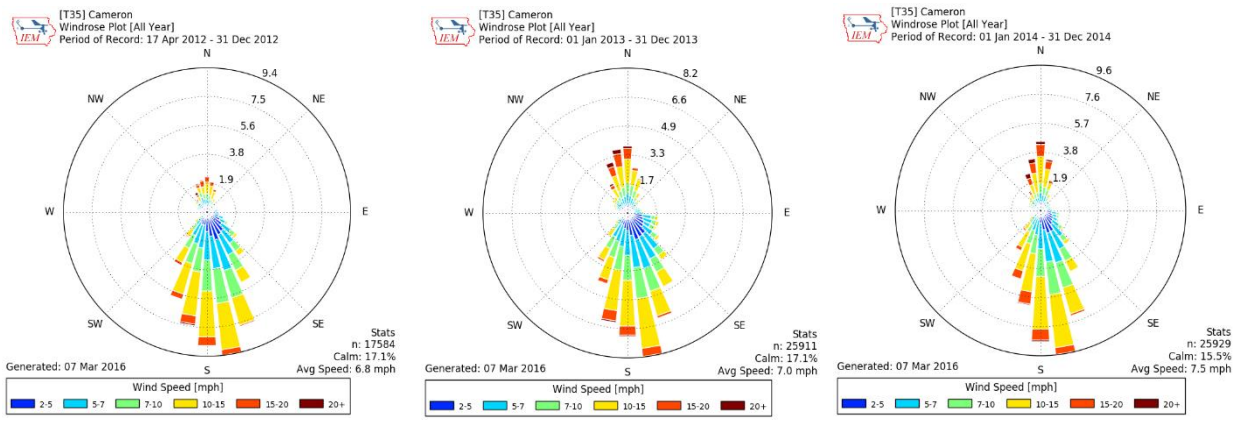

Figure 4: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

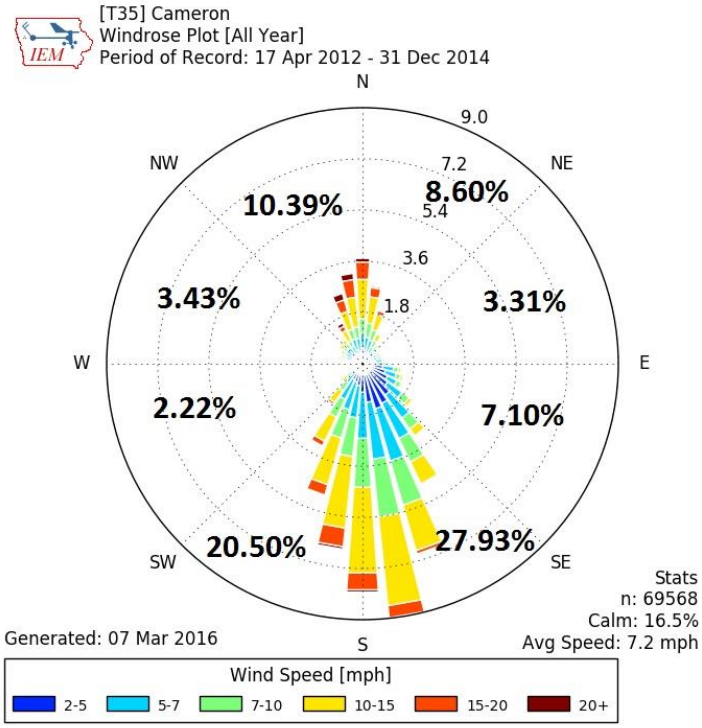

Figure 5: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the three kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 4 and 5.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 6 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a "+" symbol. Sandow's permitted properties are outlined in black. Based on this analysis, the highest normalized concentrations, greater than 95% of the predicted off-property maximum, are expected to occur 2.1 km directly north of the Sandow facilities. This area, however, is not viable for monitor placement. After thorough consideration was given to the area north of Alcoa Lake (outlined in purple in Figure 9), the TCEQ determined that no viable site locations exist in this area due to lack of power and vehicle access (see section "Siting Options and Criteria"). Approximately 2.3 km southwest of the predicted off-property maximum is the proposed monitor location identified in Figure 6 as site 7. This site is in an area of predicted normalized concentrations within 40% to 50% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property

maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 7 presents the geographic distribution of normalized frequency around the Sandow facilities. Again, the location of the predicted off-property maximum is indicated by a "+" symbol, and Sandow's permitted properties are outlined in black. Using this analysis metric, areas directly to the north of the Sandow facilities scored greater than 95% and would be expected to see the highest frequency of elevated SO_2 concentrations.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 8 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a "λ" symbol, and Sandow's permitted properties are outlined in black. Similar to the normalized 99th percentile and normalized frequency metrics, areas directly north of the Sandow facilities scored greater than 95% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did not yield a viable location for monitor placement.

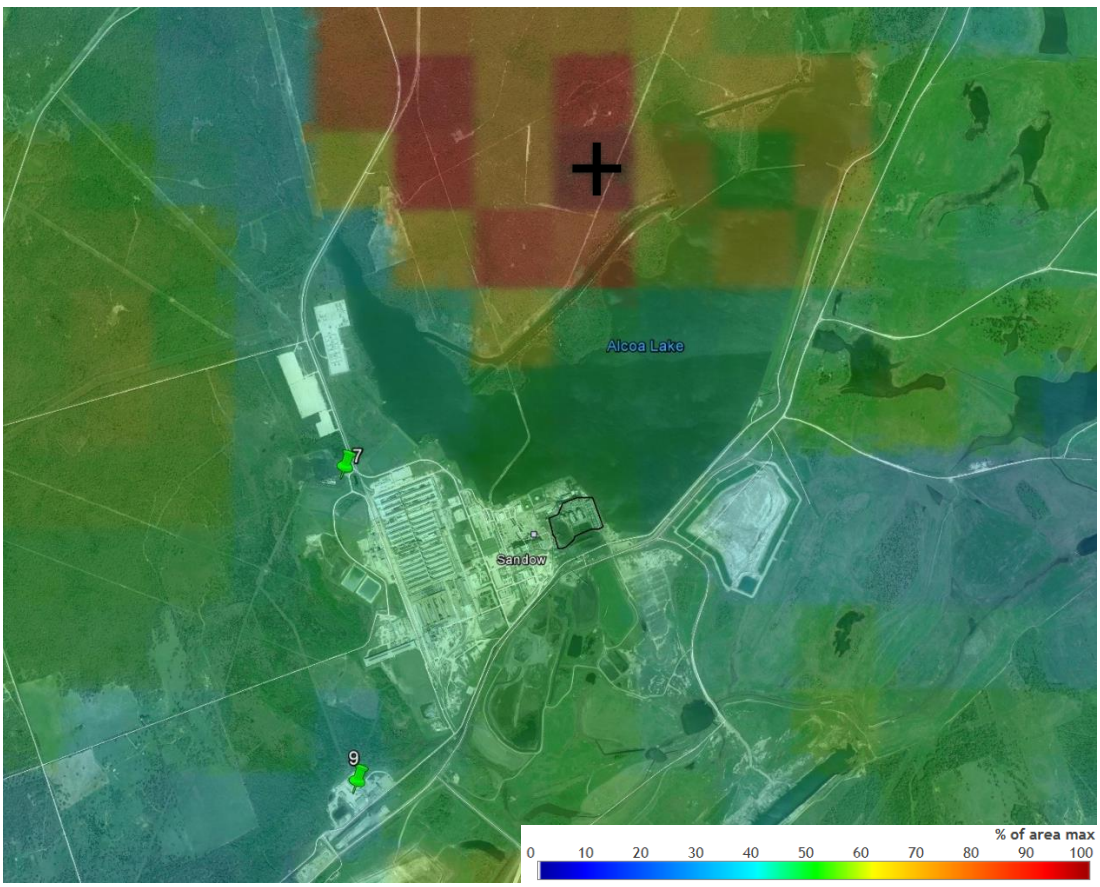

Figure 6: Sandow Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Locations (7, 9)

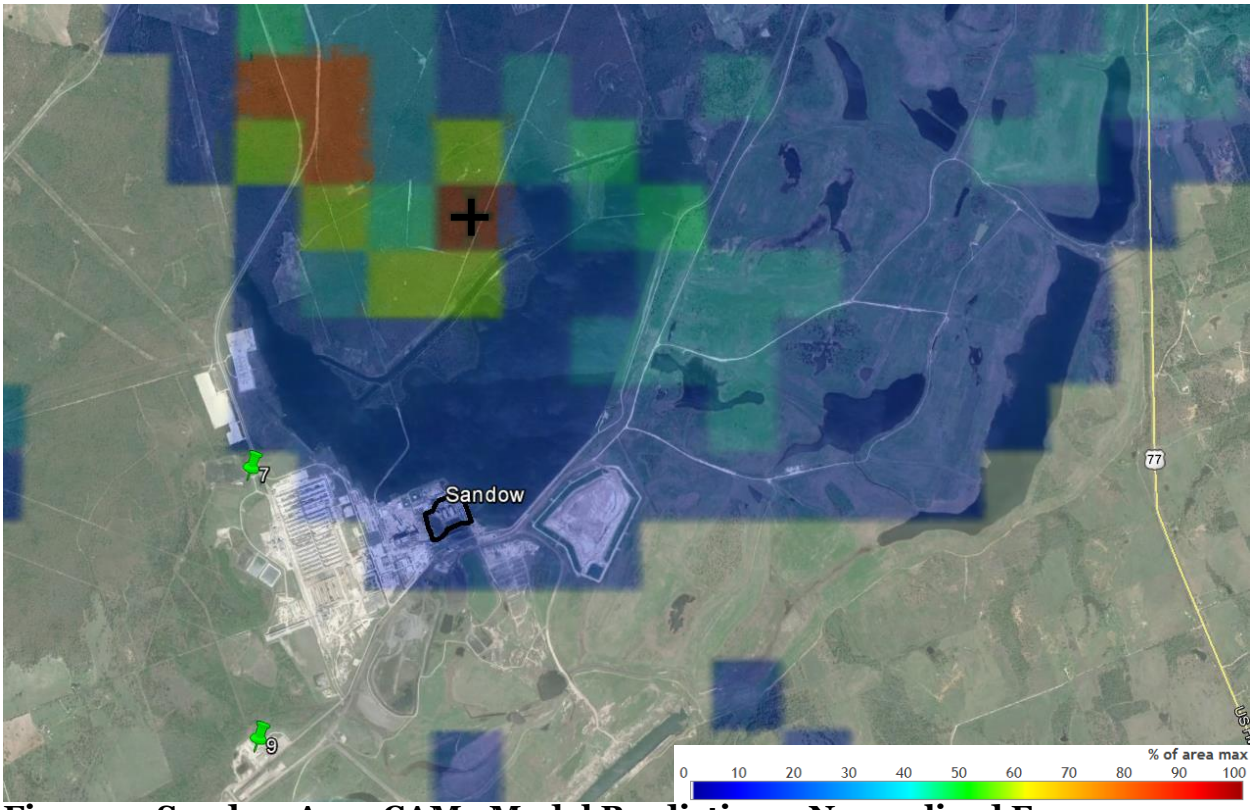

Figure 7: Sandow Area CAMx Model Predictions, Normalized Frequency, (Number of Days), and Viable Site Locations (7, 9)

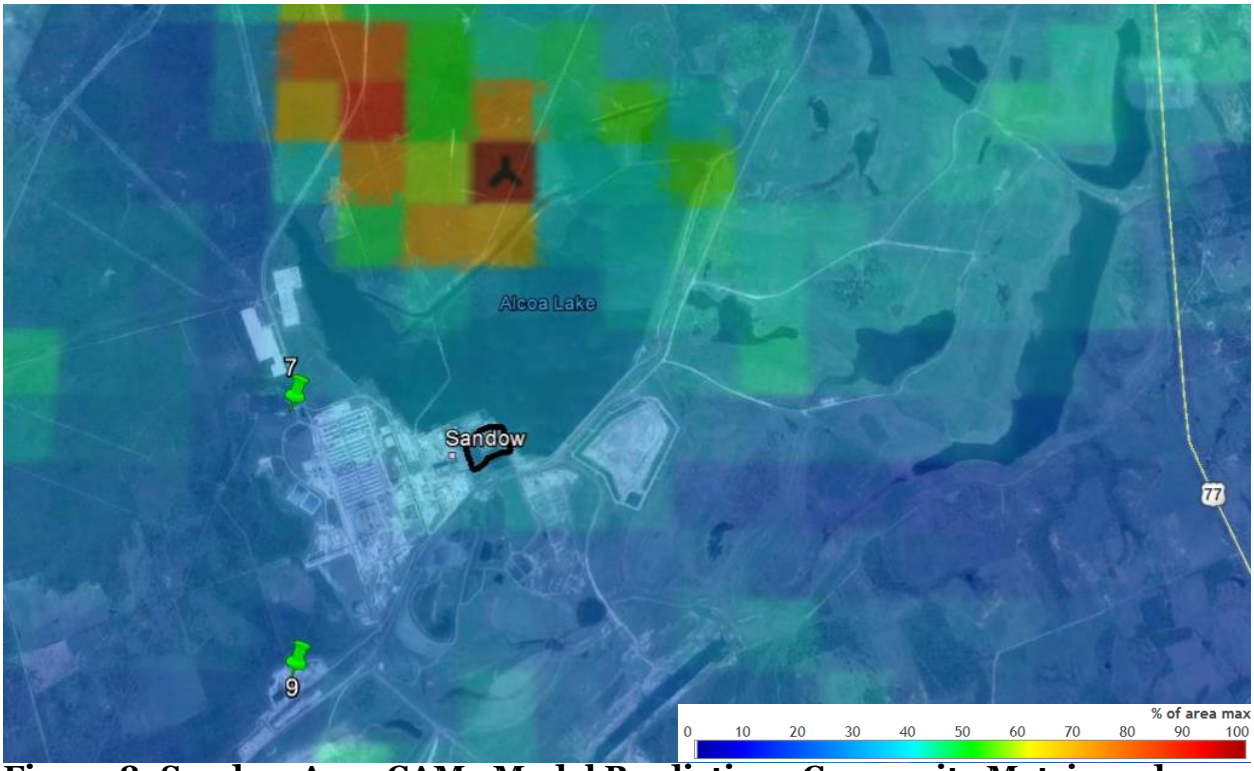

Figure 8: Sandow Area CAMx Model Predictions Composite Metric and Viable Site Locations (7, 9)

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Sandow that would be expected to characterize the highest SO_2 concentrations from these facilities; therefore a new site is proposed. The TCEQ focused on complying with the federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach included utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 6, 7, and 8 suggest that maximum SO_2 concentrations are expected to occur north of the Sandow facilities. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected within or directly north of Sandow. Figure 9 depicts all potential site locations (red and green pins), their corresponding property lines (green), Sandow's permitted property (black), and Alcoa Lake (orange). The area in the figure outlined in blue belongs to a single property owner with the exception of areas outlined in green. The aforementioned wind rose and modeling data resulted in extensive consideration for potential site locations between Alcoa Lake and the northern borders of the blue property outline (outlined in purple). It was determined, however, that necessary electricity and vehicle access infrastructure to support a monitoring site was nonexistent, and the entire area had been pledged for the development of a solar farm. Thus, no further site agreements for land use could be granted. Consequently, ten potential sites were identified northwest, west, and southwest of the facility as shown in Figure 9. Eight of the identified potential sites (1, 2, 3, 4, 5, 6, 8, and 10) are not considered viable and are indicated by red pins. Sites 1 and 4 had many siting obstructions. Site 2 is in an area with restricted access, such as a locked gate to a private road. Property owners at sites 3, 5, and 6 were unwilling to negotiate site agreements or were unresponsive.

The owner of the area outlined in blue provided options for four monitoring sites northwest and southwest of the Sandow facilities; sites 7, 8, 9, and 10. Site 10 has no access to electricity and is prone to flooding. The area surrounding site 8 (outlined in yellow) is under a solar farm lease agreement and is therefore unsuitable for monitor placement. As a result, these potential sites are no longer under consideration.

Sites 7 and 9, indicated with green pins in Figure 9, have satisfactory logistical and siting characteristics. These site locations are also identified on the model and satellite image overlays in Figures 6, 7, and 8.

- Site 7 is positioned 1.4 km west of the Sandow facilities and approximately 2.4 km southwest of the off-property maximum concentration (see Figure 8). The site offers level ground, adequate space, available power, and is close to the source (see Table 2 and section "Recommendation"). The normalized 99th percentile concentration metric analysis predicted area concentrations to be 45% of the maximum concentrations. A site agreement has been negotiated with the property owner.
- Site 9 is positioned 1.9 km southwest of the Sandow facilities and approximately 4 km southwest of the off-property maximum concentration (see Figure 8). The site

provides level ground, adequate space, and available power. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 40% of the maximum concentrations. The property owner is amenable to a site agreement.

Recommendation

Based on current facility operations, available emissions data, wind patterns, logistics, and modeling analyses, site 7 (see Figures 10 and 11) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. The most influential factors constraining potential site placement for Sandow were logistics (e.g., electricity and property access) and averse property owners. While the modeling analyses predict the highest maximum normalized concentration and composite metric score to be located 2.4 km to the northeast of site 7, a site placement in that area is not logistically feasible (electricity and access). This area was also not offered by the owner due to a preexisting lease agreement with a solar farm.

From the source, sites 7 and 9 are 1.4 km and 1.9 km respectively. In addition, the Sandow area experienced calm winds an average of 16.5% of the time from 2012-2014 (Figure 5). During calm wind conditions the proximity of site 7 would be expected to yield higher SO_2 concentrations than site 9. Site 7 is also the closest viable site to prevailing wind patterns coming from approximately 150 degrees south-southeast of the source. The recommended site has available power, adequate space, level ground, and meets all federal siting criteria. A site agreement has been negotiated with the property owner.

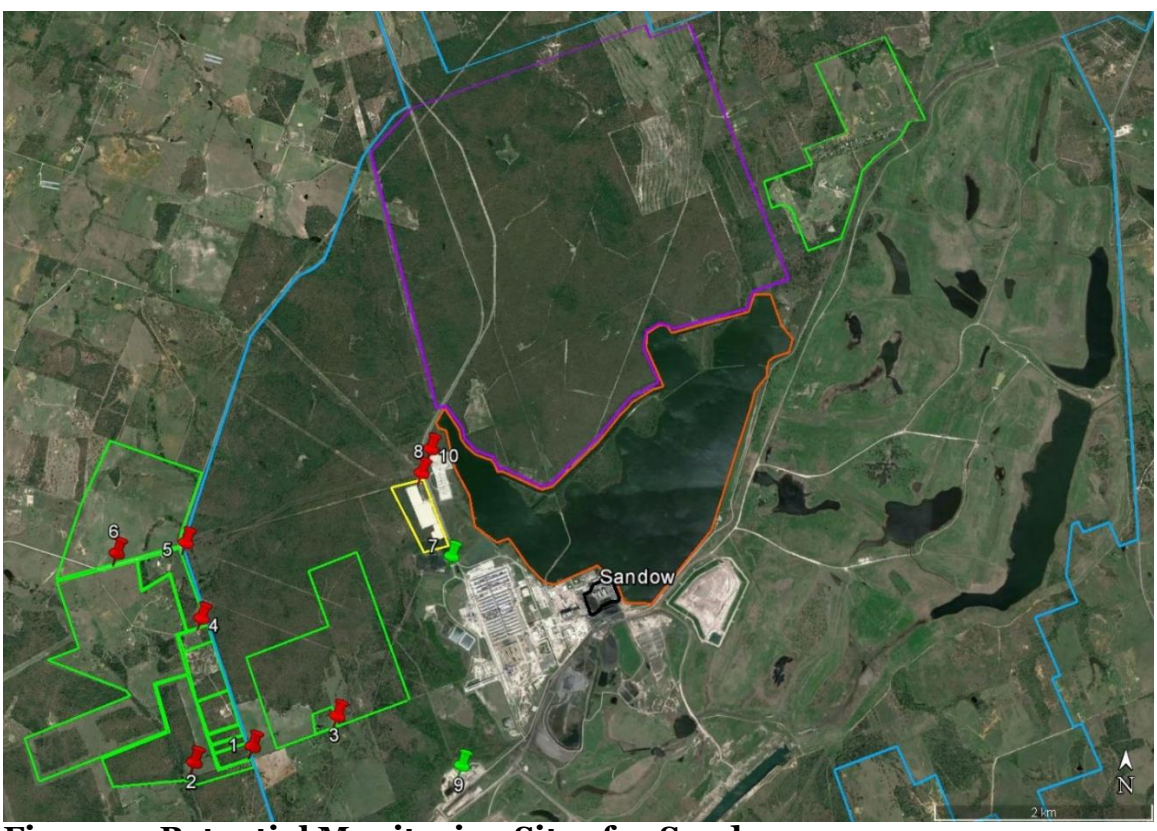

Figure 9: Potential Monitoring Sites for Sandow

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	**Sandow #1**	**Sandow #2**	**Sandow #3**
Location	30.55379, -97.09541	30.55251, -97.10099	30.55628, -97.08730
Distance from SO_2 Source[2]	3,670 m	4,190 m	2,810 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	No (SW)	No (SW)	No (SW)
Obstructions and Height	Trees (10 m)	Trees (20 m) Barn 5 m (E)	Barn (5 m)
Distance from Site to Obstructions	Trees (0-5 m N, S, E, W)	Trees (30 m SE) Trees (35 m S) Barn (15 m E)	Barn (55 m NW)
Road/Site Access	Yes	No	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Space available	• Level ground • Space available	• Level ground • Space available
Cons	• Numerous obstructions • Not downwind	• No site access • Not downwind	• Property owner declined • Not downwind
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Sandow #4	Sandow #5	Sandow #6
Location	30.56429, -97.10073	30.57064, -97.10248	30.56974, -97.10925
Distance from SO_2 Source[2]	3,790 m	4,000 m	4,610 m
Wind Direction	S, SE	S, SE	S, SE
Elevation/Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	No (W)	No (W)	No (W)
Obstructions and Height	Trees (12 m)	Trees (6 m)	None
Distance from Site to Obstructions	Trees (15-20 m, NW, W, E)	Trees (10 m NW)	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Space available	• Level ground • Space available	• Level ground • Space available
Cons	• Numerous obstructions • Not downwind	• No driveway access • Not downwind	• Unresponsive property owner • Unlevel ground • Not downwind
Viable Site (Yes, No, or Preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Sandow #7	Sandow #8
Location	30.56946, -97.07621	30.57660, -97.07919
Distance from SO_2 Source[2]	1,470 m	1,970 m
Wind Direction	S, SE	S, SE
Elevation/Grade	<1%	<1%
Flood Plains	No	No
Mountain/Valley Winds	None	None
Water Body Within 1,000 m	Yes; Lake (E)	Yes; Lake (E)
Wind Channeling	None	None
Downwind[2]	No (W)	No (NW)
Obstructions and Height	None	None
Distance from Site to Obstructions	None	None
Road/Site Access	Yes	Yes
Electricity Available <18 m	Yes	Yes
Pros	• Level ground • Space available • Close to the source • Easy operator access	• Level ground • Space available • Easy operator access
Cons	• Not downwind	• Leased to solar farm • Not downwind
Viable Site (Yes, No, or Preferred)	Preferred	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Sandow #9	Sandow #10
Location	30.55227, -97.07529	30.57869, -97.07828
Distance from SO_2 Source[2]	1,915 m	2,019 m
Wind Direction	S, SE	S, SE
Elevation/Grade	<1%	<1%
Flood Plains	No	Yes
Mountain/Valley Winds	None	None
Water Body Within 1,000 m	None	Yes; Lake (E)
Wind Channeling	None	None
Downwind[2]	No (SW)	No (NW)
Obstructions and Height	None	None
Distance from Site to Obstructions	None	None
Road/Site Access	Yes	Yes
Electricity Available <18 m	Yes	No
Pros	• Level ground • Space available • Easy operator access	• Space available • Easy operator access
Cons	• Not downwind	• No power • Prone to flooding • Rough terrain • Not downwind
Viable Site (Yes, No, or Preferred)	Yes	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
E – east
m – meter
N – north
NE – northeast
NW – northwest
S – south
SE – southeast
SO_2 – sulfur dioxide
SW – southwest
W – west
> – greater than
< – less than
– number
% – percent

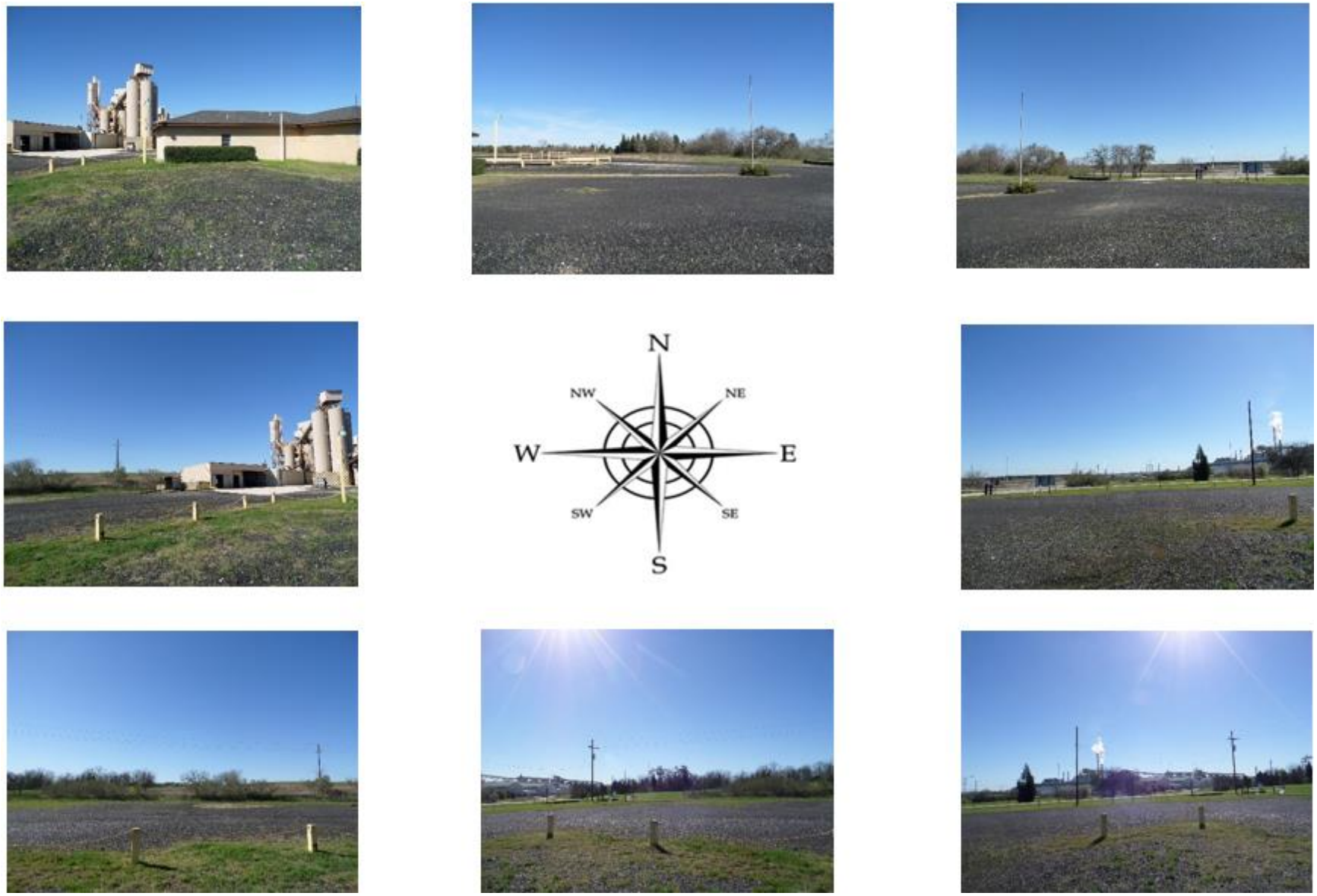

Figure 10: Sandow #7 Potential Site Cardinal Direction Photos

Figure 11: Sandow #7 Potential Site

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Borger Monitor Placement Evaluation

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

Two separately permitted facilities with sulfur dioxide (SO_2) emissions greater than 2,000 tons per year are located in Borger, Texas. The facilities are officially referred to as the Sid Richardson Carbon Company Borger Carbon Black Plant and the Orion Engineered Carbons LLC Borger Carbon Black Plant. The two plants are approximately 195 meters (m) apart from each other. All subsequent modeling and recommendations consider the two sources separately; however, for practical reasons the facilities are collectively referred to as "Borger".

Source 1

- Name: Borger Carbon Black (Figure 2)
- Owner: Sid Richardson Carbon, LTD
- Facility function: electric generation
- Location: 35.66390, -101.43500, Texas Commission on Environmental Quality (TCEQ) Region 1, Hutchinson County, Texas
- SO_2 emissions data: 4,923 tons (2013), 4,862 tons (2014)
- Long-term emissions trend: decreasing, 46 percent (%) decrease from 2004 to 2014
- Emission profile: operational year-round
- Stack height: two stacks at 547 (m) and one stack at 132 m
- SO_2 emission controls: none
- Permit related data: Federal Operating Permit #1867A and Prevention of Significant Deterioration (PSD) permit #PSDTX1032

Source 2

- Name: Borger Carbon Black (Figure 3)
- Owner: Orion Engineered Carbons, LLC
- Facility function: chemical manufacturing
- Location: 35.66636, -101.43300, TCEQ Region 1, Hutchinson County, Texas
- SO_2 emissions data: 3,172 tons (2013), 3,027 (2014)
- Long-term emissions trend: increasing, 10% increase from 2010 to 2014
- Emission profile: operational year-round
- Stack height: one stack at 37 m, one stack at 30 m, and two stacks at 25 m
- SO_2 emission controls: none
- Permit related data: Federal Operating Permit #8780 and PSD # PSDTX416M1
-

Existing Air Monitoring Sites

The TCEQ operates six ambient air monitoring sites within a 70 kilometer (km) radius of Borger. Table 1 details the six closest monitoring sites in order of proximity. Maximum SO_2 ground level concentrations can be expected within close proximity to the sources. Although one of these locations is currently monitoring SO_2, none of the existing sites are positioned downwind or within reasonable proximity to the source to characterize maximum SO_2 concentrations

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Table 1: TCEQ Air Monitoring Sites Near Borger

Site	Distance From Borger	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013–2015)
Pantex 7	33 kilometers	No	Not applicable
Pantex 5	37 kilometers	No	Not applicable
Pantex 4	39 kilometers	No	Not applicable
Amarillo SH 136	50 kilometers	No	Not applicable
Amarillo 24th Avenue	54 kilometers	Yes	22 parts per billion
Amarillo A&M	67 kilometers	No	Not applicable

TCEQ – Texas Commission on Environmental Quality

Settings and Surroundings

The rural area surrounding Borger consists of the southwestern tablelands with elevations ranging from 933 to 1009 m as shown in Figure 1 (Griffith et al. 2004). This area is characterized by rugged terrain and is undeveloped, with no power accessibility. No significant changes to the landscape were noted during the reconnaissance as compared to the satellite view shown in Figure 9. Mountain and valley wind channeling, or other terrain related meteorological impacts are not expected in this area.

Harrington Station Power Plant (Harrington Station), located approximately 55 km southwest of Borger, has the potential to influence SO_2 concentrations in the Borger area under certain meteorological conditions. Harrington Station's SO_2 emissions were reported as 15,465 tons in 2014. Due to the site's location and the area's predominant southwesterly wind flow, it is anticipated that Harrington Station could impact SO_2 concentrations around the Borger area when winds are from the southwest (approximately 21% of the time according to the Hutchinson County Airport wind rose data; Figures 4 and 5).

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 1: Borger Area Elevation Map

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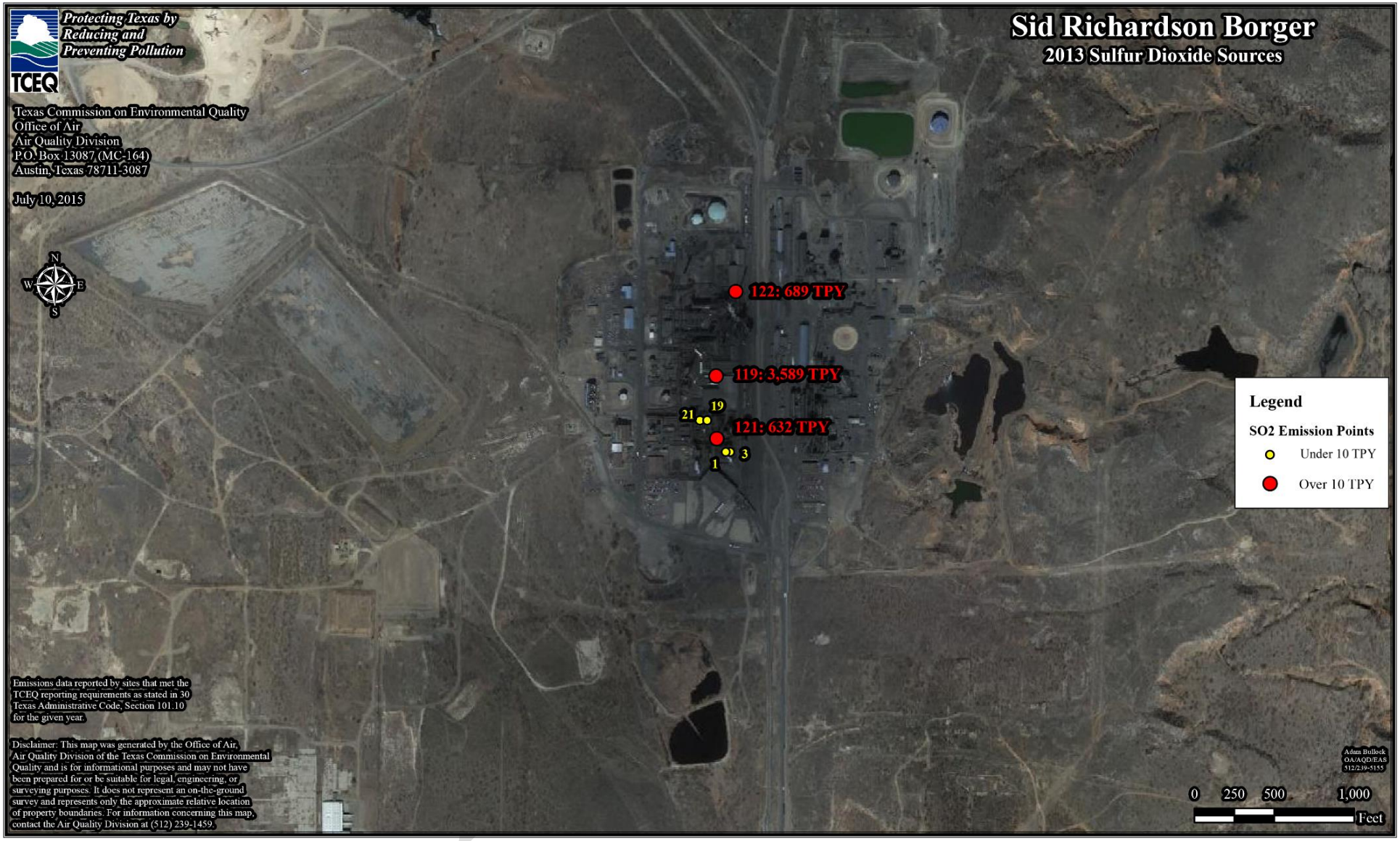

Figure 2: Borger (Sid Richardson) Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

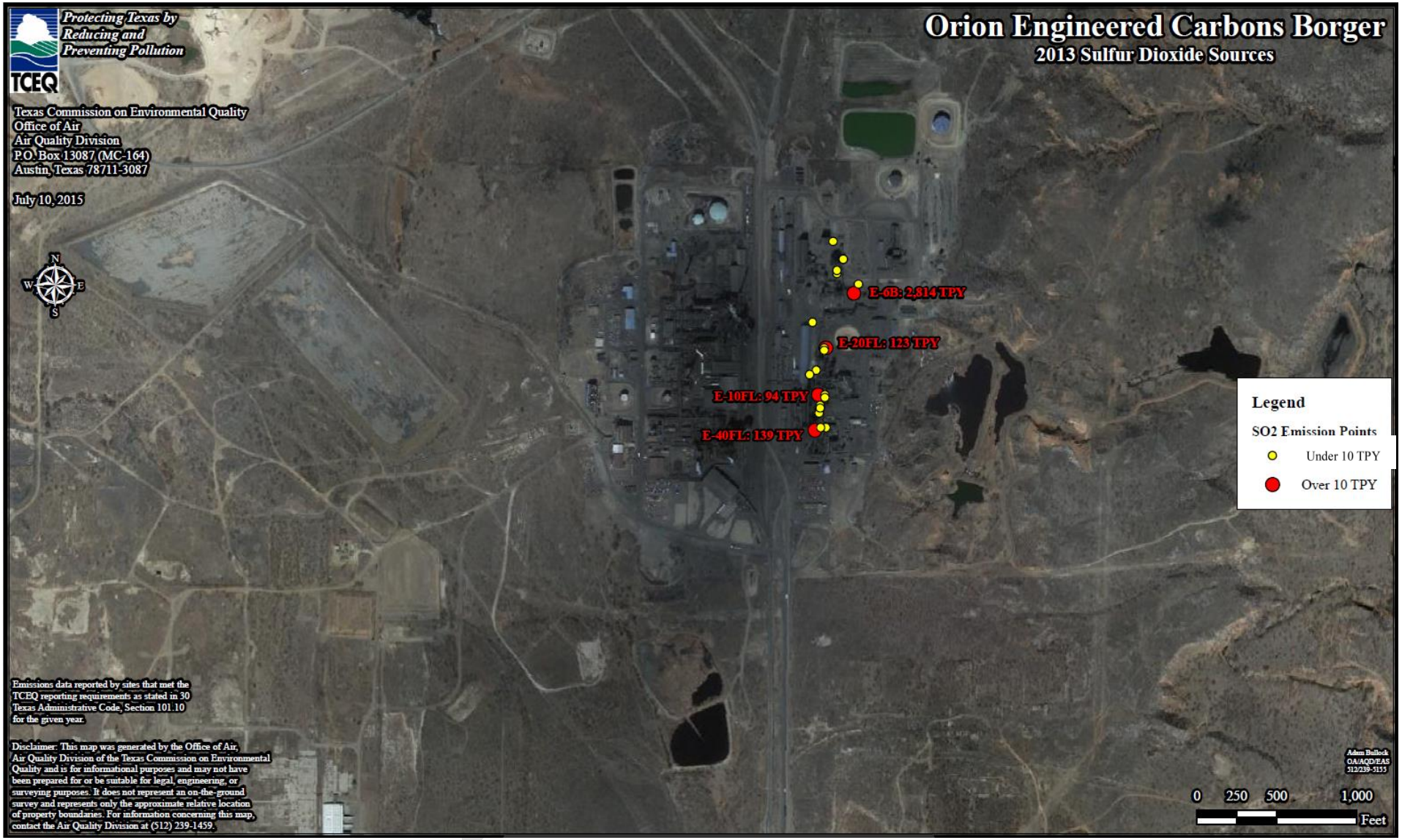

Figure 3: Borger (Orion) Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

Meteorological Data

Figure 4 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at Hutchinson County Airport, located 5 km northeast of Borger. Figure 5 illustrates the 2012-2014 annual average speed. The length of each wind rose bar corresponds to the frequency of the wind coming from indicated direction by percentage. Based on analysis of the 2012–2014 wind data, the dominant wind flow direction is 150 degrees southeast to 240 degrees west-southwest. Approximately 45% of the average area wind flows are from the dominant wind flow direction. Over this three year period, calm winds (0-2 miles per hour) occurred 9.7% of the time and wind speeds averaged 10.3 miles per hour (Iowa Environmental Mesonet 2016).

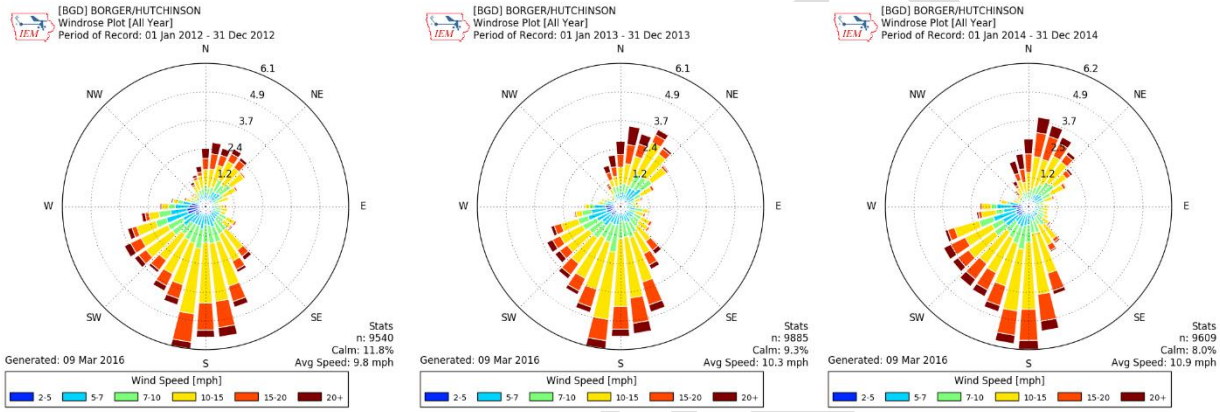

Figure 4: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

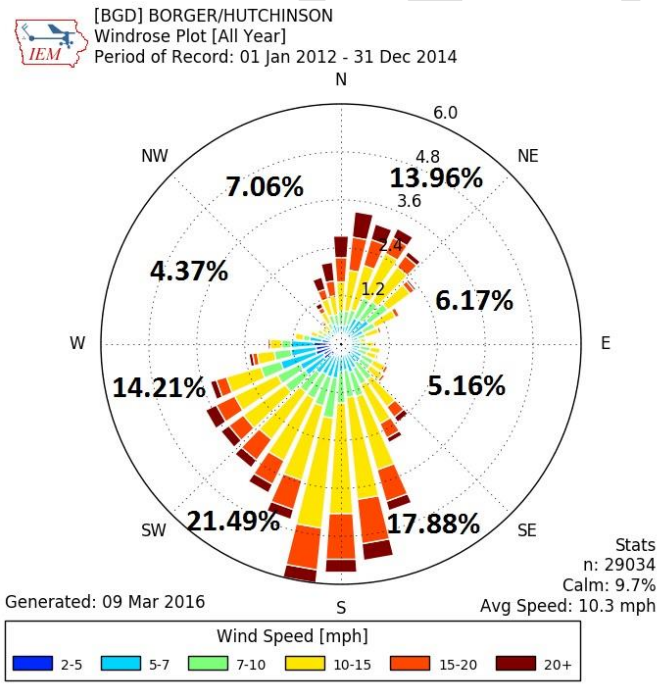

Figure 5: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx), with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the one kiln stack was modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.
-

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 4 and 5.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 6 graphically presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a "+" symbol. Borger permitted properties are outlined in black. Based on this analysis, the highest normalized concentrations, greater than 85% of the predicted off-property maximum, are expected to occur 1 km north of Borger. The viable monitor locations identified in Figure 6 as sites 9, 13, and 23 are within areas with predicted normalized concentrations between 65% and 80% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-

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property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 7 presents the geographic distribution of normalized frequency around Borger. Again, the location of the predicted off-property maximum is indicated by a "+" symbol, and the Borger permitted properties are outlined in black. Using this analysis metric, areas directly to the north of Borger scored greater than 70% and would be expected to see the highest frequency of elevated SO_2 concentrations. The areas directly to the north are not viable for monitor placement due to the undeveloped area, a lack of power sources, and no road access.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 8 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a "λ" symbol, and Borger permitted properties are outlined in black. As with the normalized 99th percentile and normalized frequency metrics, areas directly north of Borger scored greater than 90% using the composite metric. The TCEQ's site reconnaissance showed that this area is not a viable location for an air monitoring station due to undeveloped areas, a lack of power sources, and no road access.

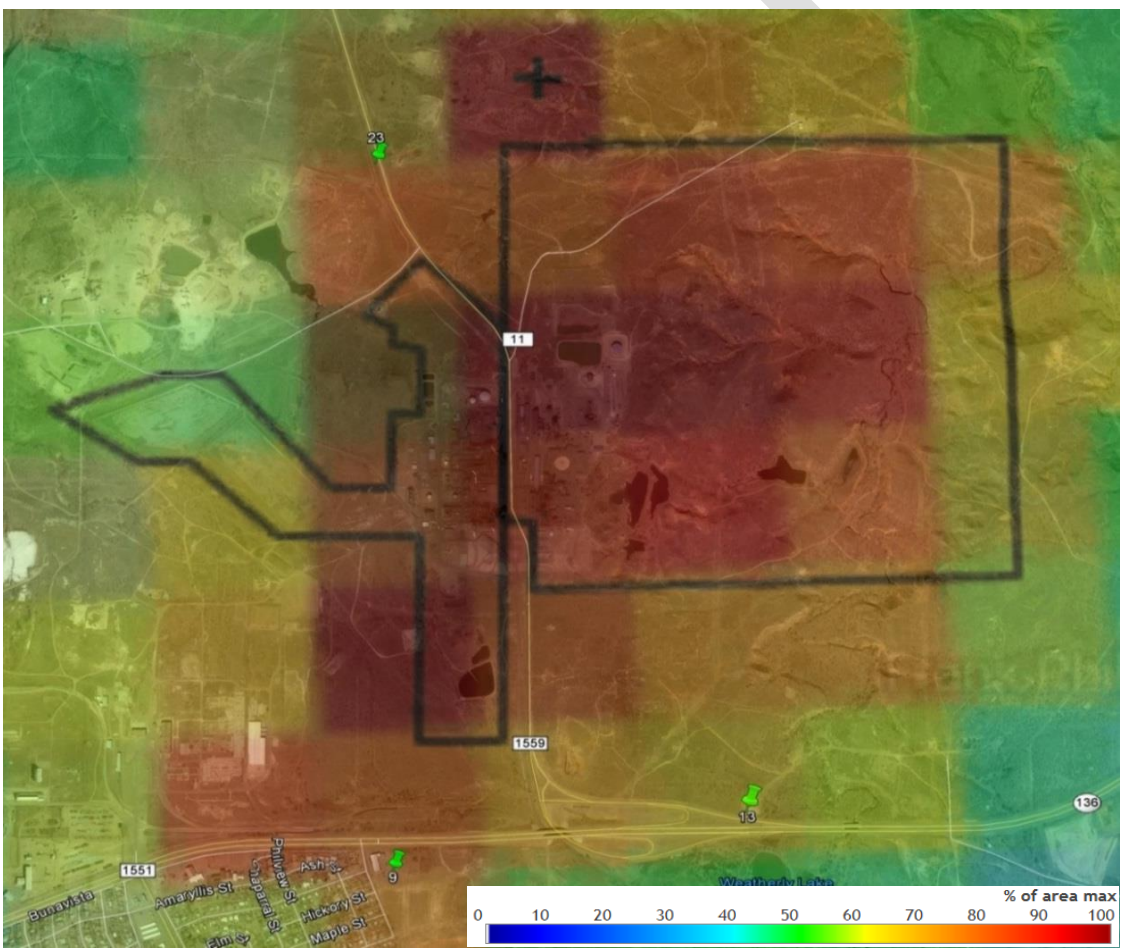

Figure 6: Borger Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Locations

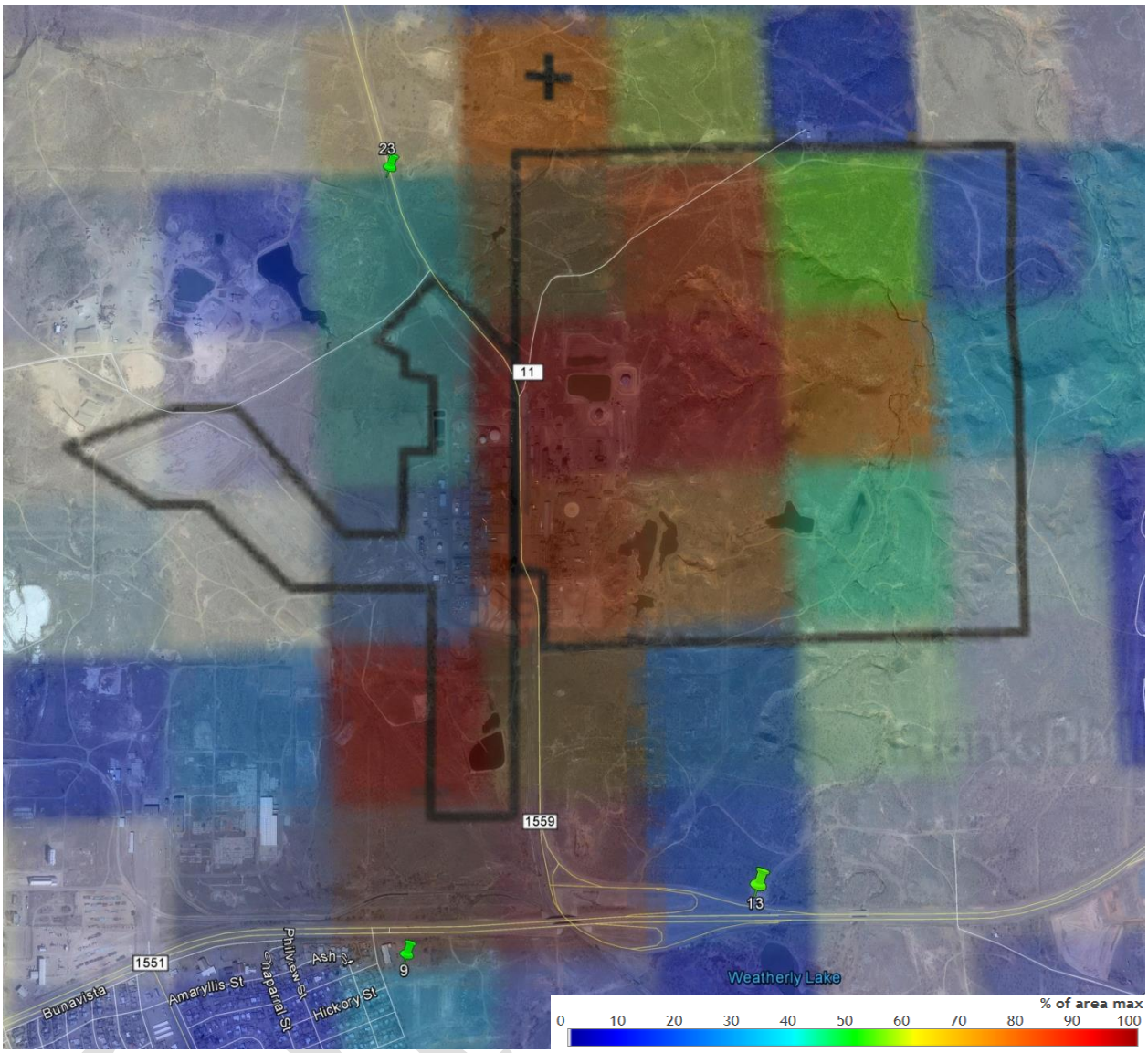

Figure 7: Borger Area CAMx Model Predictions, Normalized Frequency (Number of Days), and Viable Site Locations

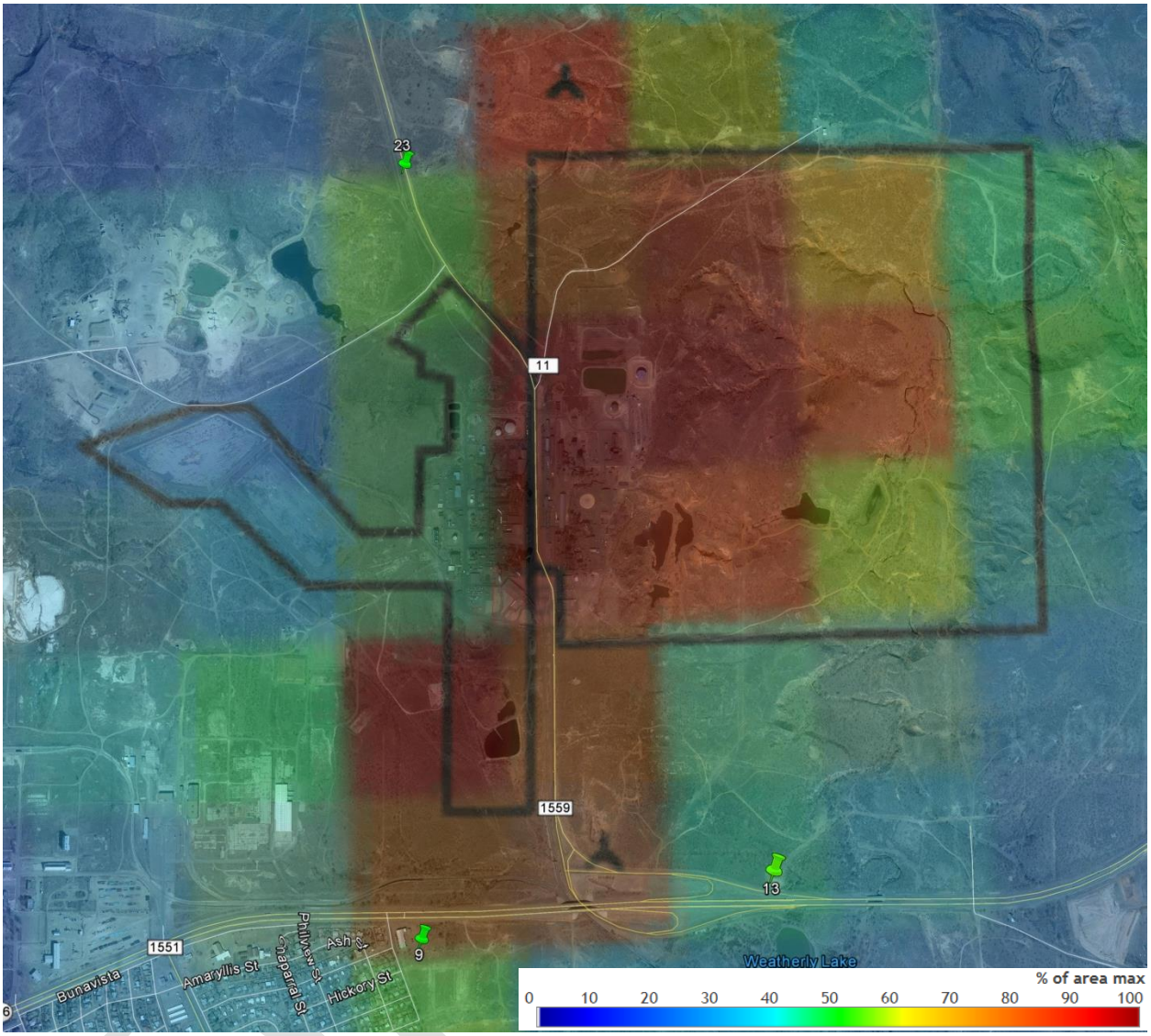

Figure 8: Borger Area CAMx Model Predictions Composite Metric and Viable Site Locations

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Borger that would be expected to characterize the highest SO_2 concentrations from these facilities; therefore, a new site is proposed. The TCEQ focused on complying with the federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach includes utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 6, 7, and 8 suggest that maximum SO_2 concentrations are expected to occur north of Borger. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected north of Borger. Upon completing field assessments north of Borger, the TCEQ determined that necessary power and vehicle access infrastructure to support a monitoring site was nonexistent in this area.

Twenty-three potential sites were identified as shown in Figure 9. Although the highest modeled concentrations are to the north of Borger, this area is undeveloped and lacks power sources. The TCEQ visited more developed areas to the east, for a broader availability of power sources and property owners. A summary of all potential sites is shown in Table 2. Twenty of the identified potential sites (1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, and 22) are not considered viable and are indicated by red pins in Figure 9. Property owners at sites 1, 11, 16, 18, and 22 declined to negotiate site agreements. Sites 2, 3, 4, 12, 15, and 17 were not downwind of Borger and had low SO_2 concentrations according to the modeling analyses. Sites 5, 6, 7, 10, 20, and 21 were not viable due to potential interference from other local SO_2 sources, such as a barbecue restaurant, a gas plant, and gas wells. Site 8, located approximately 1.6 km southwest from the source was prone to flooding. Site 14, located approximately 4.0 km northeast from the source had no available power. Site 19, located approximately 0.5 km northwest from the source, contained an uneven terrain and was prone to flooding. As a result, these potential sites are no longer under consideration.

The three sites with satisfactory logistical and siting characteristics, located in areas anticipated to have peak concentrations, are sites 9, 13, and 23. These site locations are identified with a green pin on the model and satellite image overlays shown in Figures 6, 7, 8, and 9.

- Site 9 is positioned approximately 1.5 km south-southwest of Borger. This site is downwind of Borger when winds flow from the north-northeast (approximately 19% of the time). It is on level ground and has available space and power. This site has trees in the area that would influence final monitor placement. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 75%-80% of maximum concentrations. The property owner is amenable to a site agreement.

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- Site 13 is positioned approximately 1.4 km south of Borger. This site is downwind of Borger when winds flow from the north-northwest (approximately 11% of the time). It is on level ground and has available space, power, a site pad, and an existing fence. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 55%-60% of maximum concentrations. A city owned utility building in the area would influence final monitor placement. The property owner is amenable to a site agreement
- Site 23 is positioned approximately 1.6 km northwest of Borger. This site is downwind of Borger when winds flow from the south-southeast (approximately 23% of the time). It is on level ground and has available space and power, as shown in Figure 10. Other areas within a 0.3 km radius were not considered viable due to the uneven terrain and a lack of available power sources. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 65%-70% of maximum concentrations. A site agreement has been negotiated with the property owner.

Recommendation

Due to the close proximity of Sid Richard Carbon, LTD and Orion Engineered Carbons, LLC, the TCEQ proposes one monitoring station for deployment to characterize ambient air quality surrounding these two sources. Based on property owner cooperation, proximity to the source, current facility operations, available emissions data, wind patterns, and modeling analyses, site 23 (see Figures 10 and 11) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. This site is indicated by a green pin in Figures 6, 7, 8, 9 and 11. Of the viable sites, site 23 is the only site located downwind of Borger. Therefore, the TCEQ expects that site 23 will receive higher levels of SO_2 concentrations than sites 9 and 13. Site 23 is located in an area with predicted maximum normalized SO_2 concentrations between 65% and 80%. The recommended site has available power, level ground, and meets all federal siting criteria. A site agreement has been negotiated with the property owner.

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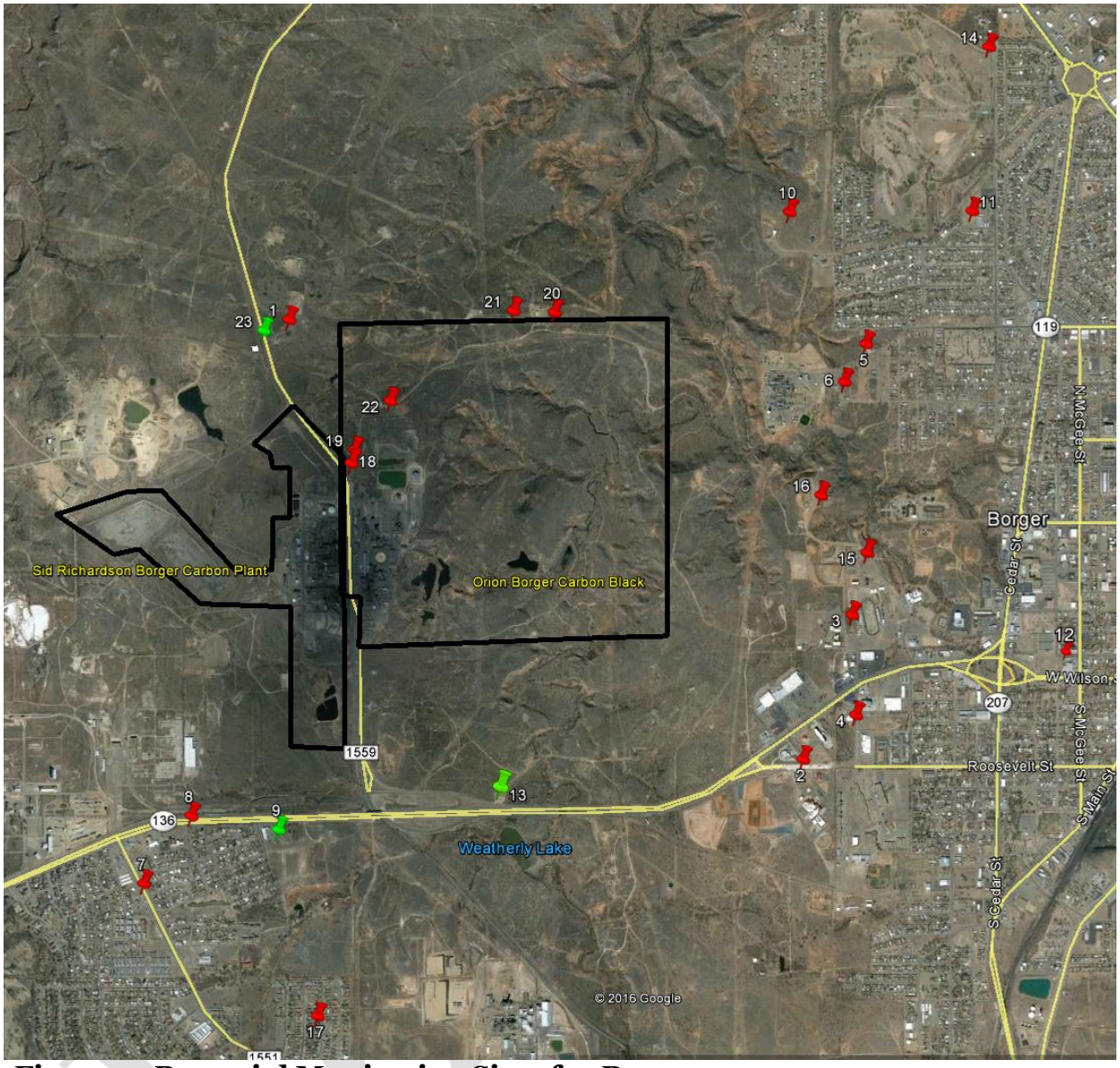

Figure 9: Potential Monitoring Sites for Borger

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	Borger #1	Borger #2	Borger #3
Location[2]	35.67678, -101.43972	35.65674, -101.40969	35.66283, -101.40707
Distance from SO_2 Source[2]	1,370 m	2,313 m	2,358 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	No (SE)	No (SE)
Obstructions and Height	None	None	Trees (3 m) Trees (7 m)
Distance from Site to Obstructions	None	None	Trees (10 m NW to dripline) Trees (7m SW to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	No	Yes	No
Pros	• Level ground • Downwind • High SO_2 modeling	• Level ground • Power available	• Level ground • Power available • Agreeable property owner
Cons	• No power • Difficult access • Property owner declined	• Not downwind • Low SO_2 modeling	• Not downwind • No power • Low SO_2 modeling
Viable Site (Yes, No, or Preferred)	No	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #4	Borger #5	Borger #6
Location[2]	35.65890, -101.40664	35.67550, -101.40591	35.67404, -101.40750
Distance from SO_2 Source[2]	2,468 m	2,661 m	2,625 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<1%	>2%	>1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	No (SE)	Yes (NNE)	Yes (NNE)
Obstructions and Height	Trees (12 m) Building (4 m)	None	Trees (3 m) Trees (5 m)
Distance from Site to Obstructions	Trees (22 m NW to dripline) Building (31 m N)	None	Trees (18 m SW to dripline) Trees (27 m NW to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	No	No	No
Pros	• Level ground	• Downwind	• Level ground • Downwind
Cons	• Not downwind • No power • Low SO_2 modeling	• No power • Possible interferences from local gas plant • Slight grade in surrounding area • Low SO_2 modeling	• No power • Possible interferences from local gas plant • Low SO_2 modeling
Viable Site (Yes, No, or Preferred)	No	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #7	Borger #8	Borger #9
Location	35.65117, -101.44652	35.65398, -101.44360	35.65380, -101.43882
Distance from SO_2 Source[2]	2,010 m	1,587 m	1,449 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<1%	<1%	<1%
Flood Plains	No	Yes	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	No (SW)	No (SW)	No (SW)
Obstructions and Height	Trees (4 m) Trees (6 m)	Trees (9 m)	Trees (10 m)
Distance from Site to Obstructions	Trees (13 m NW to dripline) Trees (18 m W to dripline)	Trees (17 m NE to dripline)	Trees (16 m E to dripline) Trees (6 m S to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Power available	• Level ground • Power available	• Level ground • Power available • Agreeable property owner • High SO_2 modeling
Cons	• Not downwind • Smoke from local restaurant may create interference • Low SO_2 modeling	• Not downwind • Smoke from local restaurant may create interference • Flood prone • Numerous pipelines underground • Low SO_2 modeling	• Not downwind • Local obstructions
Viable Site (Yes, No, or Preferred)	No	No	Yes

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #10	Borger #11	Borger #12
Location	35.67542, -101.40612	35.68162, -101.40040	35.66114, -101.39483
Distance from SO_2 Source[2]	2,740 m	3,799 m	3,805 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NNE)	Yes (NNE)	No (E)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	None	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Downwind • Power available	• Level ground • Downwind • Power available	• Level ground • Power available
Cons	• Possible interference from local gas plant • Low SO_2 modeling	• Property owner declined • Low SO_2 modeling	• Not downwind • Low SO_2 modeling
Viable Site (Yes, No, or Preferred)	No	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #13	Borger #14	Borger #15
Location	35.65547, -101.42660	35.68899, -101.39939	35.66806, -101.40916
Distance from SO_2 Source[2]	1,390 m	3,967 m	2,440 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	No (S)	Yes (NNE)	No (E)
Obstructions and Height	Building (3 m)	None	None
Distance from Site to Obstructions	Building (8 m E)	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Level ground • No pad or fence needed • Power available • Agreeable property owner • High SO_2 modeling	• Level ground • Downwind • Agreeable property owner	• Level ground • Power available • Agreeable property owner
Cons	• Not downwind • Local obstructions	• No power • Low SO_2 modeling	• Not downwind • Low SO_2 modeling
Viable Site (Yes, No, or Preferred)	Yes	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #16	Borger #17	Borger #18
Location	35.66879, -101.40861	35.64527, -101.43847	35.66806, -101.40916
Distance from SO_2 Source[2]	1,170 m	2,194 m	752 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	No (E)	No (S)	Yes (N)
Obstructions and Height	Trees (3 m)	None	None
Distance from Site to Obstructions	Trees (10 m to dripline)	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Power available	• Level ground • Power available	• Level ground • Downwind • Power available • Close proximity to source • High SO_2 modeling
Cons	• Not downwind • Property owner declined • Low SO_2 modeling	• Not downwind • Low SO_2 modeling	• Property owner declined
Viable Site (Yes, No, or Preferred)	No	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #19	Borger #20	Borger #21
Location	35.67075, -101.43464	35.67696, -101.42357	35.67703, -101.42583
Distance from SO_2 Source[2]	458 m	1,620 m	1,549 m
Wind Direction	S, SW	S, SW	S, SW
Grade	<2%	<1%	<1%
Flood Plains	Yes	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (NE)	Yes (NE)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	None	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	No	Yes	No
Pros	• Downwind • Close proximity to source • High SO_2 modeling • Agreeable property owner	• Level ground • Downwind • Power available • Agreeable property owner	• Level ground • Downwind • Agreeable property owner • High SO_2 modeling
Cons	• No power • Flood prone • High grade in surrounding area	• Possible interference from local gas well • Low SO_2 modeling	• Possible interference from local gas well • No power
Viable Site (Yes, No, or Preferred)	No	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Borger #22	Borger #23
Location	35.67296, -101.43266	35.67613, -101.43967
Distance from SO_2 Source[2]	1,035 m	1,060 m
Wind Direction	S, SW	S, SW
Grade	<1%	<1%
Flood Plains	No	No
Mountain/Valley Winds	None	None
Water Body Within 1,000 m	No	No
Wind Channeling	None	None
Downwind[2]	Yes (N)	Yes (NE)
Obstructions and Height	None	None
Distance from Site to Obstructions	None	None
Road/Site Access	Yes	Yes
Electricity Available <18 m	Yes	Yes
Pros	• Level ground • Downwind • Power available • Close proximity to source • High SO_2 modeling	• Level ground • Downwind • Power available • Agreeable property owner • High SO_2 modeling
Cons	• Property owner declined	• None
Viable Site (Yes, No, or Preferred)	No	Preferred

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
% – percent
N – north
S – south
E – east
W – west
NE – northeast
NNE – north-northeast
NW – northwest
SE – southeast
SW – southwest
m – meter
– number
< – less than
> – greater than
SO_2 – sulfur dioxide

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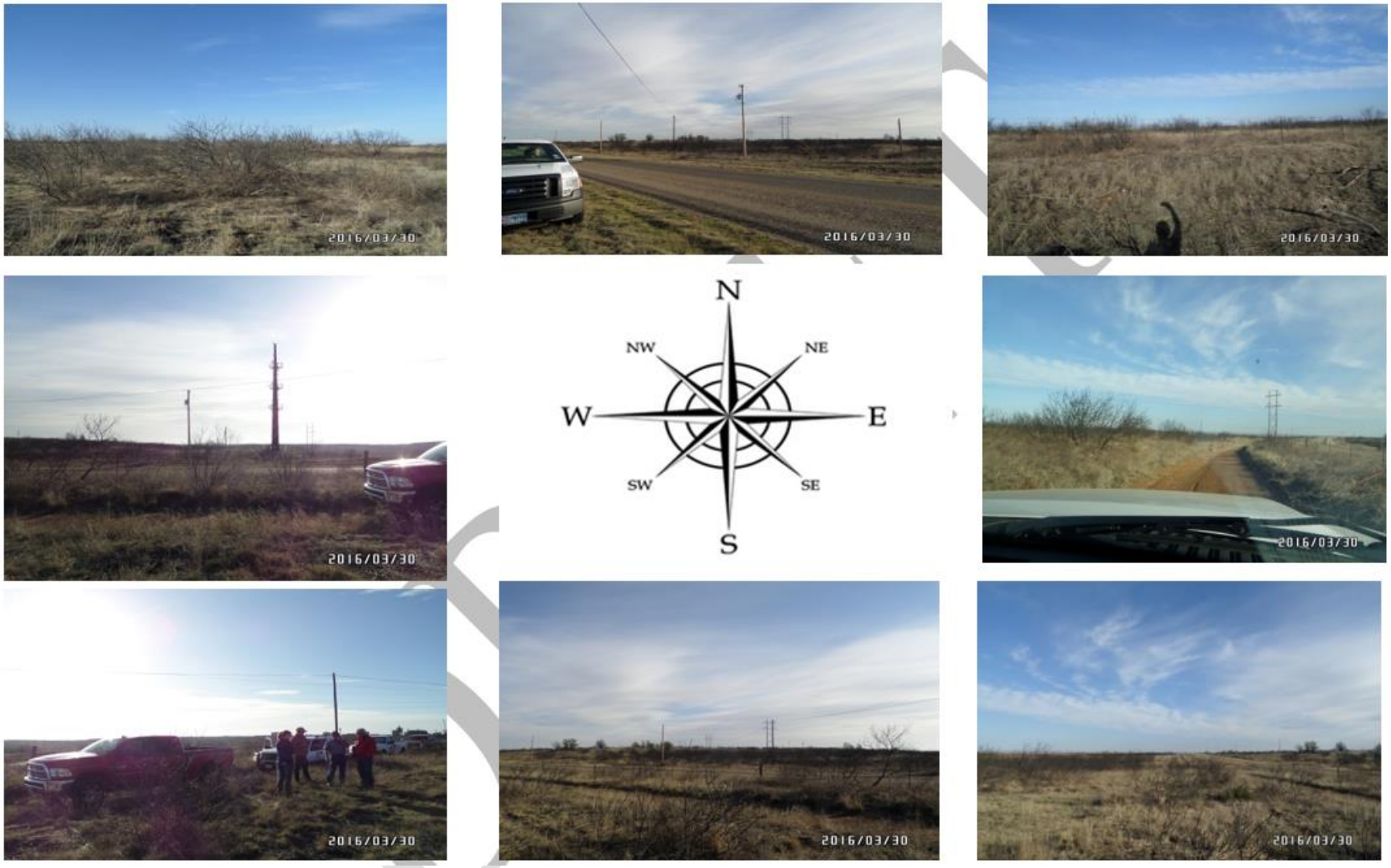

Figure 10: Borger #23 Preferred Site Cardinal Direction Photos

Figure 11: Borger Potential Site #23 Satellite Image

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. Ecoregions of Texas. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Oak Grove Monitor Placement Evaluation

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Oak Grove Steam Electric Station (Oak Grove) (Figure 2)
- Owner: Oak Grove Management Company, LLC
- Facility function: electric generation
- Location: 31.18208, -96.48806, Texas Commission on Environmental Quality (TCEQ) Region 9, Robertson County, Texas
- Sulfur dioxide (SO_2) emissions data: 6,950 tons (2013), 7,404 tons (2014)
- Long-term emissions trend: increasing, 205 percent (%) increase from 2010 to 2014
- Emission profile: operational year-round
- Stack height(s): two stacks 137 meters (m) high, currently active
- SO_2 emission controls: none
- Permit related data: New Source Review permit, Permit By Rule permit

Existing Air Monitoring Sites

The TCEQ operates three ambient air monitoring sites within a 100 kilometer (km) radius of Oak Grove. Table 1 details the three closest monitoring sites in order of proximity. Maximum SO_2 ground level concentrations can be expected close to the source. Although three of these locations are currently monitoring SO_2, none of the existing sites are within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air Monitoring Sites Near Oak Grove

Site	Distance from Oak Grove	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013–2015)
Waco Mazanec	76 km northwest	Yes	7 parts per billion (ppb)
Temple Georgia	90 km west	No	Not applicable
Corsicana Airport	94 km north	Yes	39 ppb

km – kilometer

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Settings and Surroundings

The primarily rural area surrounding Oak Grove is located in the northern portion of the Southern Post Oak Savanna ecoregion of the East Central Texas Plains. This area is characterized by a mix of post oak woods, improved pasture, and rangeland (Griffith et al. 2004). The elevation ranges from 156 to 159 m as shown in Figure 1. The area is speckled with inactive oil and gas drilling pad sites with no access to power (Figure 8). No significant changes to the landscape were noted during the reconnaissance as compared to the satellite image shown in Figure 8. Due to the general lack of geographical obstructions and thick elevated vegetation, wind patterns are highly consistent across the Central Texas area. Mountain and valley wind channeling, or other terrain related meteorological impacts, are not expected in this area.

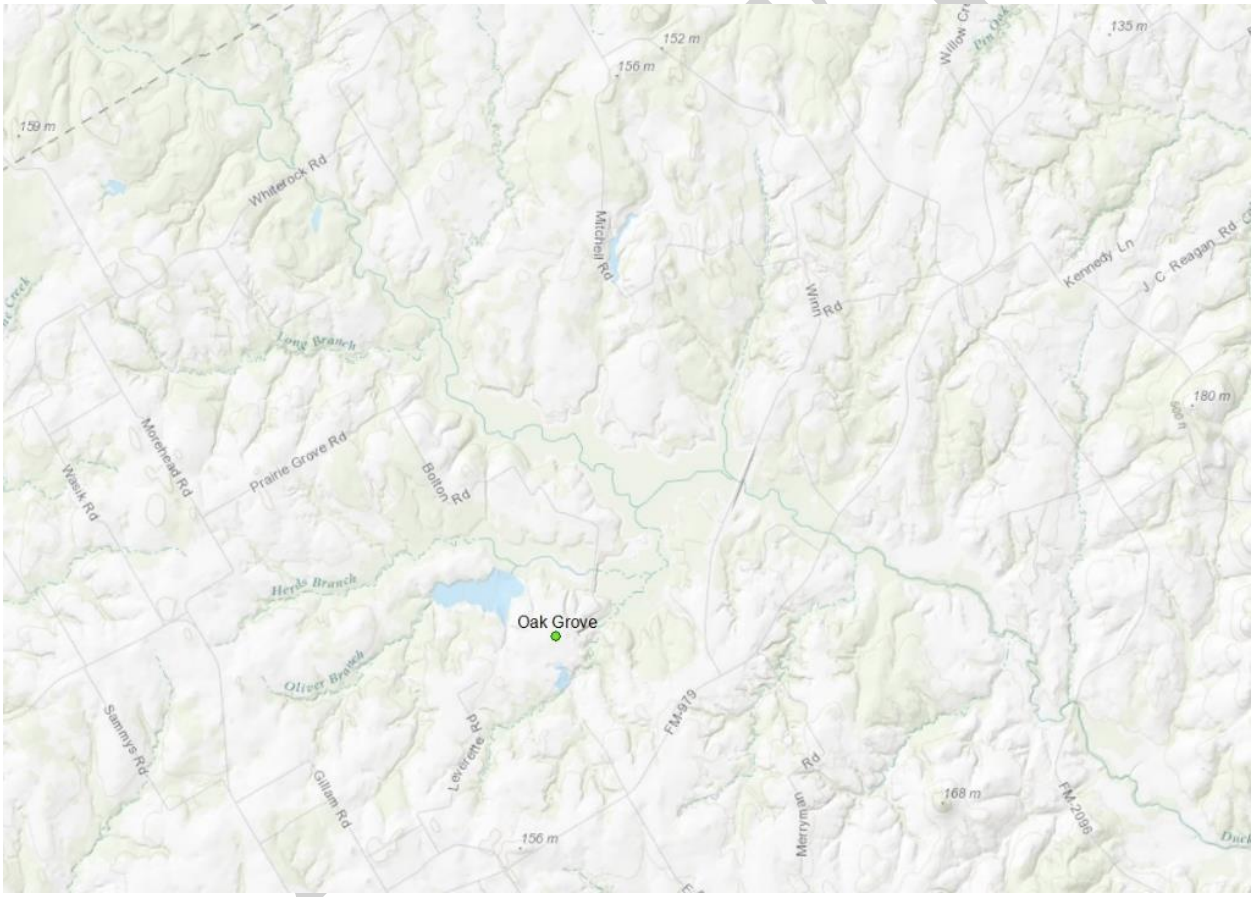

Figure 1: Oak Grove Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 2: Oak Grove Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at Hearne Airport, located 35 km southwest of Oak Grove. Figure 4 illustrates the 2012-2014 annual average wind speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on the analysis of the 2012-2014 wind data, the dominant wind flow direction for the area is 115 degrees southeast to 175 degrees south. Approximately 42% of the average area wind flows move from these directions. Over this three year period, calm winds (0-2 miles per hour) occurred on average 28.5% of the time, and wind speeds averaged 7.2 miles per hour (Iowa Environmental Mesonet 2016).

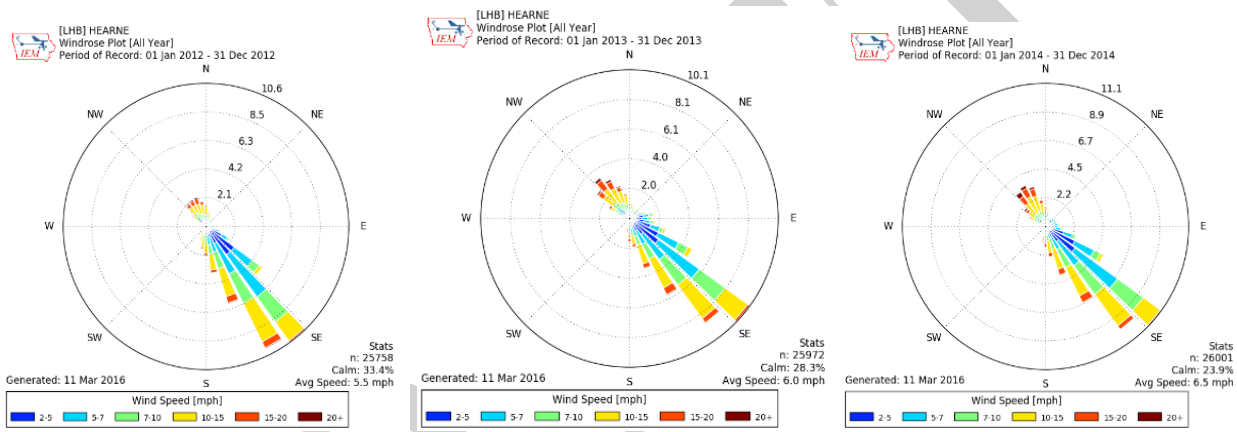

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

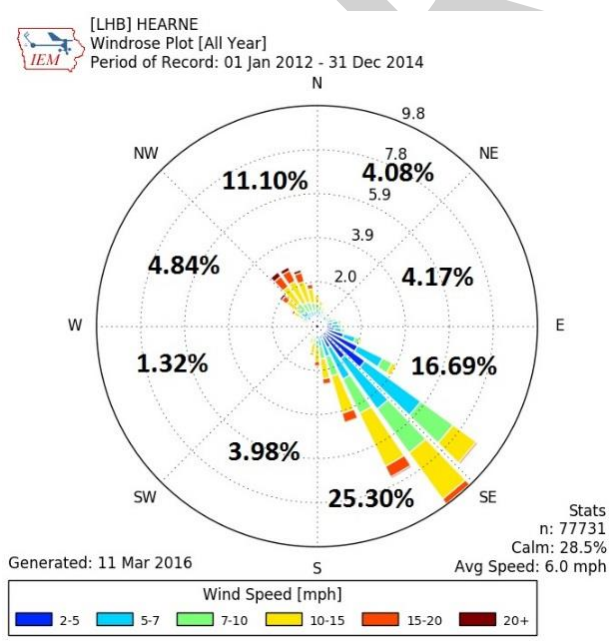

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the two kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a "+" symbol. Oak Grove's permitted property is outlined in black. Based on this analysis, the highest normalized concentrations, greater than 95% of the predicted off-property maximum, are expected to occur 2.6 km south of the Oak Grove facility; 0.3 km from the southern property line. Approximately 1.7 km northeast of the predicted off-property maximum is the proposed monitor location identified in Figure 5 as site 6. This site is in an area of predicted normalized concentrations within 50% to 55% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the

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99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around Oak Grove. Again, the location of the predicted off-property maximum is indicated by a "+" symbol, and Oak Grove's permitted property is outlined in black. Using this analysis metric, the same area 2.6 km south of the facility scored greater than 95% and would be expected to see the highest frequency of elevated SO_2 concentrations.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a "λ" symbol, and Oak Grove's permitted property is outlined in black. As with the normalized 99th percentile and normalized frequency metrics, the same area south of the Oak Grove facility scored greater than 95% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did not yield a viable location for monitor placement as amenable property owners were not located in these areas.

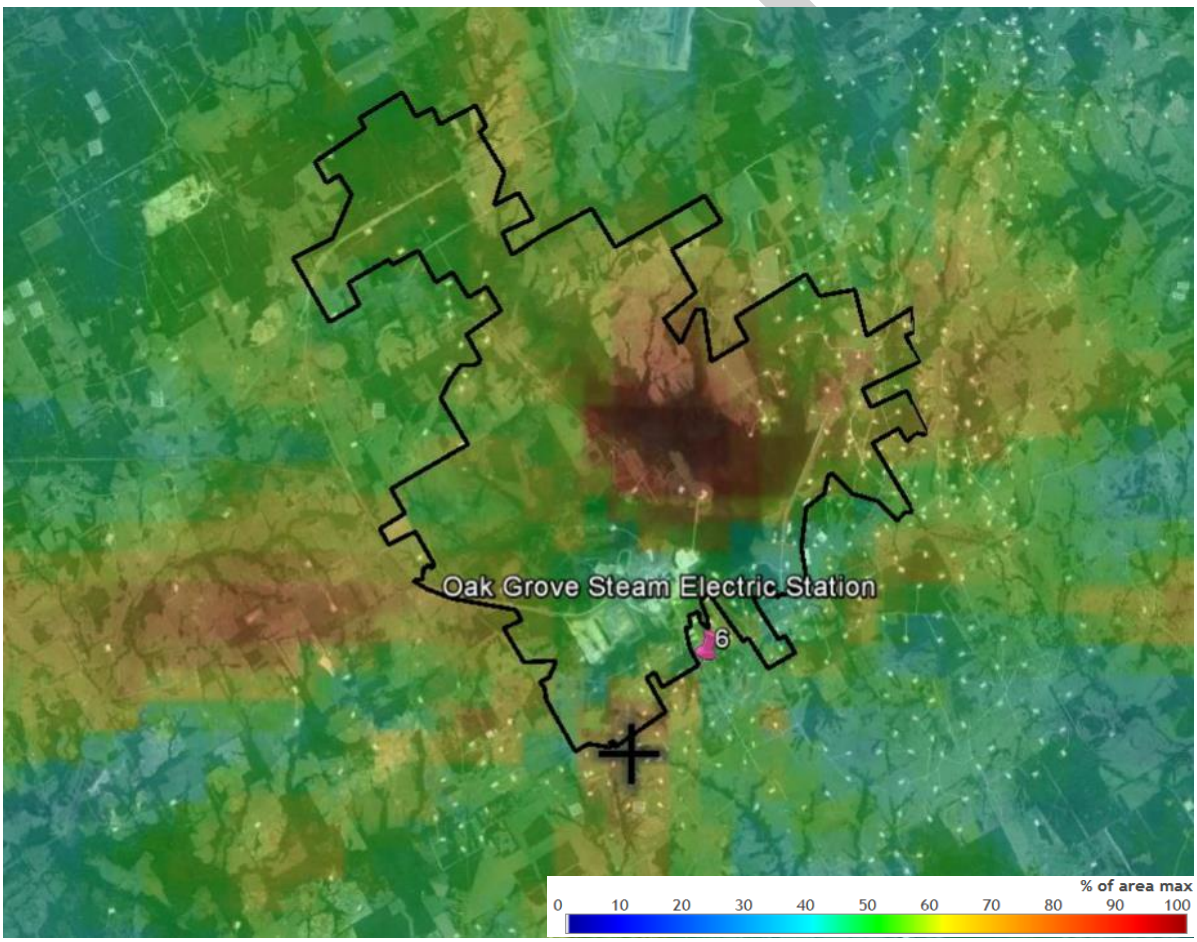

Figure 5: Oak Grove Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Location 6

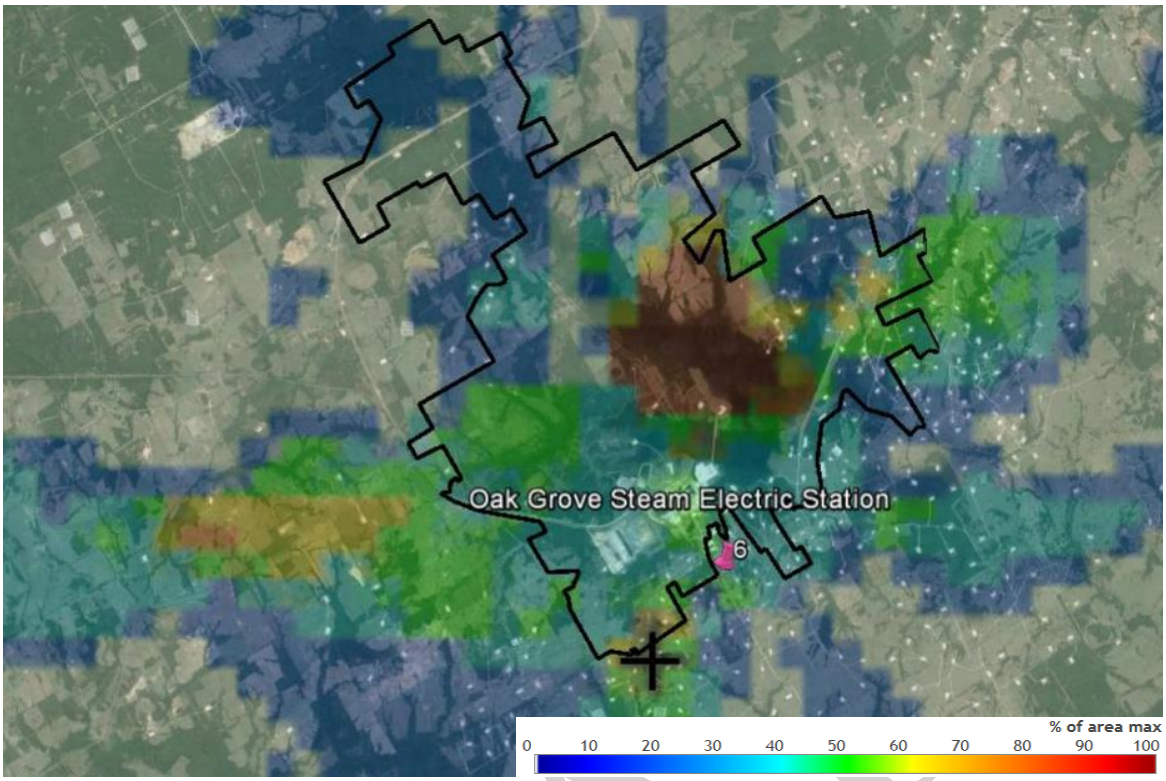

Figure 6: Oak Grove Area CAMx Model Predictions, Normalized Frequency (Number of Days), and Viable Site Location

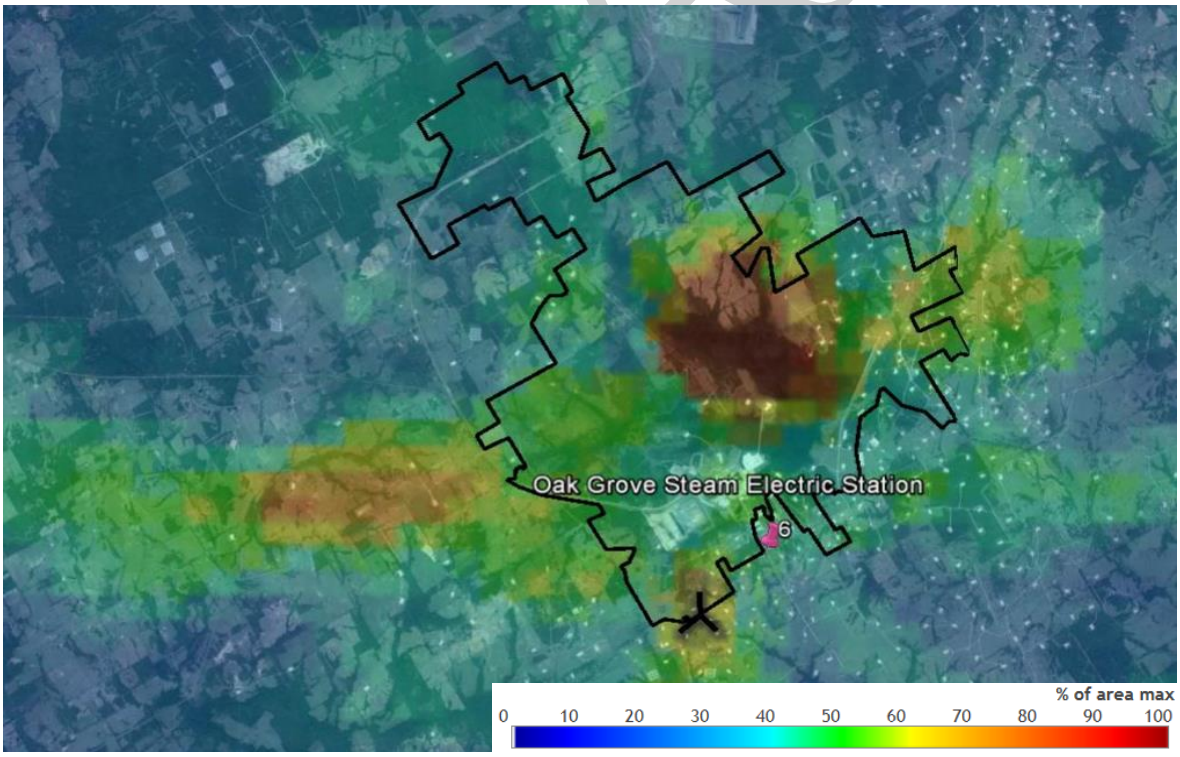

Figure 7: Oak Grove Area CAMx Model Predictions Composite Metric and Viable Site Location

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Oak Grove that would be expected to characterize the highest SO_2 concentrations from this facility, therefore, a new site is proposed. The TCEQ focused on complying with the federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach included utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 5, 6, and 7 suggest that off-property maximum SO_2 concentrations are expected to occur south of the Oak Grove facility. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected south of Oak Grove. Figure 8 depicts all potential site locations (yellow, red, and pink pins), their corresponding private property lines (yellow), and the facility property line (black). A total of 25 potential sites were identified as shown in the figure. Upon first contact, property owners at sites 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, and 25 (yellow pins) all refused any monitor placements, or their property was unsuitable. Therefore, no reconnaissance was performed in these locations, and they do not appear in Table 2. More detailed reconnaissance was performed at all other potential sites (red and pink pins). Six of the identified potential sites (1, 2, 3, 4, 5, and 8) are not considered viable; they are indicated by red pins. Site 1 is in an area with restricted access and the property owner was unresponsive. Property owners at sites 2, 3, and 4 were unwilling due to the obstruction a site would create. Site 5 is not considered viable due to lack of power on the property. After consideration, the property owner of Site 8 declined an air monitoring station on the property. As a result, these potential sites are no longer under consideration.

The one site with satisfactory logistical and siting characteristics is site 6. Site 6 is located in an area anticipated to experience elevated SO_2 concentrations and is indicated by a pink pin in Figures 5, 6, 7, and 8. Site 6 is positioned approximately 1.48 km south-southeast of the Oak Grove facility. This site is downwind of the source when winds are from the northwest, 15.9% of the year on average (see Figure 4). The site offers level ground, adequate space, available power, and is close to the source (see section "Recommendation" and Table 2), which is a benefit during calm conditions. The normalized 99th percentile concentration metric analysis predicted area concentrations in this area to be 45-50% of the maximum concentrations. A site agreement has been negotiated with the property owner.

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Recommendation

Based on current facility operations, available emission data, wind patterns, logistics, and modeling analyses, site 6 (Figures 9 and 10) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. The most influential factors constraining site placement for Oak Grove were averse property owners and logistics (e.g., property access and electricity). Property owners in areas where modeling predicted the highest concentrations (sites 7, 8, 9, 10, 11, and 16) all declined to negotiate site agreements. Additional locations were considered based on wind rose data but were either logistically unsuitable or property owners declined (sites 1, 2, 3, 4 and 5).

Historical meteorological data from 2012-2014 (Figure 4) show the area around site 6 experiences calm conditions an average of 28.5% of the year and is downwind of Oak Grove during northwesterly winds 15.9% of the year. Combined, calm or northwesterly wind conditions occurred an average of 44.4% annually, a greater percentage of time than prevailing wind patterns (42%). Site 6 is the closest viable location to the source (1.4 km) and the predicted off-property maximum normalized SO_2 concentrations with available power, adequate space, level ground, and meets all federal siting criteria. A site agreement has been negotiated with the property owner.

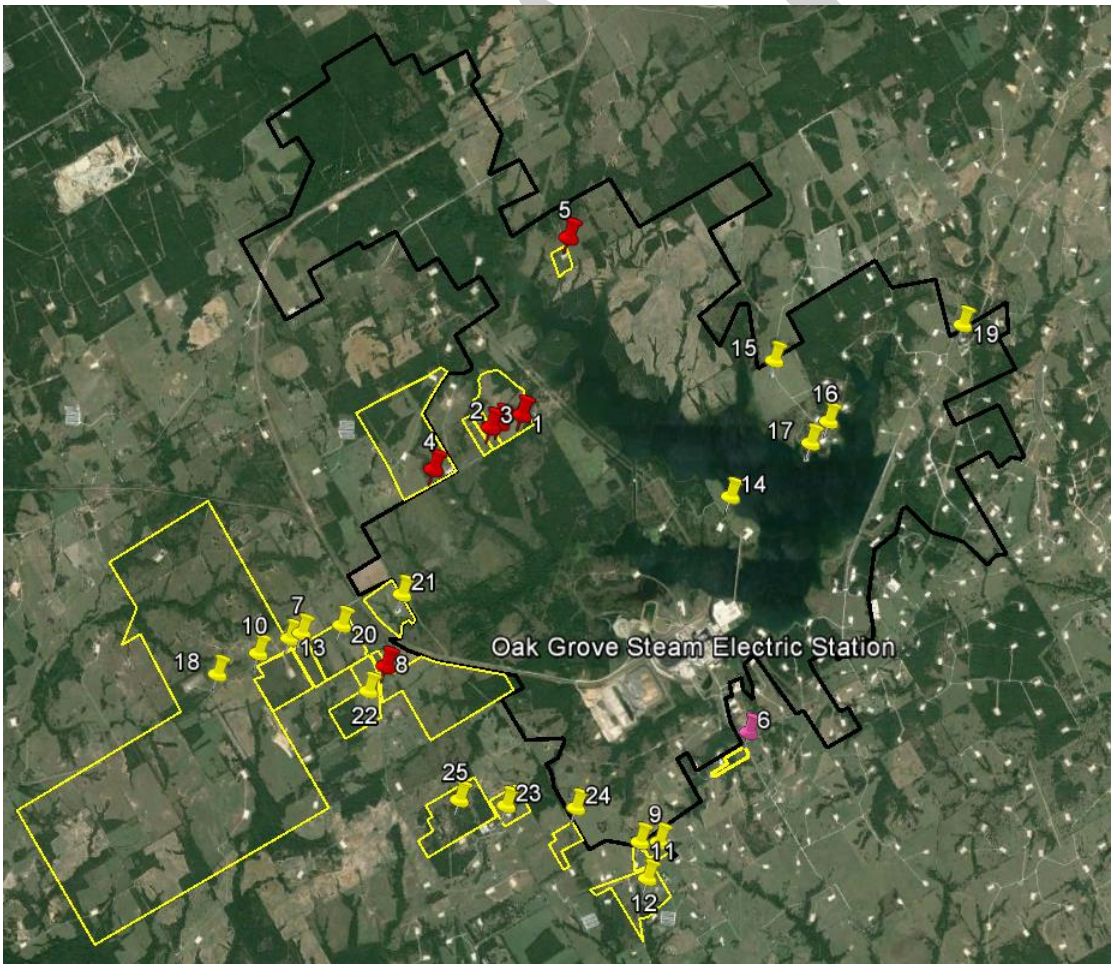

Figure 8: Potential Monitoring Sites for Oak Grove

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	Oak Grove #1	Oak Grove #2	Oak Grove #3
Location[2]	31.20789, -96.51338	31.20619, -96.51809	31.20628, -96.51869
Distance from SO_2 Source[2]	3,728 m	3,842 m	3,885 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; reservoir (E)	None	None
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Trees (20 m)	Trees (4 m, 30 m)	Trees (4 m, 30 m)
Distance from Site to Obstructions	Trees (30 m E, SW)	Trees (23 m E, 64 m SE, 28-50 m S, 8 m SW)	Trees (23 m E, 64 m SE, 28-50 m S, 8 m SW)
Road/Site Access	No	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Level ground • Power available • Downwind	• Level ground • Downwind	• Level ground • Power available • Space available • Downwind
Cons	• Unresponsive property owner • No site access • Requires new road construction	• Property owner declined • Requires work to access electricity • Local obstructions	• Property owner declined • Local obstructions
Viable Site (Yes, No, or Preferred)	No	No	No

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Oak Grove #4	Oak Grove #5	Oak Grove #6
Location[2]	31.20115, -96.52689	31.22970, -96.50714	31.16895, -96.48191
Distance from SO_2 Source[2]	4,165 m	5,570 m	1,483 m
Wind Direction	S, SE	S, SE	S, SE
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	Yes; lake (S)	Yes; lake (N)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	No (SSE)
Obstructions and Height	Trees (10 m, 15 m)	Trees (6 m, 7 m, 10 m)	Trees (5 m, 12 m)
Distance from Site to Obstructions	Trees (36 m S, 46 m SE, 70 m E)	Trees (30 m W, E, NNE) Tanks (38 m SE)	Trees (12 m W, 40 m N)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	No	Yes
Pros	• Level ground • Power available • Downwind • Space available	• Level ground • Downwind	• Level ground • Power available • Space available • Strong cell phone signal • Agreeable property owner
Cons	• Property owner declined	• Power unavailable • Existing oil and gas site	• Not downwind
Viable Site (Yes, No, or Preferred)	No	No	Preferred

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Oak Grove #8
Location[2]	31.17705, -96.53370
Distance from SO_2 Source[2]	4,383 m
Wind Direction	S, SE
Grade	<1%
Flood Plains	No
Mountain/Valley Winds	None
Water Body Within 1,000 m	None
Wind Channeling	None
Downwind[2]	No (W)
Obstructions and Height	Trees (12 m)
Distance from Site to Obstructions	Trees (34 m SE)
Road/Site Access	Yes
Electricity Available <18 m	No
Pros	• Level ground • Power available • Space Available
Cons	• Property owner declined • Not downwind
Viable Site (Yes, No, or Preferred)	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
E – east
m – meter
N – north
NE – northeast
NW – northwest
S – south
SE – southeast
SO_2 – sulfur dioxide
SW – southwest
W – west
> – greater than
< – less than
– number
% – percent

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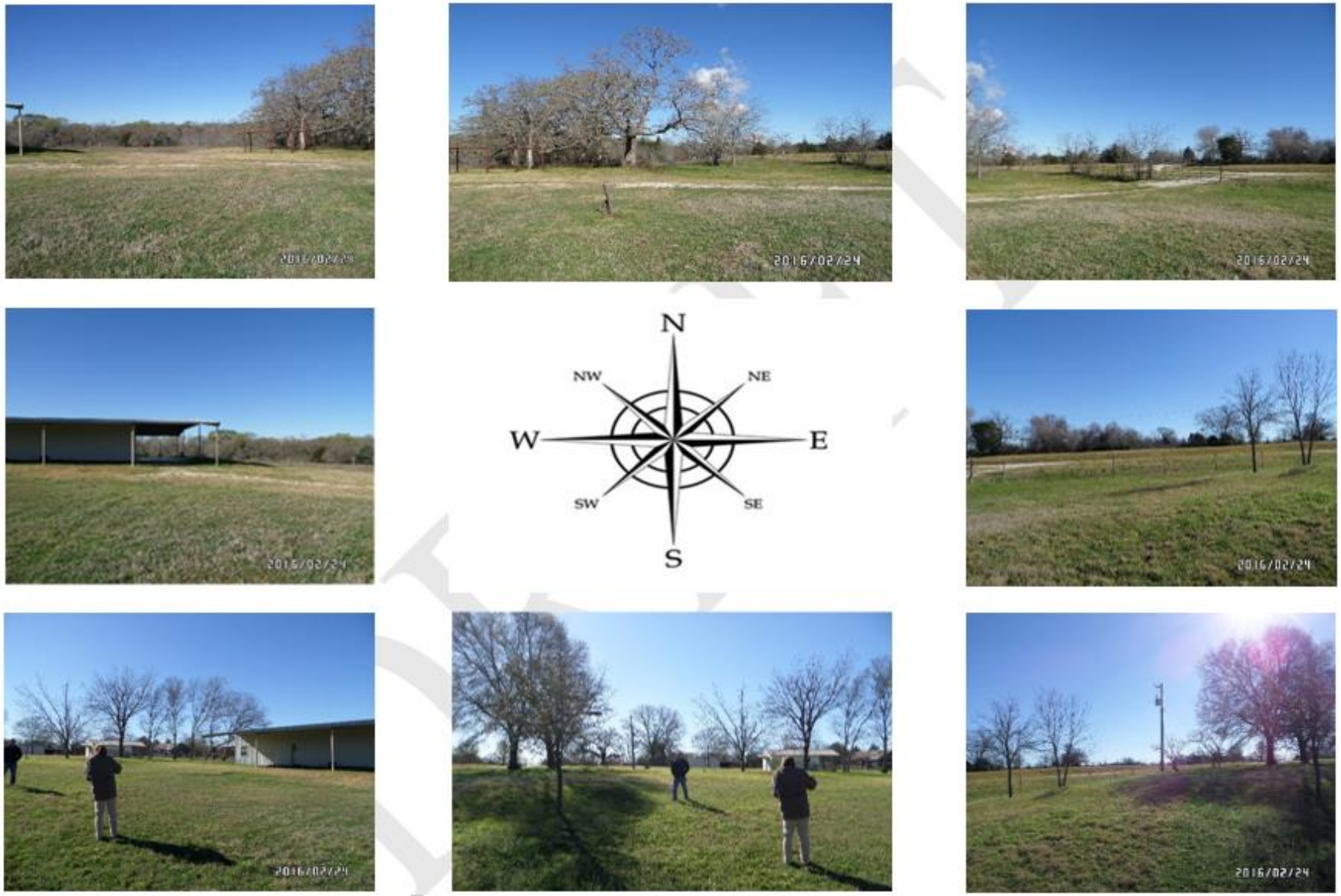

Figure 9: Oak Grove Potential Site #6 Cardinal Direction Photos

Figure 10: Oak Grove Potential Site #6 Satellite Image

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS

Orion Echo Carbon Black Plant Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Orion Echo Carbon Black Plant (Orion Echo) (Figure 2)
- Owner: Orion Engineered Carbons, Limited Liability Company (LLC)
- Facility function: chemical manufacturing
- Location: 30.15245, -93.72090, Texas Commission on Environmental Quality (TCEQ) Region 10, Orange County, Texas
- Sulfur dioxide (SO_2) emission data: 4,132 tons (2013), 4,255 tons (2014)
- Long-term emissions trend: decreasing, 23 percent (%) decrease from 2004 through 2014
- Emission profile: operational year-round
- Stack height(s): 10 stacks over 10 tons per year, 31-50 meters (m) high, with 11 currently active sources
- SO_2 emission controls in place: none
- Permit related data: Federal Operating Permit, Prevention of Significant Deterioration (PSD) permit #PSDTX627M2

Existing Air Monitoring Sites

The TCEQ operates four ambient air monitoring sites within a 30 kilometer (km) radius of Orion Echo. Table 1 details the four closest monitoring sites in order of proximity. Maximum SO_2 ground level concentrations can be expected within close proximity to the source. None of the existing sites monitor for SO_2, and none are positioned downwind or within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air Monitoring Sites Near Orion Echo

Site	Distance From Orion Echo	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2012-2015)
West Orange	8.3 km southwest	No	Not applicable
SETRPC 42 Mauriceville	14.3 km northwest	No	Not applicable
Groves	27 km southwest	No	Not applicable
Port Neches Avenue L	29 km southwest	No	Not applicable

km – kilometer
SETRPC – South East Texas Regional Planning Commission

Settings and Surroundings

The Texas Gulf Coast includes the relatively flat Gulf Coastal Plains as shown in Figure 1. The prairies transition to the Interior Coastal Plains just west of Corpus Christi, Houston, and Beaumont-Port Arthur. These plains reach a maximum elevation of 800 feet and are marked by more forested vegetation and river valleys (Wermund 1996). The area surrounding Orion Echo contains dense forests and swampland. No significant changes to the landscape were noted during the reconnaissance as compared to the satellite view in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area.

The Temple-Inland Paper Mill (Temple-Inland) located approximately 7 km north-northwest of Orion Echo, has the potential to influence SO_2 concentrations in the Orion Echo area under certain meteorological conditions. Temple-Inland's SO_2 emissions were reported as 1,756 tons in 2014. Due to the site's location and the area's southeasterly wind flow, it is anticipated that Temple-Inland could impact SO_2 concentrations in the Orion Echo area when winds are from the northwest (approximately 7% of the time according to the Orange County Airport wind rose data; Figures 3 and 4).

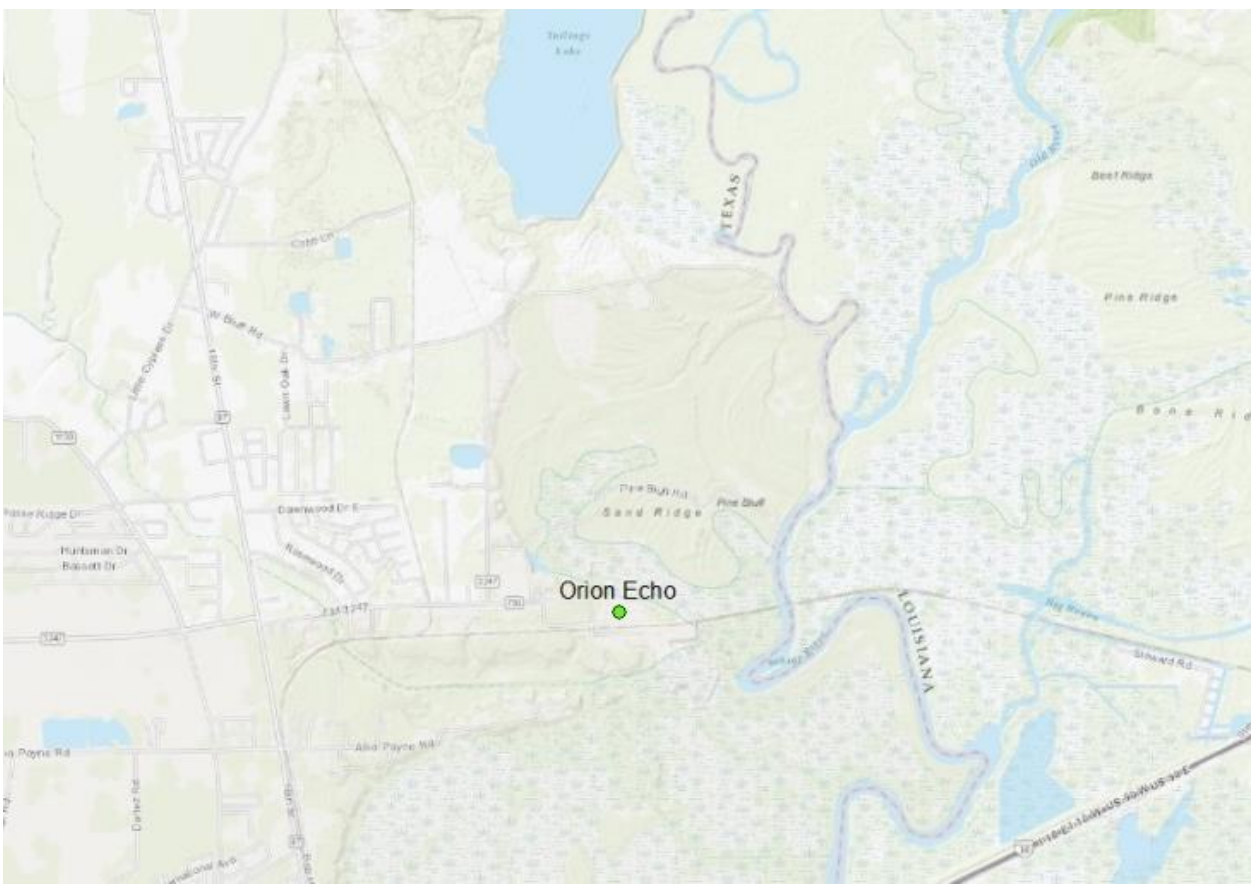

Figure 1: Orion Echo Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 2: Orion Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Orange County Airport, located 12 km southwest of Orion Echo. Figure 4 illustrates the 2012-2014 annual average wind speed and direction. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012-2014 wind data, the dominant wind flow direction is 135 degrees southeast to 205 degrees south-southeast. Approximately 26% of average annual wind flows are from the dominant wind flow direction. Over this three year period, calm winds (0-2 miles per hour) occurred 27% of the time, and wind speeds averaged 5.4 miles per hour (Iowa Environmental Mesonet 2016).

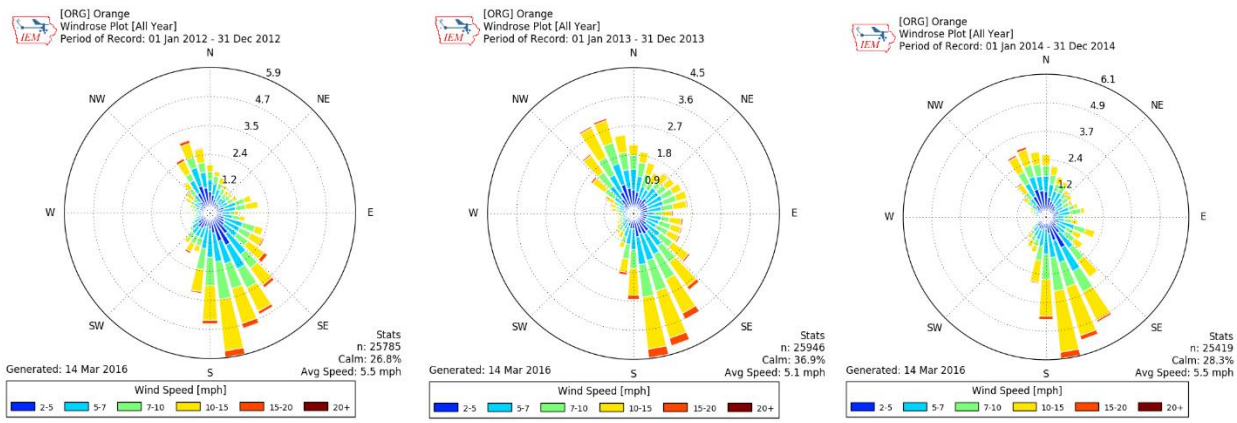

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

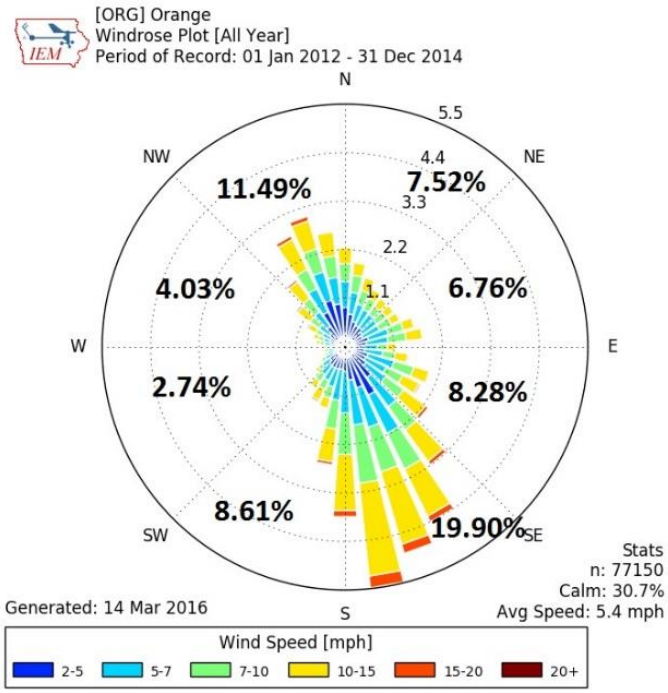

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-m PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a "+" symbol. Orion Echo's permitted property is outlined in black. Based on this analysis, the highest normalized concentrations, greater than 80% of the predicted off-property maximum, are expected to occur in the area approximately 0.8 km to the north of Orion Echo in a densely forested region. Swamps and dense vegetation make the area directly to the north of Orion Echo an unsuitable location to deploy an air monitoring station. The proposed monitor location identified within Figure 5 as site 21 is in an area of 75%-85% of predicted normalized off-property maximum concentrations. Site 21 is located 0.9 km southwest of the predicted off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the

99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around Orion Echo. Again, the location of the predicted off-property maximum is indicated by a "+" symbol, and Orion Echo permitted property is outlined in black. Using this analysis metric, areas directly to the north of Orion Echo scored greater than 80% and would be expected to see the highest frequency of elevated SO_2 concentrations. This area, within Orion Echo property along with areas directly to the north, is not viable due to dense vegetation and swamps.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a "λ" symbol, and Orion Echo permitted property is outlined in black. As with the normalized 99th percentile and normalized frequency metrics, areas within Orion Echo permitted property and areas directly to the north scored greater than 80% using the composite metric. Areas with a high composite metric were not viable due to dense vegetation and swamps.

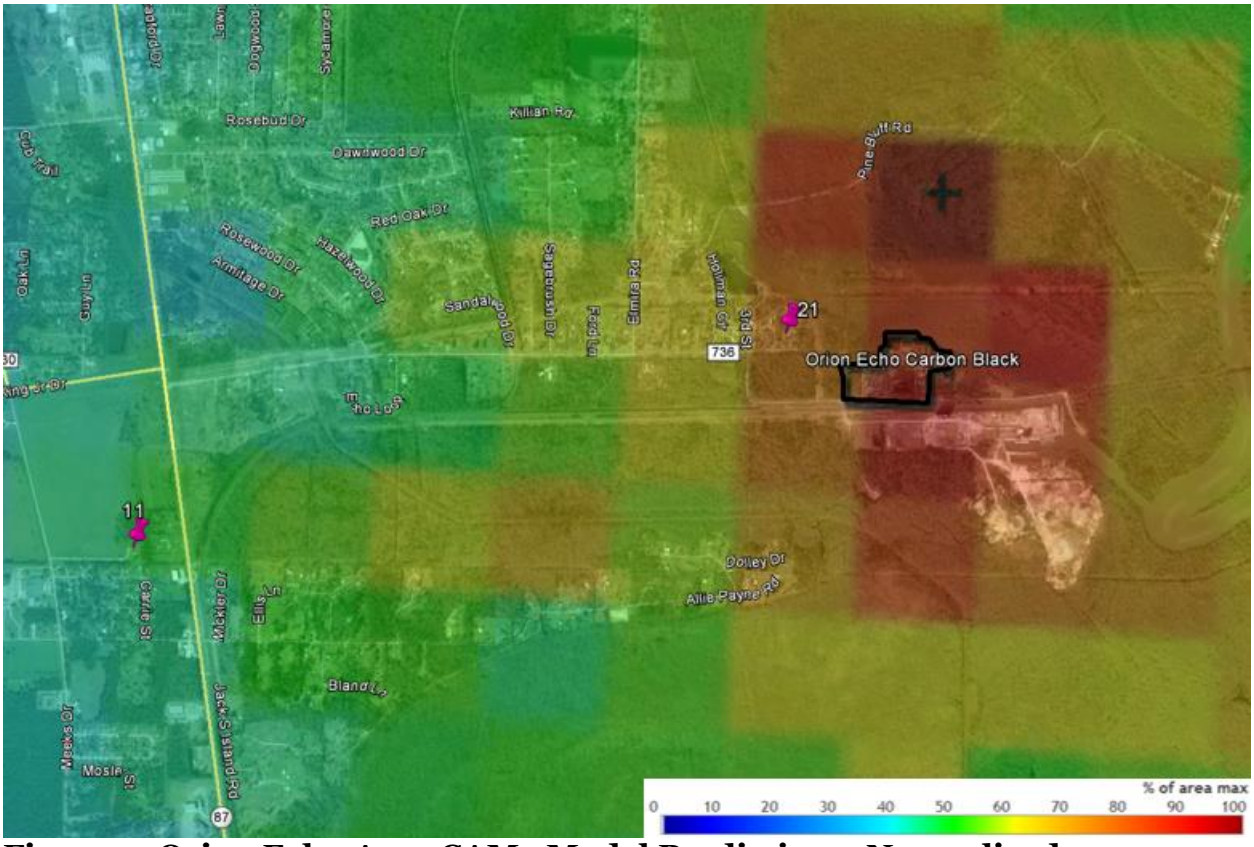

Figure 5: Orion Echo Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Locations

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

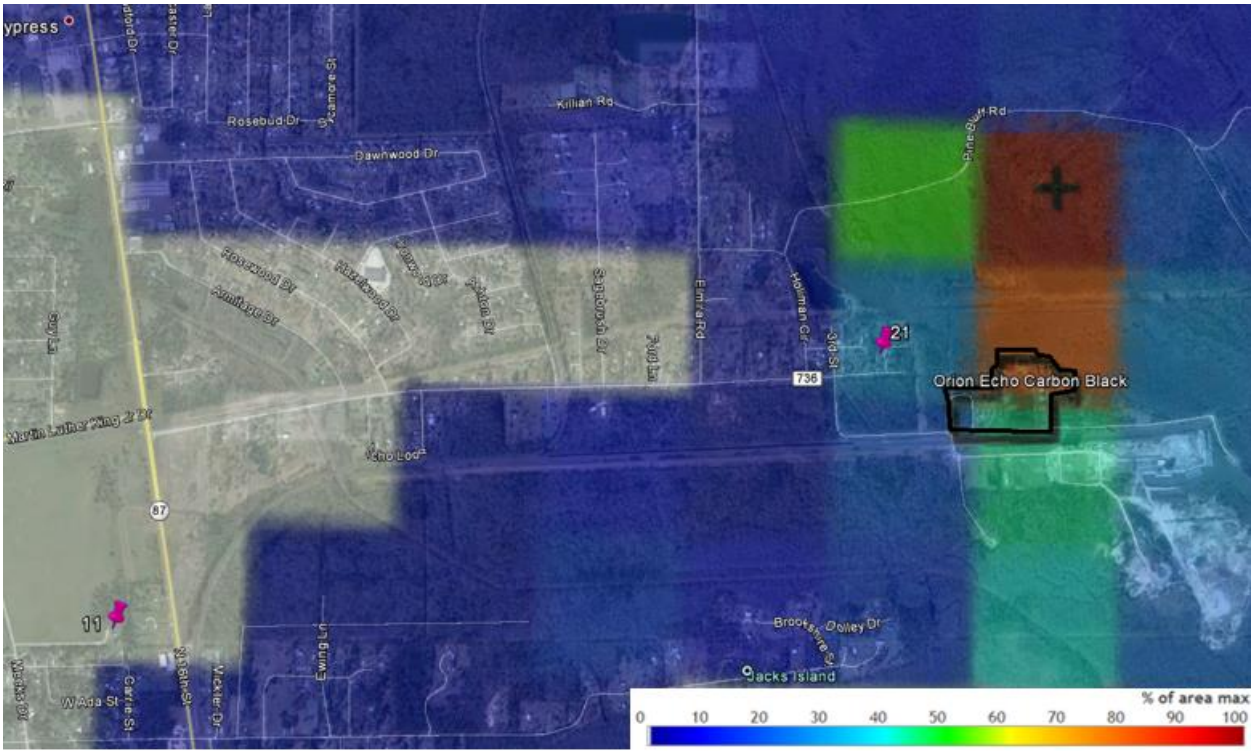

Figure 6: Orion Echo Area CAMx Model Predictions, Normalized Frequency (number of days), and Viable Site Locations

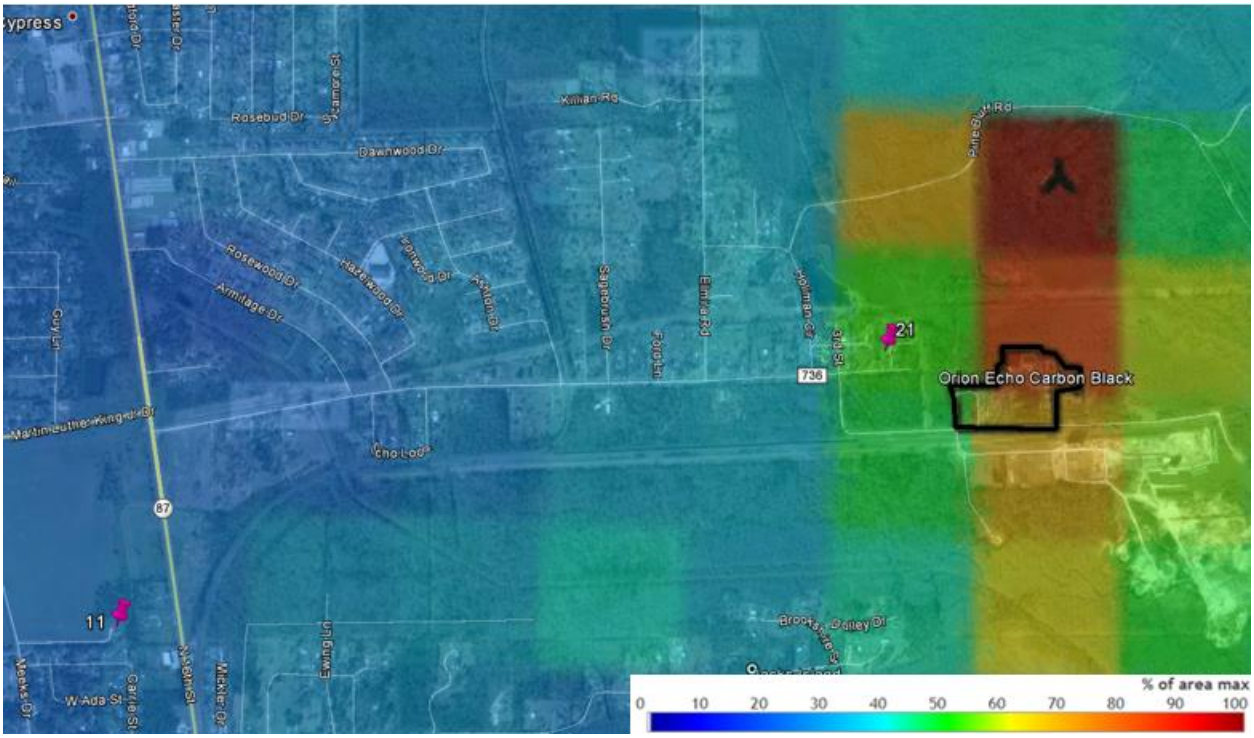

Figure 7: Orion Echo Area CAMx Model Predictions Composite Metric and Viable Site Locations

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Orion Echo that would be expected to characterize SO_2 concentrations from this facility; therefore a new site is proposed. The TCEQ focused on complying with the federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach included utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 5, 6, and 7 suggests that maximum SO_2 concentrations are expected to occur within the Orion Echo permitted area and the area directly north and northeast of Orion Echo. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 75% of the off-property maximum is expected directly north of Orion Echo over a densely forested region. The TCEQ determined that the necessary space and stable ground to support a monitoring site in this area was nonexistent.

Twenty-one potential sites were identified as shown in Figure 8. A summary of all potential sites is shown in Table 2. The TCEQ was unable to explore regions to the north and east of Orion Echo due to an expansive forest and swamp terrain that encompasses the entire area. Nineteen of the potential sites (sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, and 20) are not considered viable and are indicated by red pins in Figure 8. Flood plains or obstructions made sites 1, 2, 3, 5, 12, 13, 17, and 20 unsuitable for monitor placement. Property owners at sites 4, 7, 8, 9, 10, 14, 16, 18, and 19 either were unwilling to negotiate a site agreement or were unresponsive. Site 6, located approximately 2.8 km from the source, contained numerous underground pipelines and associated easements. Site 15, located approximately 3.2 km from the source, is currently for sale by the owner. As a result, these sites are no longer under consideration.

The two sites with amenable property owners and satisfactory logistical and siting characteristics are sites 11 and 21. These site locations are identified with a pink pin on the model and satellite image overlays in Figures 5, 6, 7, and 8.

- Site 11 is positioned approximately 3.2 km southwest of Orion Echo. This site is downwind of Orion Echo approximately 7% of the time when wind flows from the northeast. The area is level and has available space and power. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 45%-55% of maximum concentrations. The property owner is amenable to a site agreement
- Site 21 is positioned approximately 0.5 km northwest of Orion Echo. This site is downwind of Orion Echo approximately 20% of the time when winds flow from the south-southeast. The area is level and has available space and power. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 70%-80% of maximum concentrations. A site agreement has been negotiated with the property owner.

Recommendation

Based on current facility operations, available emissions data, wind patterns, and modeling analysis, site 21 (see Figures 9 and 10) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. Site 21 is indicated by a pink pin in Figures 5, 6, 7, and 8. Site 21 is positioned downwind of Orion Echo and is expected to monitor a greater frequency of maximum concentrations than site 11. Located in an area with predicted maximum normalized SO_2 concentrations between 70% and 80%, site 21 has available power, level ground, and meets all federal siting criteria. A site agreement has been negotiated with the property owner.

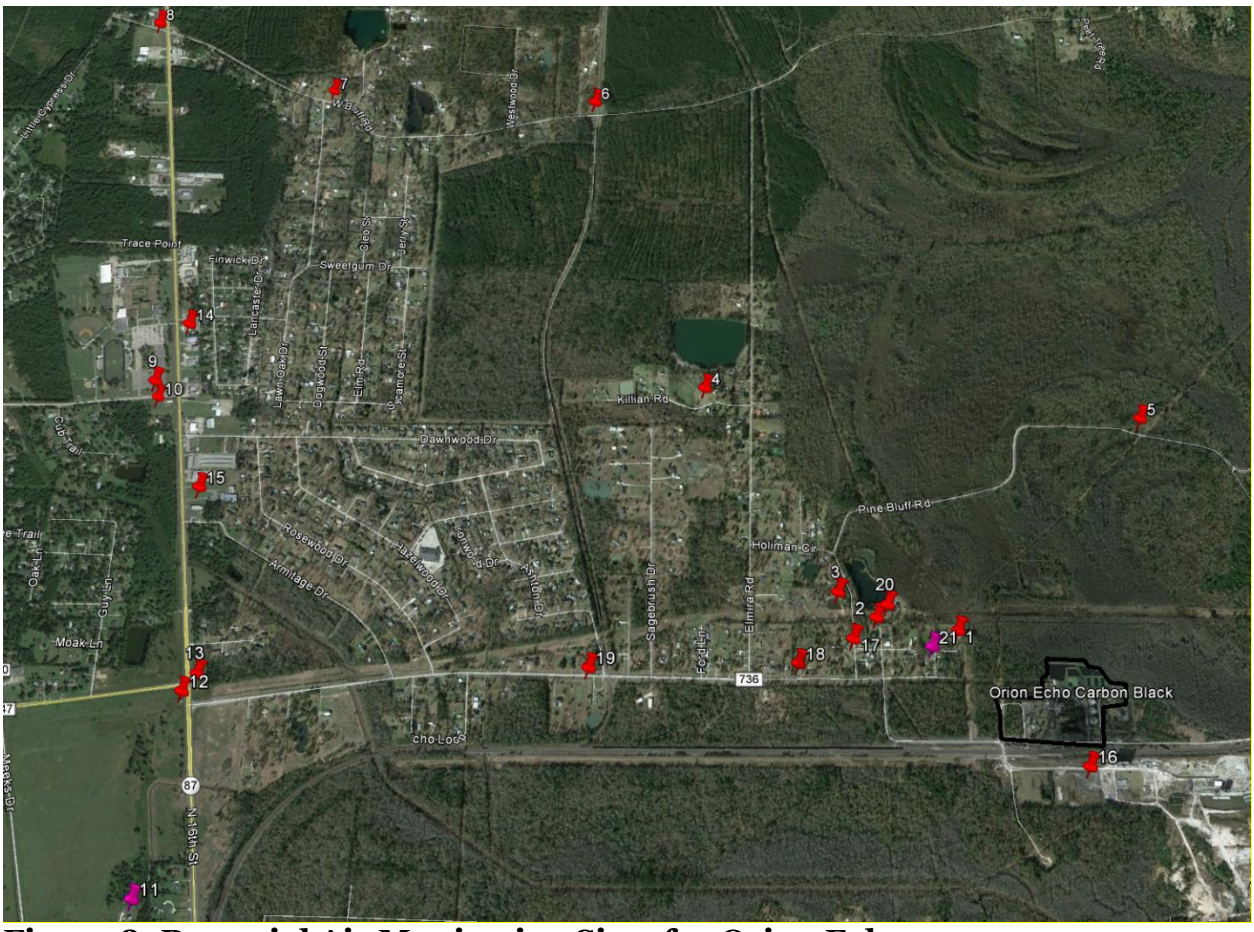

Figure 8: Potential Air Monitoring Sites for Orion Echo

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	Orion Echo #1	Orion Echo #2	Orion Echo #3
Location[2]	30.15395, -93.72501	30.15459, -93.72767	30.15491, -93.72866
Distance from SO_2 Source[2]	438 m	709 m	870 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	>2%	<1%	>2%
Flood Plains	Yes	No	Yes
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; pond (NW)	Yes; pond (N)	Yes; ponds (NE, NW)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Tree (17-20 m)	Trees (20 m)	Trees (20 m)
Distance from Site to Obstructions	Tree (30 m S to dripline)	Trees (7 m N to dripline), Trees (7 m W to dripline), Trees 7 m S to dripline)	Trees (30 m to dripline in all directions)
Road/Site Access	Yes	Yes	No
Electricity Available <18 m	No	No	No
Pros	• Downwind • Space available • Close proximity to source • High SO_2 modeling	• Downwind • Space available • Level ground • High SO_2 modeling	• Downwind • High SO_2 modeling
Cons	• Uneven terrain • No power available • Flood prone	• Numerous obstructions • No power available	• Flood prone • Numerous obstructions • No power available • Uneven terrain • No access
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Orion Echo #4	Orion Echo #5	Orion Echo #6
Location[2]	30.16163, -93.73438	30.16137, -93.71763	30.17233, -93.73891
Distance from SO_2 Source[2]	1,670 m	1,050 m	2,830 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	>2%
Flood Plains	No	Yes	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; ponds (N, SW, SE)	No	Yes; ponds (W, NW)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	No (NNE)	Yes (NW)
Obstructions and Height	Trees (10-13 m)	Trees (25 m)	Trees (20 m)
Distance from Site to Obstructions	Tree (20 m SE from dripline), Trees (15 m SW from dripline)	Trees (30 m W to dripline), Trees (30 m W to dripline), Trees (30 m E to dripline)	Trees (28 m NW, 47 m SE)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Level ground • Power available	• Level ground • Power available • High SO_2 modeling	• Downwind • Space available • Level ground • Power available
Cons	• Unresponsive property owner • Low SO_2 modeling • Numerous obstructions	• Flood prone • Not downwind • Numerous obstructions	• Existing underground pipelines • Low SO_2 modeling
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Orion Echo #7	Orion Echo #8	Orion Echo #9
Location[2]	30.17244, -93.74998	30.17496, -93.75784	30.16119, -93.75614
Distance from SO_2 Source[2]	3,570 m	4,320 m	3,470 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; ponds (NE, E)	Yes; pond (E)	Yes; pond (S)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	Trees (13 m)	None	None
Distance from Site to Obstructions	Trees (23 m W to dripline), Trees (23 m E to dripline)	NA	NA
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Level ground • Power available	• Downwind • Level ground • Power available	• Downwind • Level ground • Power available
Cons	• Property owner declined • Numerous obstructions • Low SO_2 modeling	• Property owner declined • Low SO_2 modeling	• Property owner declined • No space available • Low SO_2 modeling
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Orion Echo #10	Orion Echo #11	Orion Echo #12
Location[2]	30.16076, -93.75513	30.14519, -93.75350	30.15128, -93.75278
Distance from SO_2 Source[2]	3,435 m	3,244 m	3,076 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	>1%
Flood Plains	No	No	Yes
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; pond (S)	Yes; pond (N)	Yes; pond (NW)
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	No (SW)	No (W)
Obstructions and Height	None	Building (5 m), Building (5 m)	None
Distance from Site to Obstructions	NA	Building (15 m E), Building (15 m E)	NA
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Space available • Level ground • Power available	• Space available • Level ground • Power available • Agreeable property owner	• Power available
Cons	• Property owner declined • Low SO_2 modeling	• Not downwind • Low SO_2 modeling • Numerous obstructions	• Slight grade in surrounding area • Not downwind • Existing underground pipelines • Flood prone • Low SO_2 modeling
Viable Site (yes, no, or preferred)	No	Yes	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Orion Echo #13	Orion Echo #14	Orion Echo #15
Location[2]	30.15178, -93.75232	30.16333, -93.75449	30.15774 -93.75321
Distance from SO_2 Source[2]	3,028 m	3,452 m	3,168 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	>1%	<1%	<1%
Flood Plains	Yes	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; pond (NW)	Yes; pond (SW)	Yes; ponds (W, SW)
Wind Channeling	None	None	None
Downwind[2]	No (W)	Yes (NW)	Yes (NW)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	NA	NA	NA
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Power available	• Downwind • Level ground • Power available	• Downwind • Level ground • Power available • Space available
Cons	• Slight grade in surrounding area • Not downwind • Existing underground pipelines • Flood prone • Low SO_2 modeling	• Property owner declined • Low SO_2 modeling	• Property is for sale • Low SO_2 modeling
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Orion Echo #16	Orion Echo #17	Orion Echo #18
Location[2]	30.15029, -93.72044	30.15383, -93.72877	30.15298, -93.73077
Distance from SO_2 Source[2]	242 m	775 m	953 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; pond (NW), river (E)	Yes; ponds (N)	Yes; ponds (NE)
Wind Channeling	None	None	None
Downwind[2]	No (S)	Yes (NW)	No (W)
Obstructions and Height	None	Trees (20 m)	Tree (15 m)
Distance from Site to Obstructions	N/A	Tree (27 m NW to dripline), Tree (45 m W to dripline)	Tree 19 m (NE to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	No	Yes	No
Pros	• Space available • Level ground • Close proximity to source • High SO_2 modeling	• Downwind • Space available • Level ground • Close proximity to source • Power available	• Level ground • Close to source • Easy site access
Cons	• No power available • Not downwind • Potential interference from railroad • Property owner declined	• Numerous obstructions • Low SO_2 modeling	• Property owner declined • Not downwind • No space available • No power available • Numerous obstructions • Low SO_2 modeling
Viable Site (yes, no, or preferred)	No	No	No

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Orion Echo #19	Orion Echo #20	Orion Echo #21
Location[2]	30.15255, -93.73833	30.15495, -93.72751	30.15369, -93.72592
Distance from SO_2 Source[2]	1,680 m	698 m	503 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; ponds (N, S)	Yes; lake (N)	Yes; ponds (NW, E)
Wind Channeling	None	None	None
Downwind[2]	No (W)	Yes (NW)	Yes (NW)
Obstructions and Height	None	Trees (10 m)	Trees (10 m)
Distance from Site to Obstructions	NA	Trees (10 m N to dripline), Trees (10 m W to dripline)	Trees (15 m N to dripline), Tree (18 m S to dripline), Trees (23 m W to dripline)
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Power available	• Downwind • Level ground • Power available • High SO_2 modeling	• Downwind • Level ground • Power available • Close to source • High SO_2 modeling
Cons	• Unresponsive property owner • Low SO_2 modeling • Not downwind	• Existing underground pipelines • Numerous obstructions	• Numerous obstructions
Viable Site (yes, no, or preferred)	No	No	Preferred

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
% – percent
N – north
S – south
E – east
W – west
NA – not applicable
NNE – north-northeast
NW – northwest
SE – southeast
SW – southwest
m – meter
– number
< – less than
> – greater than
SO_2 – sulfur dioxide

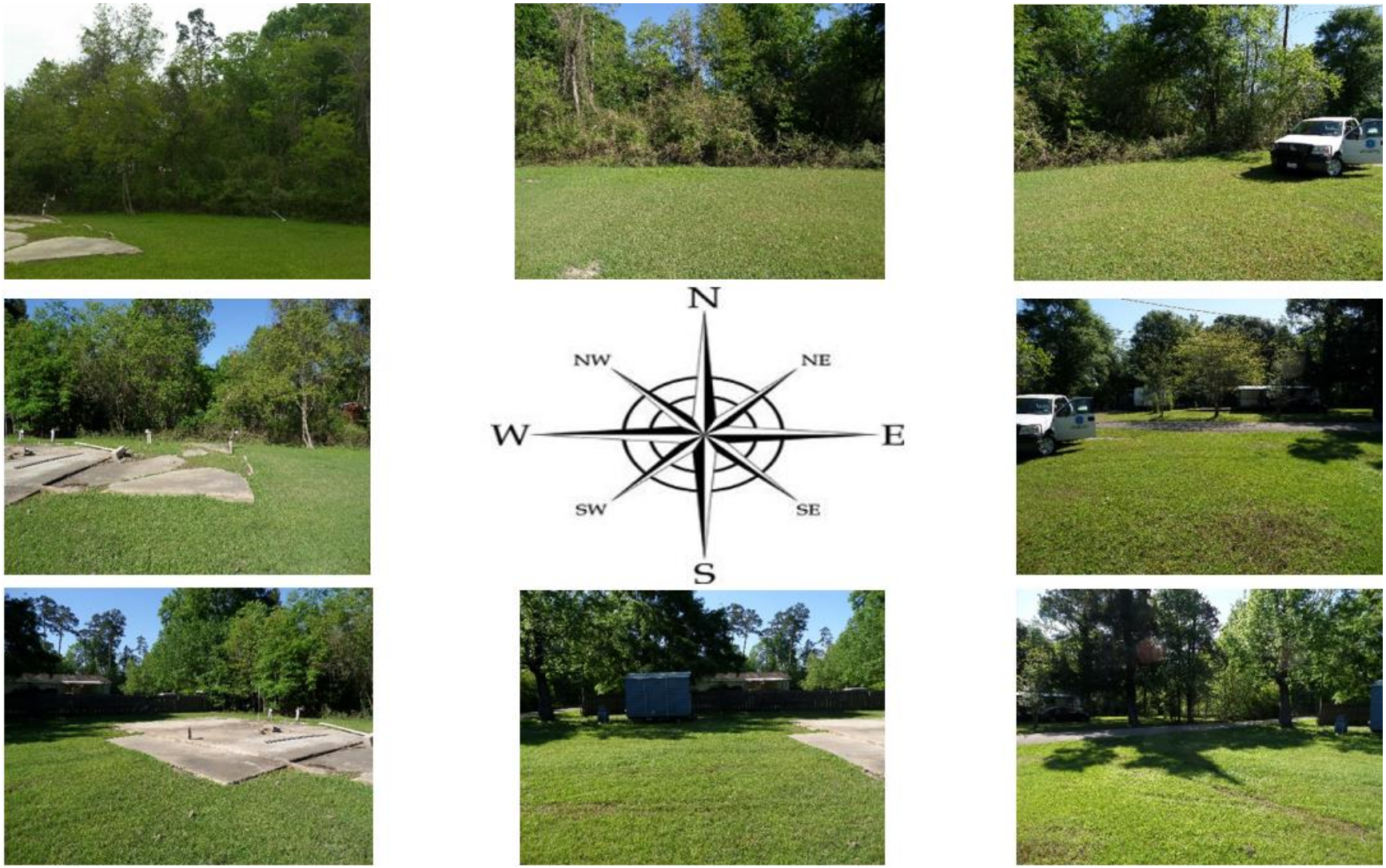

Figure 9: Orion Echo #21 Potential Site Cardinal Direction Photos

Figure 10: Orion Echo #21 Potential Site Location

References

Wermund, E.G., *Physiographic Map of Texas*, The University of Texas at Austin Bureau of Economic Geology, 1996.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Harrington Station Power Plant Monitor Placement Evaluation

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Harrington Station Power Plant (Harrington Station) (Figure 2)
- Owner: Southwestern Public Service Company
- Facility function: electric generation
- Location: 35.29920, -101.74700, Texas Commission on Environmental Quality (TCEQ) Region 1, Potter County, Texas
- Sulfur dioxide (SO_2) emissions data: 15,349 tons (2012), 14,309 tons (2013), 15,465 tons (2014)
- Long-term emissions trend: decreasing, 44 percent (%) decrease from 2004 through 2014
- Emission profile: operational year-round
- Stack height(s): three stacks; stack 1-1, 76 meters (m), stacks 2-1 and 3-1, 91 m
- SO_2 emission controls: none
- Permit related data: Federal Operating Permit, Permit of Significant Deterioration (PSD) permit #PSDTX017M2 and #PSDTX631M1

Existing Air Monitoring Sites

The TCEQ operates six ambient air monitoring sites within a 25 kilometer (km) radius of Harrington Station. Table 1 details the sites in order of proximity. Maximum SO_2 ground level concentrations can be expected within close proximity to the source. One of these locations is currently monitoring SO_2 (Amarillo 24th Avenue) and has a design value below the current SO_2 standard of 75 parts per billion (ppb). None of the six sites around Harrington Station are positioned downwind or within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air Monitoring Sites near Harrington Station

Site	Distance from Harrington Station	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2013–2015)
Amarillo SH 136	3.5 km southwest	No	Not applicable
Amarillo 24th Avenue	7.8 km southwest	Yes	22 parts per billion
Pantex 4	15 km northeast	No	Not applicable
Pantex 5	16 km northeast	No	Not applicable
Amarillo A & M	18 km southwest	No	Not applicable
Pantex 7	19 km north	No	Not applicable

km – kilometer
& – and
SH – state highway

Settings and Surroundings

The rural and suburban areas surrounding Harrington Station consist of the Llano Estacado ecoregion of the high prairies of north Texas. This area is characterized by level, treeless expanses and arid conditions (Griffith et al. 2004). The elevation ranges from 1066 to 1095 meters as shown in Figure 1. Several small bodies of water surround Harrington Station, with river channels running to the west. No significant changes to the landscape were noted during the reconnaissance as compared to the satellite image shown in Figure 8. Mountain and valley wind channeling or other terrain related meteorological impacts are not expected in this area.

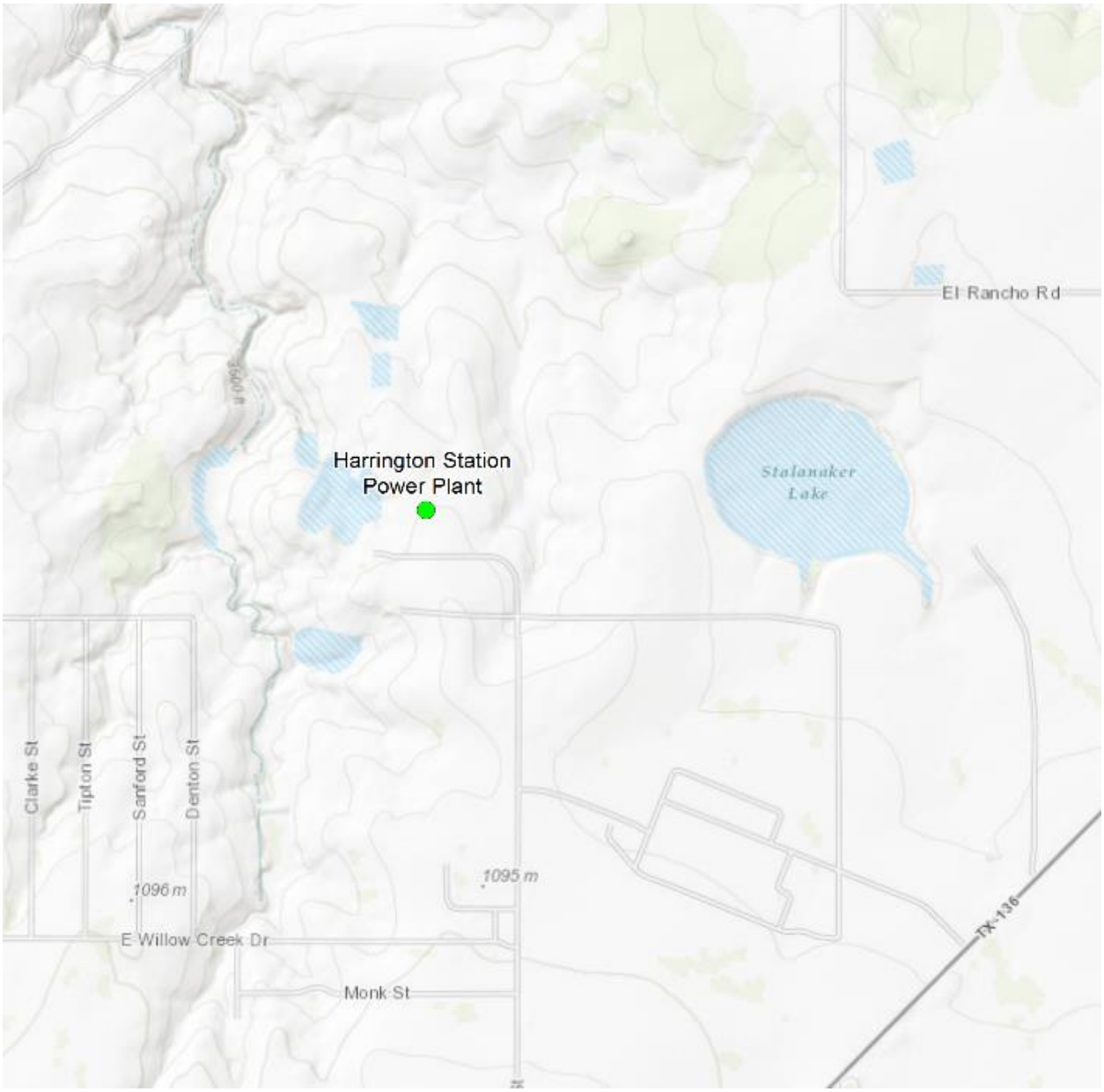

Figure 1: Harrington Station Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Figure 2: Harrington Station Sulfur Dioxide (SO_2) Stacks and Emissions, 2013

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Amarillo Airport located 8 km southeast of Harrington Station. Figure 4 illustrates the 2012-2014 annual average wind speed and direction. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on analysis of the 2012-21014 wind data, the dominant wind flow direction is 135 degrees southeast to 235 degrees southwest. Approximately 45% of average annual wind flows are from the dominant wind flow direction. Calm winds (0-2 miles per hour) occurred on average 3.9% of the time, and wind speeds averaged 13.3 miles per hour (Iowa Environmental Mesonet 2016).

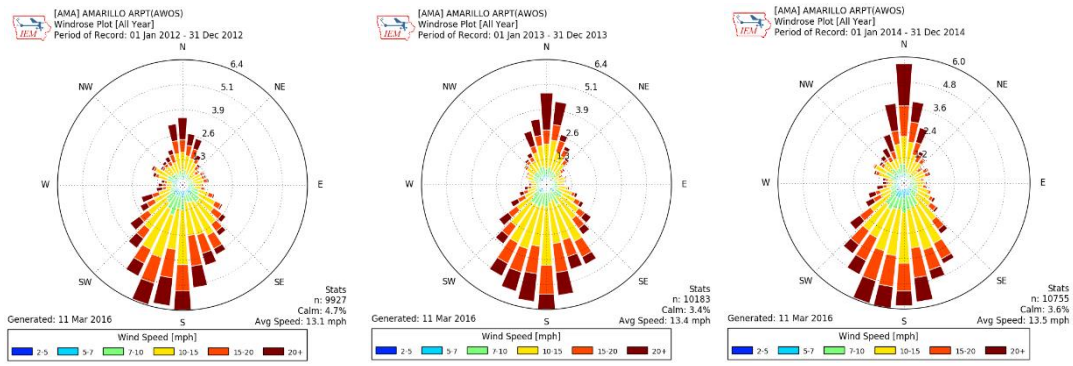

Figure 3: (From left to right) 2012, 2013, and 2014 Individual Wind Rose Plots

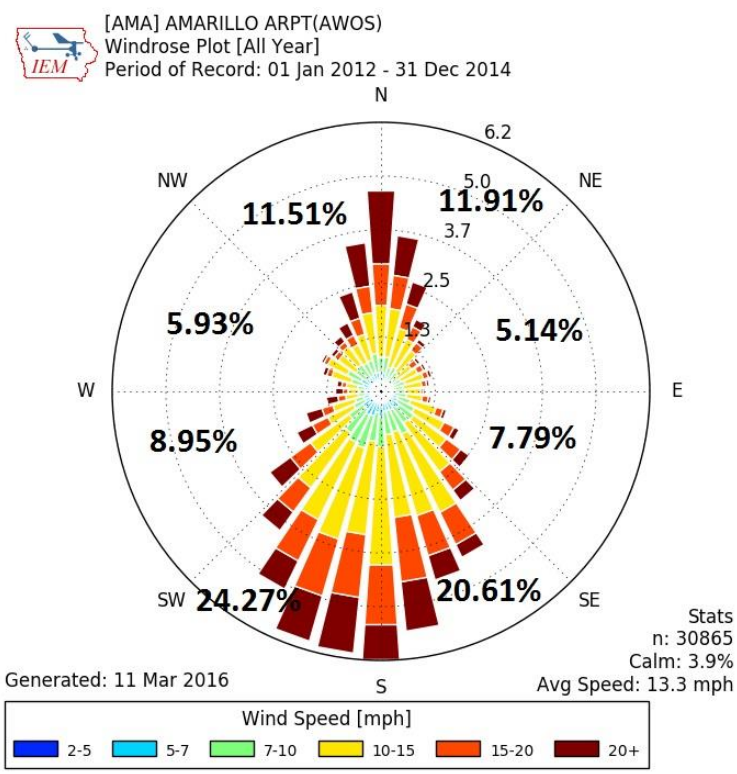

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the three kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 3 and 4.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a "+" symbol. Harrington Station's permitted property is outlined in black. Based on this analysis, the highest normalized concentrations, greater than 95% of the predicted off-property maximum, are expected 2.5 km north-northeast of Harrington Station's permitted property. This area is located on a water retention and overflow area that is not viable for monitor placement based on site reconnaissance and property owner discussions. However, the proposed monitor location identified in Figure 5 as site 1 is in an area of predicted normalized concentrations within 85% to 90% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-

property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized frequency around the Harrington Station facility. Again, the location of the predicted off-property maximum is indicated by a "+" symbol, and Harrington Station's permitted property is outlined in black. Using this analysis metric, the area 2.3 km to the north of the Harrington Station facility scored greater than 90% and would be expected to see the highest frequency of elevated SO_2 concentrations. This area is not viable for monitor placement due to lack of power and public access.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a "λ" symbol, and Harrington Station's permitted property is outlined in black. Similar to the normalized frequency metric, the area 2.3 km north of Harrington Station scored greater than 90% using the composite metric. However, based on the TCEQ's site reconnaissance, areas with the highest composite metric score did not yield a viable location for monitor placement.

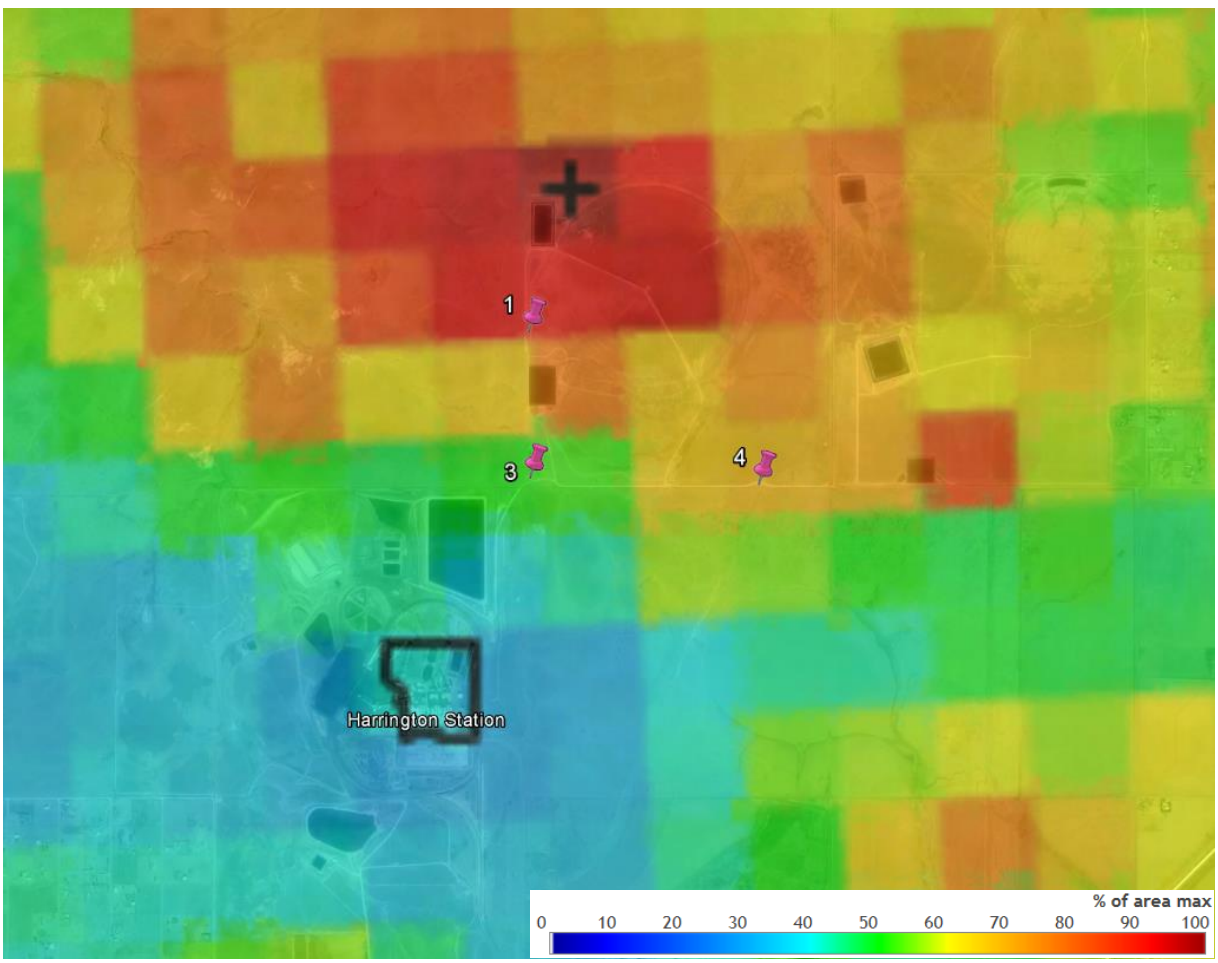

Figure 5: Harrington Station Area CAMx Model Predictions, Normalized 99th Percentile Concentrations, and Viable Site Locations (1, 3, 4)

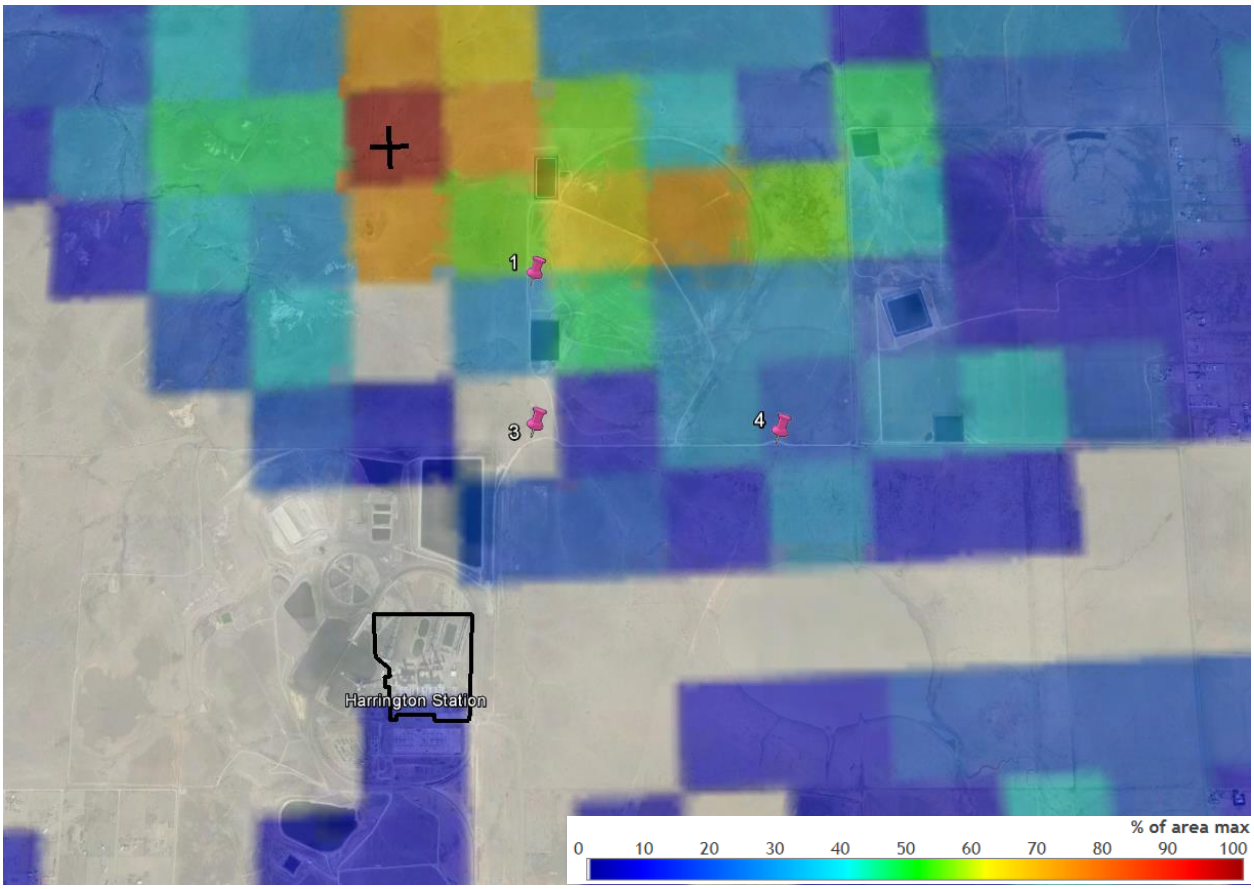

Figure 6: Harrington Station Area CAMx Model Predictions, Normalized Frequency (Number of Days), and Viable Site Locations (1, 3, 4)

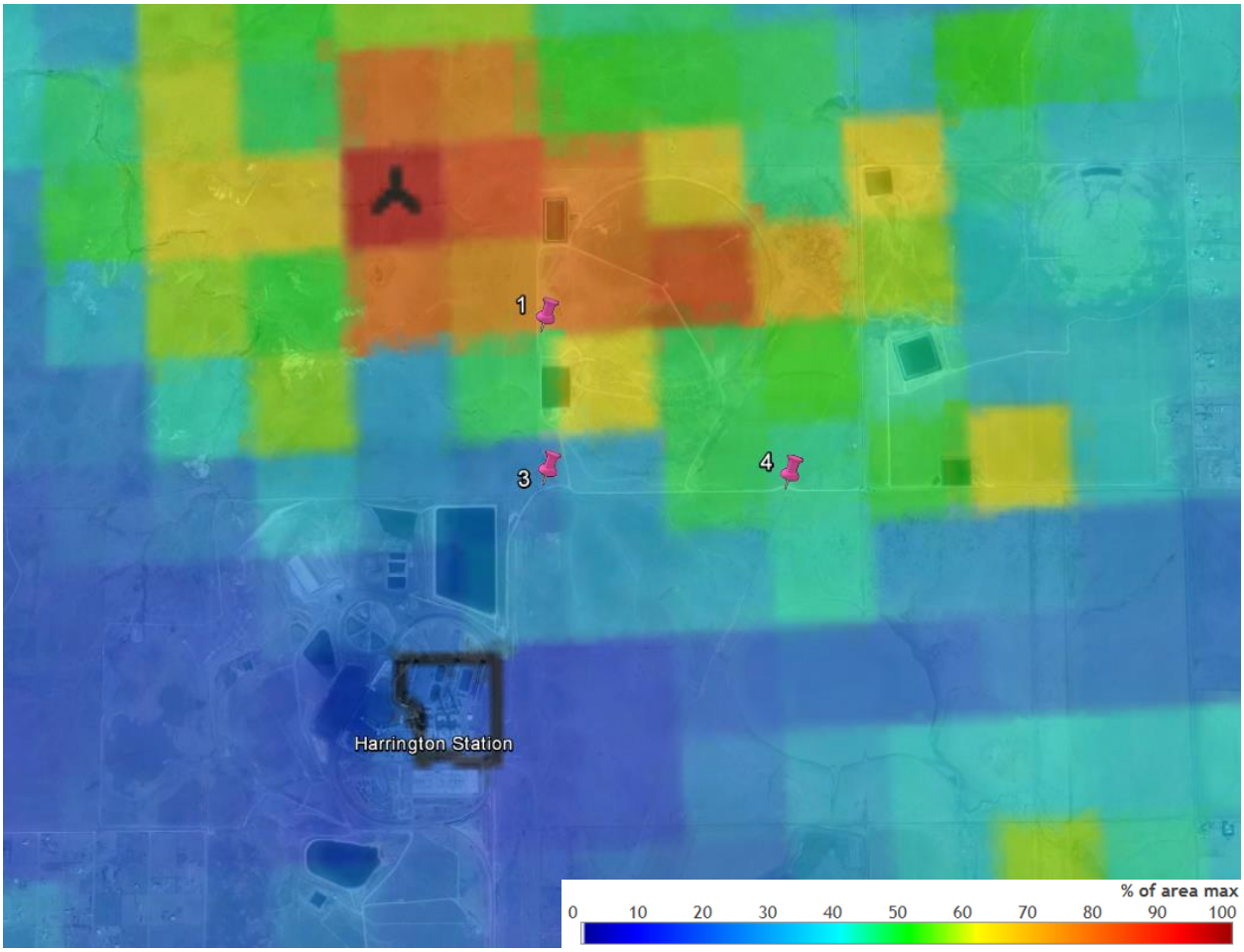

Figure 7: Harrington Station Area CAMx Model Predictions Composite Metric and Viable Site Locations (1, 3, 4)

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Siting Options and Criteria

The TCEQ does not currently have SO_2 monitors located in the area surrounding Harrington Station that would be expected to characterize the highest SO_2 concentrations from this facility; therefore a new site is proposed. The TCEQ focused on complying with the federal requirements listed in 40 Code of Federal Regulations (CFR) Part 58, Appendix E regarding siting criteria. In addition, the TCEQ evaluated monitoring site locations that would appropriately and sufficiently characterize air quality in areas around an SO_2 emissions source. This approach included utilizing multiple techniques and guidance provided in the Monitoring TAD.

The modeling analyses provided in Figures 5, 6, and 7 suggest that maximum SO_2 concentrations are expected to occur north-northeast of Harrington Station and slightly south on days with northerly and/or calm winds. In addition, the highest frequency of SO_2 concentrations predicted to be greater than 95% of the off-property maximum is expected directly north of the Harrington Station facility. Figure 8 depicts all potential site locations (red and pink pins), their corresponding property lines (blue), Harrington Station's permitted property line (black), and Stalanaker Lake (purple). The area in the figure outlined in yellow is prone to flooding, the area outlined in white has no public access, and the area outlined in orange has no power. The property surrounding Stalanaker Lake has been leased to farmers. These areas are nonviable for monitor placement. Areas to the west and north of the blue property line containing sites 1, 2, and 3 have no power and no public access; these areas are nonviable monitor site locations.

Six potential sites were identified north-northeast and northeast of Harrington Station as shown in Figure 8. Three of the identified potential sites (2, 5, and 6) are not considered viable and are indicated by red pins. Site 2 has uneven terrain. Site 5 has uneven terrain and is prone to flooding. After consideration, the property owner of site 6 declined an air monitoring station on the property. As a result, these potential sites are no longer under consideration.

The three sites with satisfactory logistical and siting characteristics, located in areas anticipated to have peak concentrations, are sites 1, 3, and 4. These sites are located with a pink pin on the model and satellite image overlays shown in figures 5, 6, 7, and 8.

- Site 1 is positioned north-northeast and approximately 1.9 km from Harrington Station. This potential site is downwind and provides level ground, adequate space, and available power. This location also rests on top of a hill where up-slope air flow is maximized. The normalized 99th percentile concentration metric analysis predicted concentrations in this area to be 85%-90% of the maximum concentrations. A site agreement has been negotiated with the property owner.
- Site 3 is located north-northeast of Harrington Station. This site is approximately 1.2 km from the source and is downwind. The site has adequate space and available power. However, this site is prone to flooding and is located in a low-lying area. Normalized 99th percentile concentration metric analysis predicted this area to be 45%-50% of the maximum concentrations.
- Site 4 is located northeast and approximately 2.0 km from Harrington Station. The site offers level ground, available space, and power. The normalized 99th

percentile concentration metric analysis predicted concentrations in this area are 60% of the maximum concentrations.

Recommendation

Based on property owner cooperation, current facility operations, available emission data, wind patterns, logistics, and modeling analyses, site 1 (Figures 9 and 10) is the recommended location for placement of a new source-oriented ambient SO_2 monitoring station. Although site 1 and 4 have comparable siting logistics, historical meteorological data from 2012-14 (Figure 4) indicates site 4 averaged winds from the source approximately 9% of the year, compared to 24% for site 1.

Site 1 is the closest viable site to the off-property maximums for all three modeling analyses performed. Despite the proximity of site 3 to the source and similar winds to site 1, geographic influences (elevation) contributed to site 3 receiving the lowest scores on each modeling analysis. Site 3 is also prone to flooding. Based on historical meteorological data and modeling, site 1 is expected to characterize maximum off-property SO_2 concentrations and meets all logistical and federal siting criteria. A site agreement has been negotiated with the property owner.

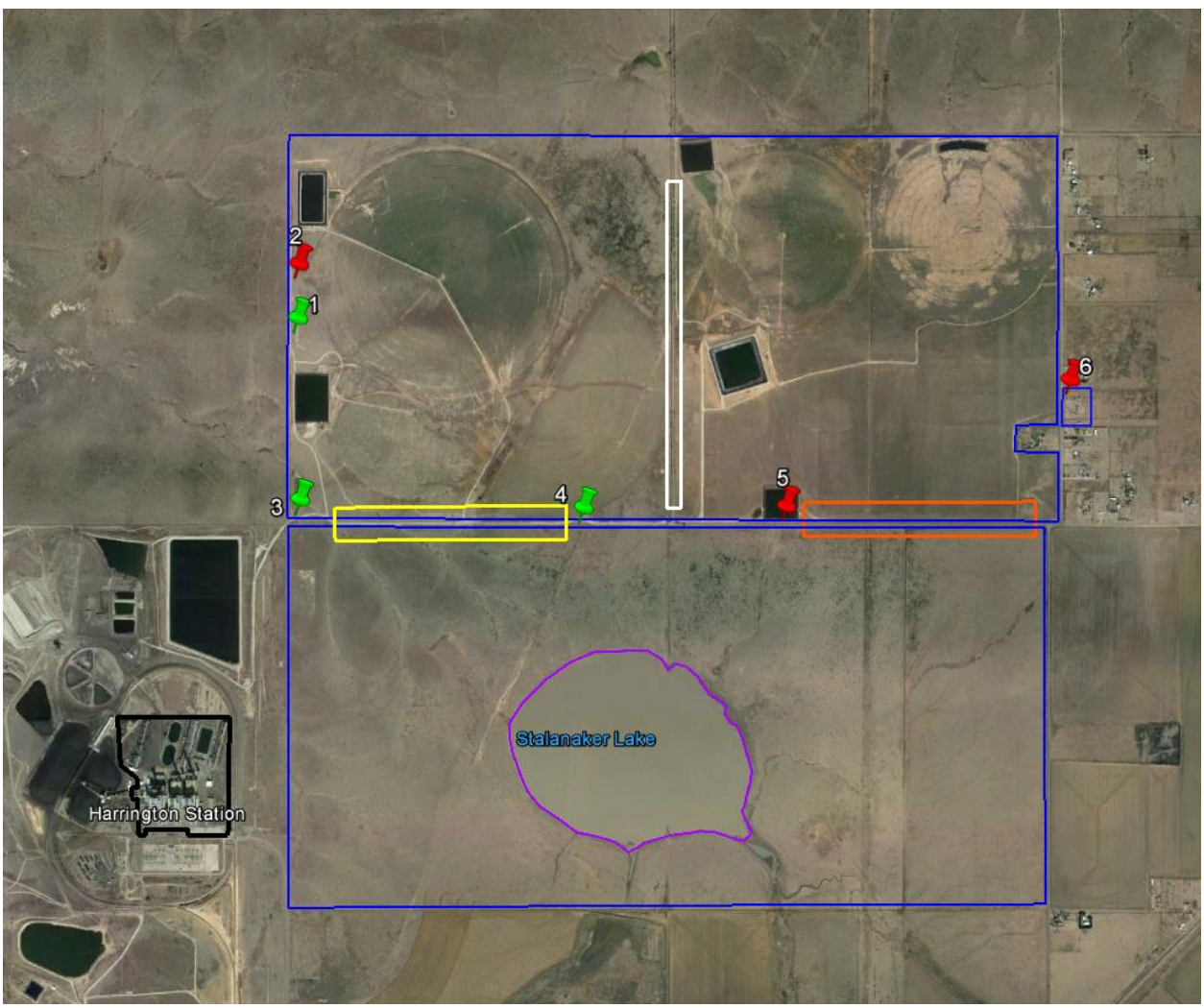

Figure 8: Potential Monitoring Sites for Harrington Station

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Table 2: Potential Sites Assessment[1]

Site Number	**Harrington #1**	**Harrington #2**	**Harrington #3**
Location[2]	35.31629, -101.74176	35.31833, -101.74171	35.30942, -101.74168
Distance from SO_2 Source[2]	1,959 m	2,181 m	1,235 m
Wind Direction	SW, S, SE	SW, S, SE	SW, S, SE
Grade	<1%	>1%	<1%
Flood Plains	No	No	Yes
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	No	No	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NNE)	Yes (NNE)	Yes (NNE)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	NA	NA	NA
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Power available • Space available • Level ground • Agreeable property owner • Accessible • High SO_2 modeling	• Downwind • Power available • Space available • Accessible • High SO_2 modeling	• Downwind • Power available • Space available • Level ground • Close to source • Accessible
Cons	• None	• Uneven terrain	• Flood prone • Low SO_2 modeling
Viable Site (Yes, No, or Preferred)	Preferred	No	Yes

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Site Number	Harrington #4	Harrington #5	Harrington #6
Location[2]	35.30891, -101.72851	35.30916, -101.71912	35.31394, -101.70598
Distance from SO_2 Source[2]	1,995 m	2,762 m	4,067 m
Wind Direction	SW, S, SE	SW, S, SE	SW, S, SE
Grade	<1%	>1%	<1%
Flood Plains	No	Yes	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; lake (S)	Yes; lake (S)	No
Wind Channeling	None	None	None
Downwind[2]	Yes (NE)	Yes (NE)	Yes (NE)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	NA	NA	NA
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Power available • Space available • Level ground • Accessible • Agreeable property owner	• Downwind • Power available • Space available • Accessible • Agreeable property owner • High SO_2 modeling	• Downwind • Power available • Space available • Level ground • Accessible
Cons	• Low SO_2 modeling	• Flood prone • Uneven terrain • Will require major work to level ground	• Property owner declined • Low SO_2 modeling
Viable Site (Yes, No, or Preferred)	Yes	No	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
m – meter
NA – not applicable
NE – northeast
NNE – north-northeast
S – south
SE – southeast
SO_2 – sulfur dioxide
SW – southwest
> – greater than
< – less than
– number
% – percent

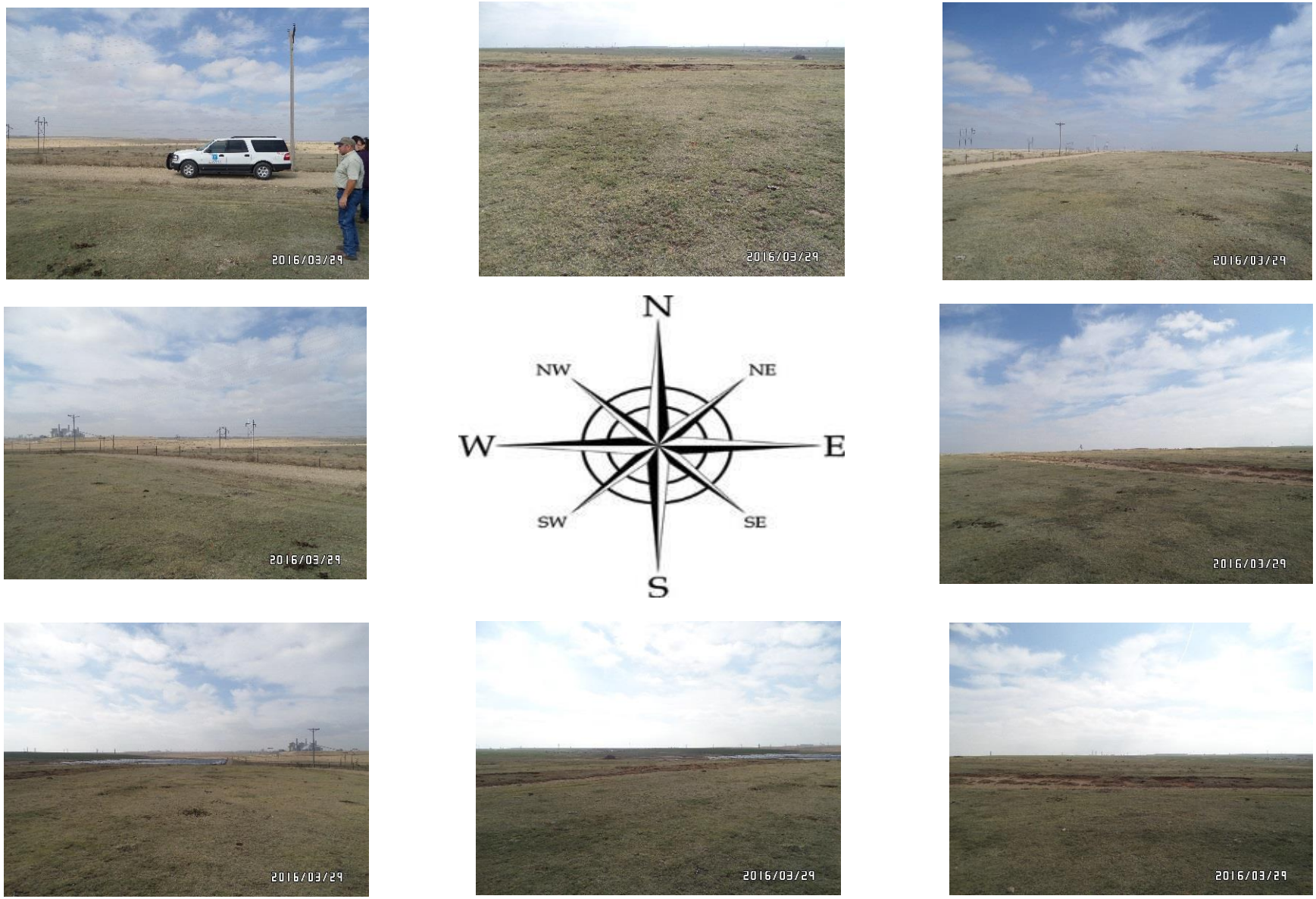

Figure 9: Harrington Station Potential Site #1 Cardinal Direction Photos

Figure 10: Harrington Station Potential Site #1 Satellite Image

References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. Ecoregions of Texas. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

Baytown Refinery Monitor Placement Evaluation

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Source Information

- Name: Baytown Refinery (Figure 2)
- Owner: ExxonMobil Refining & Supply Company
- Facility function: Petroleum refining
- Location: 29.74351, -95.00271, TCEQ (Texas Commission on Environmental Quality) Region 12, Harris County, Texas
- Sulfur dioxide (SO_2) emissions: 2,409 tons (2013), 2,204 tons (2014)
- Long-term emissions trend: Increasing, 41 percent (%) increase from 2010 to 2014
- Emission profile: Operational year-round
- Stack height(s): 183 sources of SO_2 at facility; top 20 emitting stacks range from 25 to 68 meters
- SO_2 emission controls in place: None
- Permit related data: Prevention of Significant Deterioration (PSD)

Existing Air Monitoring Sites

The four closest TCEQ-operated ambient air monitoring sites are within a 7 kilometer (km) radius of the Baytown Refinery. Table 1 details these sites in order of proximity. Maximum SO_2 ground level concentrations can be expected close to the source. Although Baytown Garth is currently monitoring SO_2, it is not within reasonable proximity to the source to characterize maximum SO_2 concentrations.

Table 1: Air monitoring sites near the Houston Plant

Site	Location	Current Sulfur Dioxide (SO_2) Monitoring	SO_2 Design Value (2012–2014)
Baytown	0.5 km northwest	No	Not applicable
Baytown Wetlands Center	1.2 km southeast	No	Not applicable
Lynchburg Ferry	5.2 km west	No	Not applicable
Baytown Garth	7.0 km northeast	Yes	8 ppb

km – kilometer

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Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

Settings and Surroundings

The ecoregion historically surrounding the Baytown Refinery is referred to as the northern Humid Gulf Coastal Prairies. Today, these coastal prairies have almost entirely been converted to cropland, rangeland, pasture, and urban and industrial uses. (Griffith et al. 2004). The elevation map is shown in Figure 1. No significant changes to the landscape were noted during the area field reconnaissance as compared to the Google Earth image of the area shown in Figure 4. There are no expected concerns for mountain or valley wind channeling or other terrain related meteorological impacts for any of the potential sites as noted in Table 2.

The Baytown Refinery is located in a highly industrial area with nearby fugitive SO_2 sources. The Rohm and Hass Deer Park Plant (Deer Park Plant) is located approximately 6 km to the west, and the Eco Service Houston Plant (Houston Plant) is located approximately 24 km to the west. These sources and other near-by fugitive SO_2 sources have the potential to influence SO_2 concentration in the Baytown Refinery area under certain meteorological conditions. In 2013, SO_2 emissions reported for the Deer Park Plant and Houston Plant were 1,337 and 3,840 tons respectively. Due to the facilities' locations and the predominant wind flow in the area (Figure 4), emissions from the Deer Park Plant and the Houston Plant could have a moderate impact during periods of westerly winds. These conditions occurred an average of 1.9% of the time from 2012-2014.

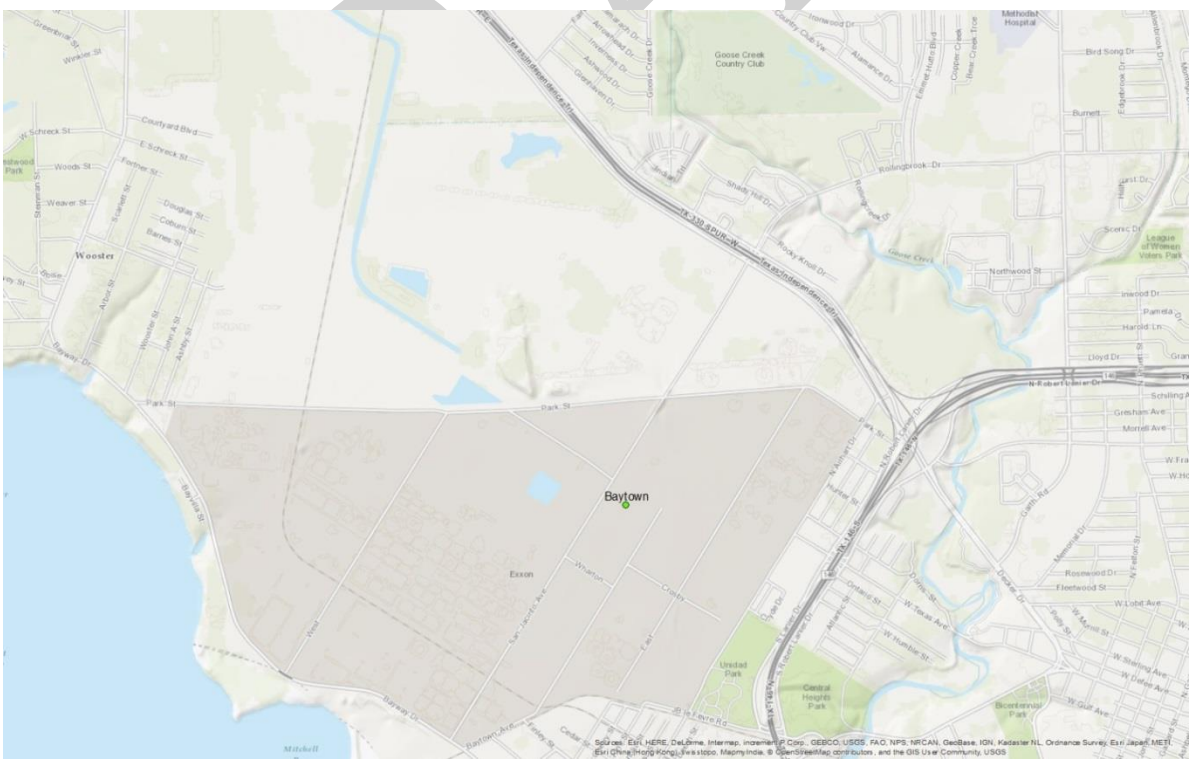

Figure 1: Baytown Refinery Area Elevation Map

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

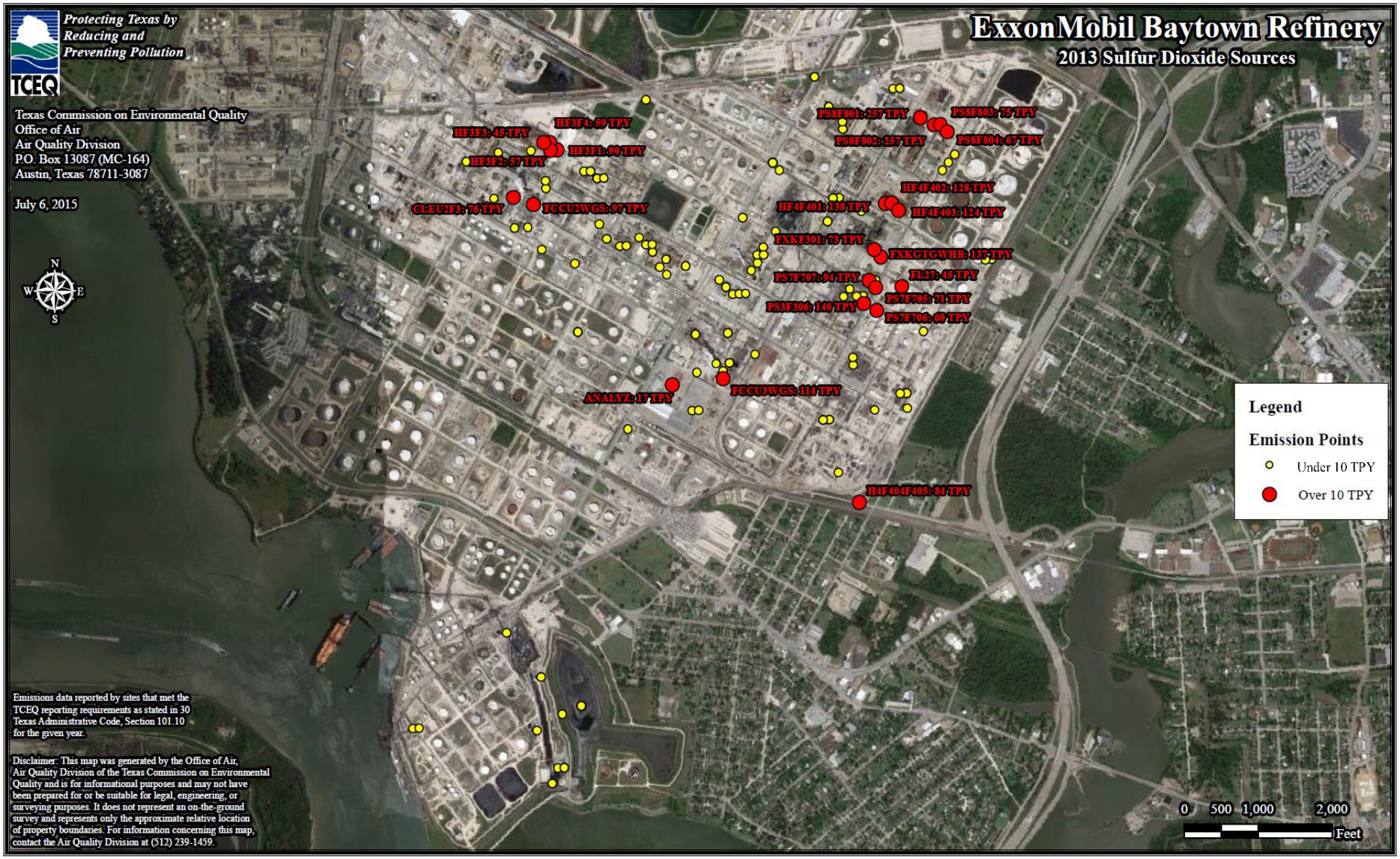

Figure 2: Baytown Refinery SO2 Stacks and Emissions, 2013

Meteorological Data

Figure 3 provides illustrations of area annual average wind speed and direction for 2012, 2013, and 2014 from meteorological sensors at the Houston Hobby Airport, located 26 km southwest of the Baytown Refinery. Figure 5 illustrates the 2012-2014 annual average wind speed. The length of each wind rose bar corresponds to the frequency of the wind coming from the indicated direction by percentage. Based on the analysis of the 2012-2014 wind data, the dominant wind flow direction is 95 degrees east to 225 degrees southwest. Approximately 49% of the average area wind flows move from these directions. Over this three year period, calm winds (0-2 miles per hour) occurred on average 16.4% of the time, and wind speeds averaged 7.5 miles per hour (Iowa Environmental Mesonet 2016).

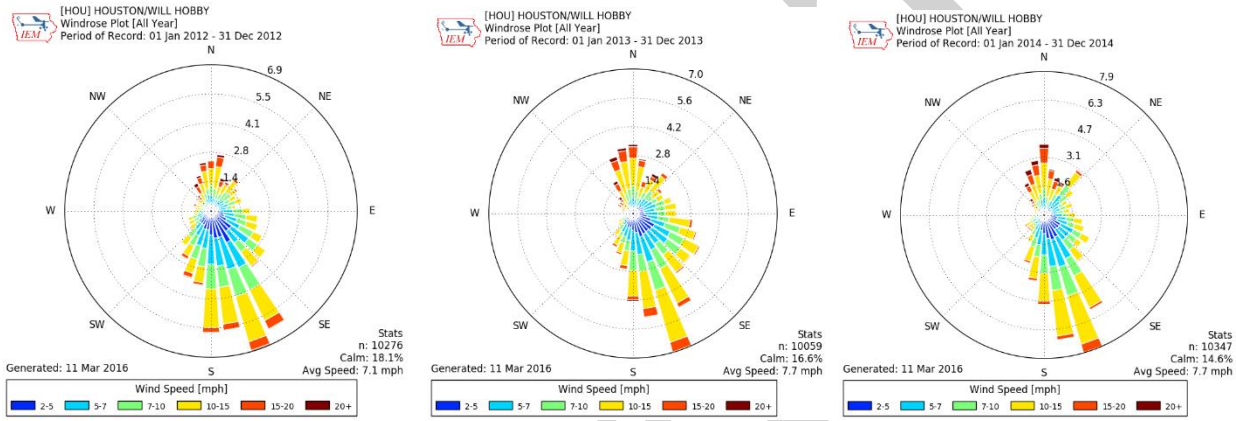

Figure 3: (From left to right) 2012, 2013, and 2014 individual Wind Rose Plots

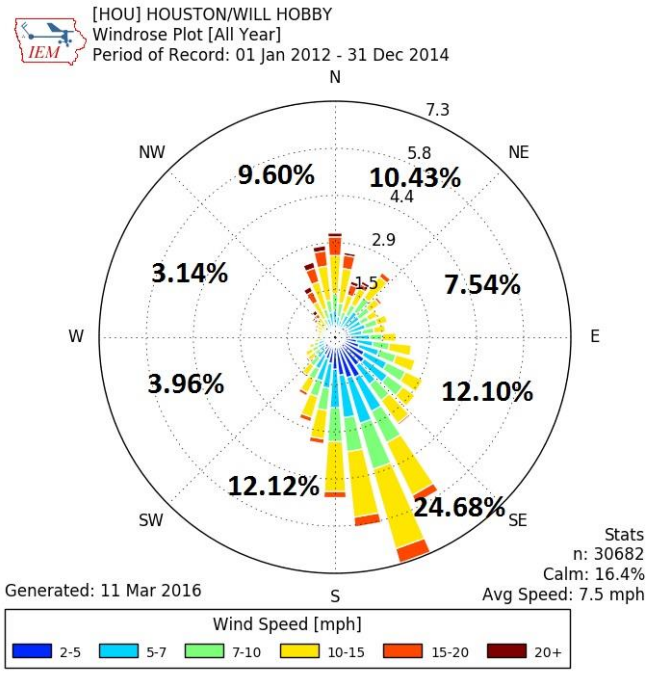

Figure 4: 2012-2014 Combined Average Wind Rose Plot

Modeling Analysis for Monitoring Site Placement

The *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistant Document* (Monitoring TAD) suggests that modeling is one technique that may be used to assist in identifying potential monitoring sites. The TCEQ's modeling for monitor placement used the Comprehensive Air Model with Extensions (CAMx) with model options set as equivalent as possible to American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The setup included the following parameterizations:

- CAMx 6.20 with speed ups and Plume-in-Grid (PiG) fix, without chemistry and without half-life decay;
- 500-meter PiG sampling grid centered on the source spatially covering 72 km by 72 km;
- the kiln stacks were modeled and tracked as individual PiG puffs;
- full year of 2012 12 km gridded Weather Research and Forecasting Model (WRF) meteorology interpolated to 4 km;
- 2014 hourly point source electric generating unit (EGU) emissions; and
- 2014 annual point source non-EGU emissions from State of Texas Air Reporting System (STARS) processed down to hourly emissions.

All model outputs were normalized relative to the predicted off-property maximum concentration, and therefore do not represent absolute predicted results comparable to the NAAQS. The results were then analyzed using three metrics: normalized 99th percentile concentration, normalized frequency, and a composite using both the 99th percentile and frequency metrics. The primary areas targeted for monitor placement included consideration of all three model output metrics, along with the meteorological data presented in Figures 4 and 5.

From the model outputs, normalized 99th percentile concentrations were calculated by dividing the 99th percentile daily maximum concentration for each grid cell within the modeling domain by the predicted off-property maximum concentration for the domain. The calculated results thus represent a percentage of the predicted concentrations for each grid cell to the off-property maximum. Figure 5 presents the results for the normalized 99th percentile concentration metric analysis with the location of the predicted off-property maximum indicated by a "+" symbol. Baytown's permitted property is outlined in blue. Based on this analysis, the highest normalized concentrations, greater than 95% of the predicted off-property maximum, are expected to occur 0.8 km directly south of the Baytown Refinery. The proposed monitor location is identified in Figure 5 as site 19. This site is in an area of predicted normalized concentrations within 80-85% of the off-property maximum.

To evaluate the frequency at which high concentrations may be expected, a normalized frequency metric was developed to represent the number of days the modeled concentration for each grid cell was predicted to be greater than 75% of the off-property maximum concentration. This metric was calculated by dividing the number of days the 99th percentile concentration for each grid cell was greater than 75% of the predicted off-property maximum concentration by the number of days the off-property maximum was predicted to occur. Figure 6 presents the geographic distribution of normalized

DRAFT

frequency around the Baytown Refinery. Again, the location of the predicted off-property maximum is indicated by a "+" symbol, and Baytown's permitted properties are outlined in blue. Using this analysis metric, the area directly to the south of the Baytown Refinery scored greater than 95% and would be expected to see the highest frequency of elevated SO_2 concentrations.

Finally, a composite metric was developed to aid in identifying areas where the predicted highest concentration and predicted highest frequency overlap. The composite metric was calculated at each grid cell by averaging the normalized 99th percentile concentration and normalized frequency metrics. Figure 7 illustrates the geographic distribution of the composite metric analysis results with the location of the predicted off-property maximum with a "λ" symbol, and Baytown's permitted properties are outlined in blue. Similar to the normalized 99th percentile and normalized frequency metrics, the area directly south of the Baytown facilities scored greater than 95% using the composite metric. Based on the TCEQ's site reconnaissance and outreach to property owners, areas with the highest composite metric score did not yield a viable location for monitor placement.

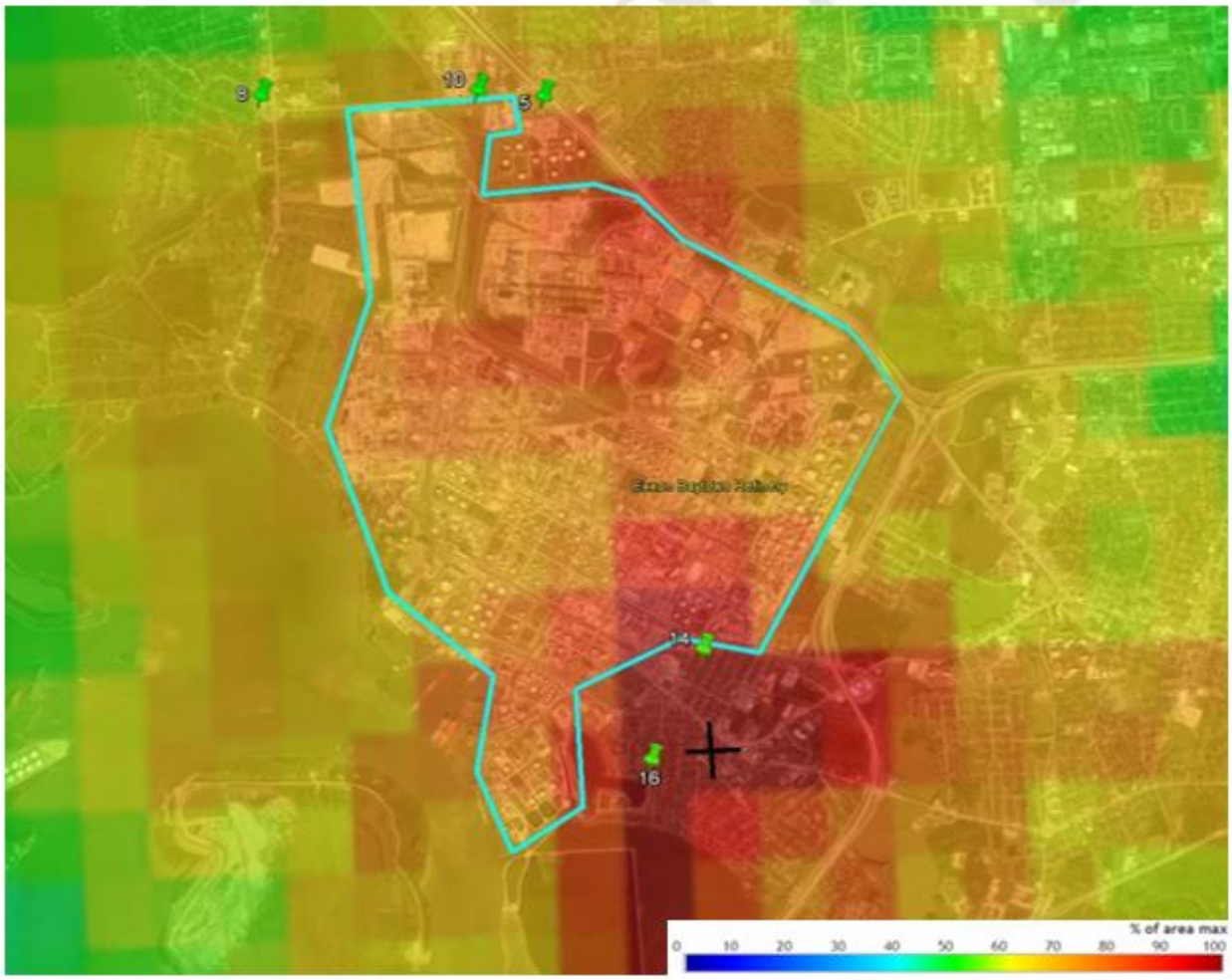

Figure 5: Baytown Refinery Area CAMx Model Predictions, Normalized Concentrations, and Viable Site Locations (5, 8, 10, 14, 16)

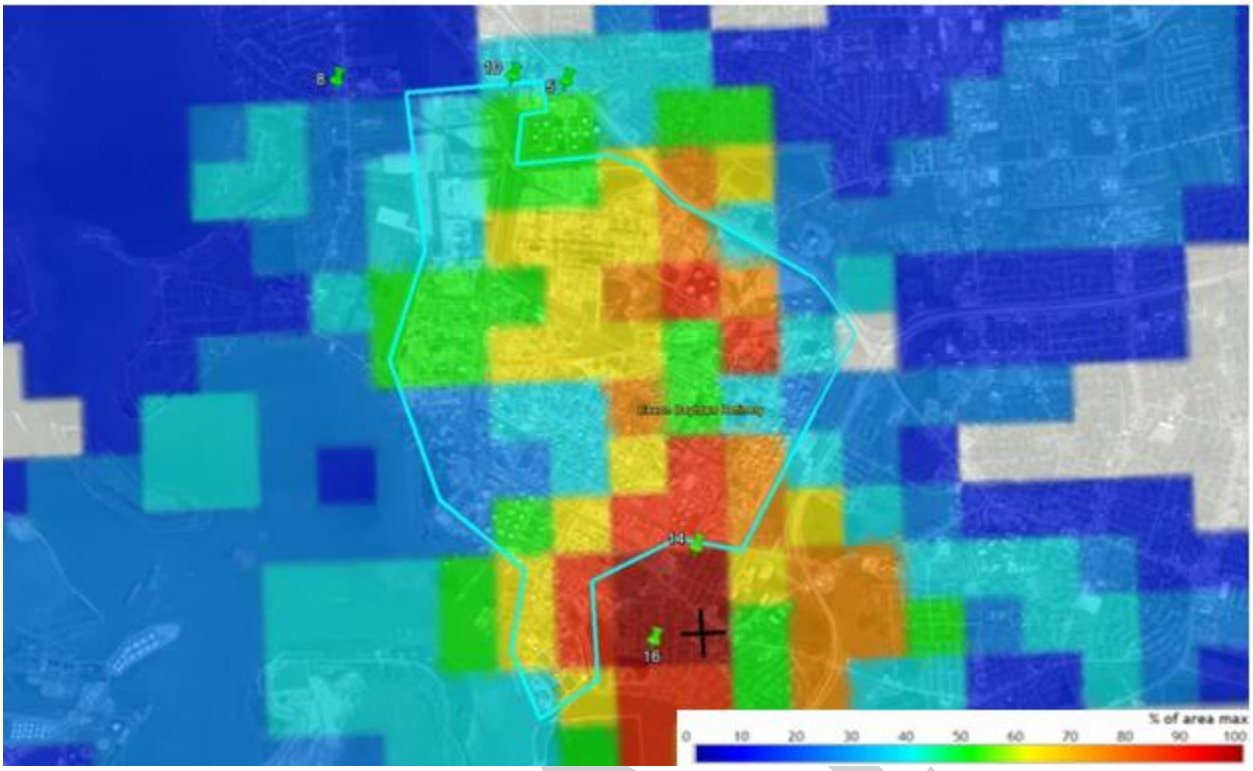

Figure 6: Baytown Refinery Area CAMx Model Predictions, Normalized Frequency, (Number of Days), and Viable Site Locations (5, 8, 10, 14, 16)

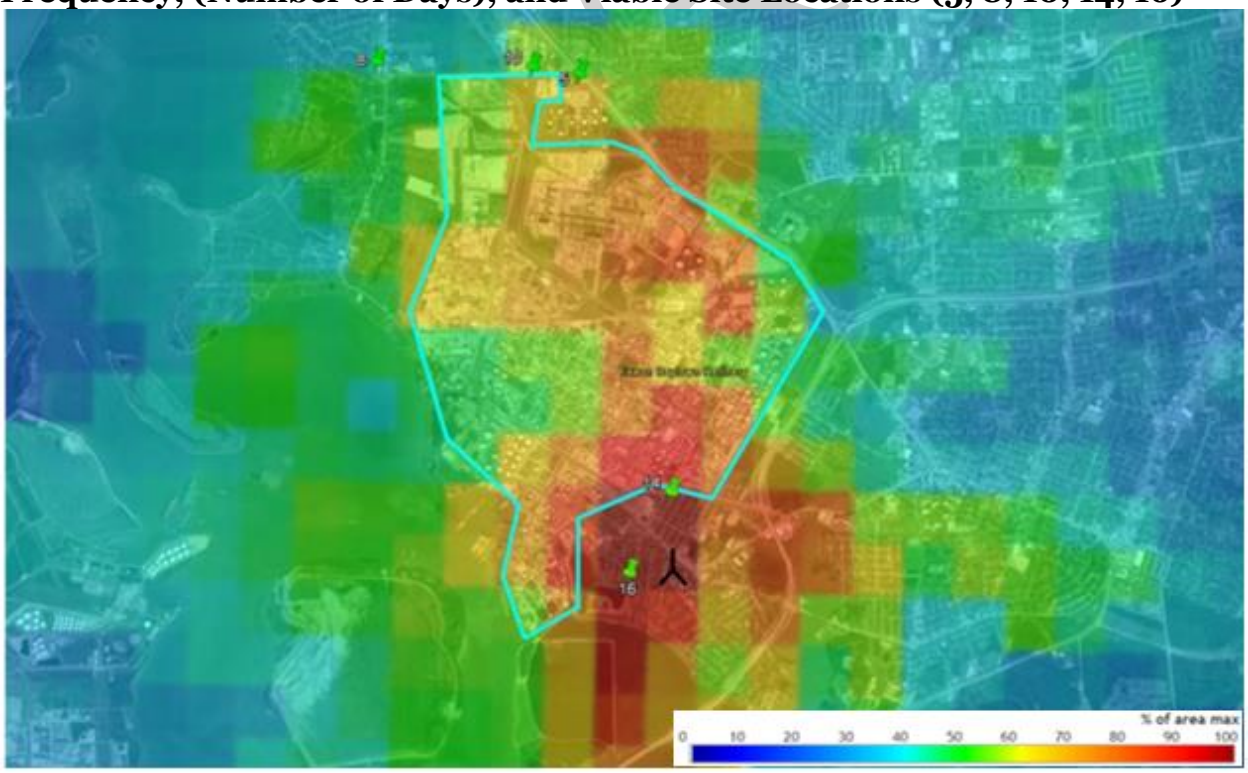

Figure 7: Baytown Refinery Area CAMx Model Predictions Composite Metric and Viable Site Locations (5, 8, 10, 14, 16)

Appendix E: Sulfur Dioxide Data Requirements Rule Monitor Placement Evaluations

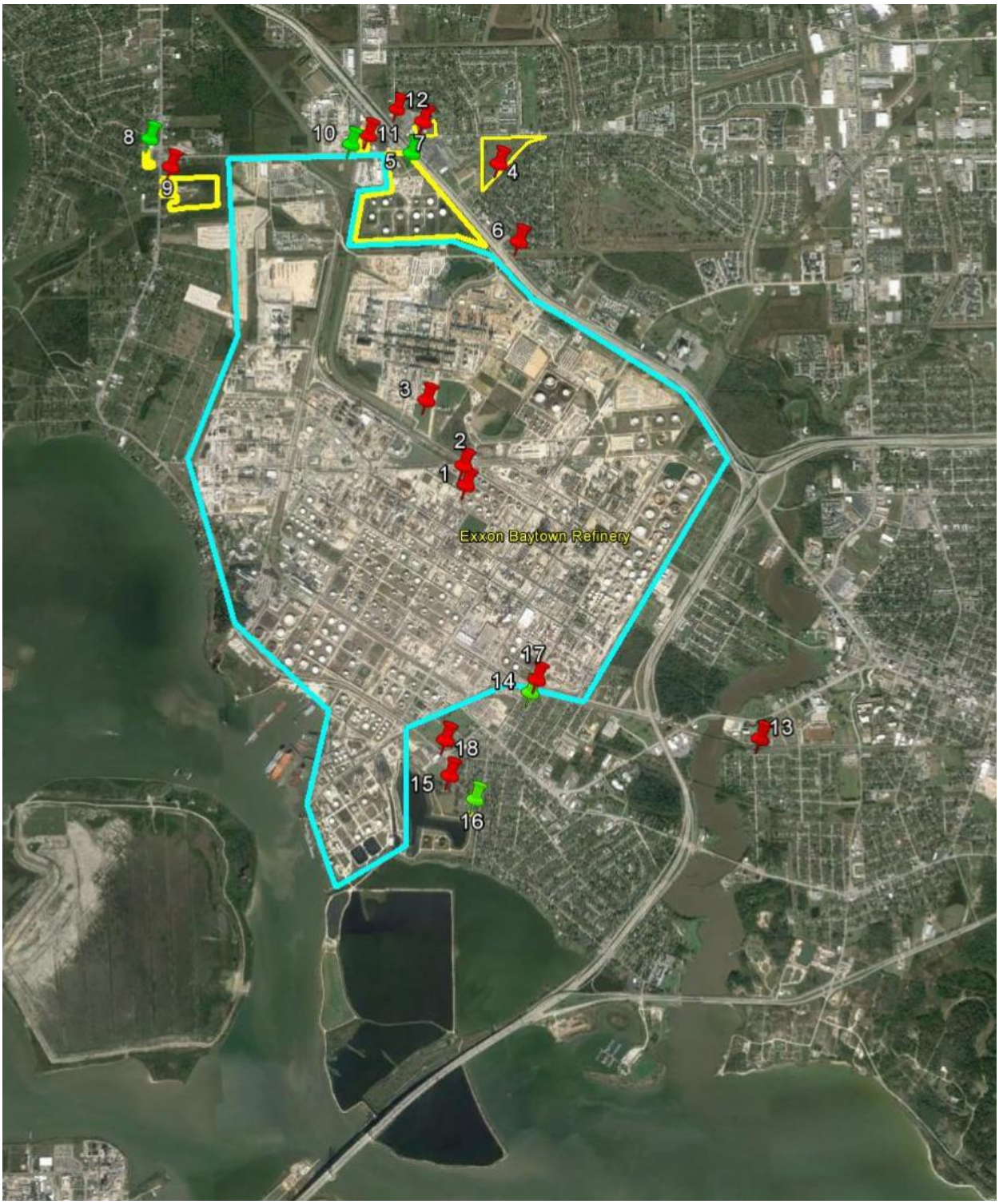

Figure 8: Potential monitoring sites for the Baytown Refinery

Table 2: Potential Sites Assessment[1]

Site Number	Baytown #1	Baytown #2	Baytown #3
Location[2]	29.746153, -95.008520	29.747459, -95.008716	29.751847, -95.011559
Distance from SO_2 Source [2]	NA	NA	NA
Wind Direction	E, SE, S, SW	E, SE, S, SW	E, SE, S, SW
Grade	NA	NA	NA
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	None	None	None
Distance from Site to Obstructions	None	None	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Close to the source	• Downwind • Close to the source •	• Downwind • Close to the source
Cons	• On Exxon Baytown Refinery property	• On Exxon Baytown Refinery property	• On Exxon Baytown Refinery property
Viable Site (yes, no, or preferred)	No	No	No

DRAFT

Site Number	Baytown #4	Baytown #5	Baytown #6
Location[2]	29.76799, -95.00615	29.76858, -95.01234	29.76253, -95.00475
Distance from SO_2 Source [2]	2,730 m	2,954 m	2,124 m
Wind Direction	E, SE, S, SW	E, SE, S, SW	E, SE, S, SW
Grade	NA	<1%	NA
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	Yes (N)	Yes (NW)	Yes (N)
Obstructions and Height	None	Building and bushes	None
Distance from Site to Obstructions	None	Building (43 m W), bushes (20 m E and 20m N)	None
Road/Site Access	Yes	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Space available	• Downwind • Level ground • Space available	• Downwind • Space available • Close to the source
Cons	• Underground oil and gas pipeline.	• None	• Underground oil pipeline easement
Viable Site (yes, no, or preferred)	• No	Yes	• No

DRAFT

Site Number	Baytown #7	Baytown #8	Baytown #9
Location[2]	29.76253, -95.00475	29.76977, -95.03324	29.76707, -95.03002
Distance from SO_2 Source[2]	3,156 m	4,130 m	3,862 m
Wind Direction	E, SE, S, SW	E, SE, S, SW	E, SE, S, SW
Grade	NA	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	Yes; Bay (W)	Yes; Bay (W)
Wind Channeling	None	None	None
Downwind[2]	Yes NW	Yes NW	Yes NW
Obstructions and Height	NA	Buildings (6 m SSE and 7 m SE)	Trees (18 m N) Building (10 m E)
Distance from Site to Obstructions	NA	Building (92 m SSE and 72m SE)	Trees (18 m N) Building (31 m E)
Road/Site Access	No	Yes	Yes
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Downwind • Space available • Power available	• Level ground • Downwind • Space available • Power available	• Level ground • Downwind • Space available • Power available
Cons	• No access	• None	• Declined by owner • Underground waterline
Viable Site (yes, no, or preferred)	No	Yes	No

DRAFT

Site Number	Baytown #10	Baytown #11	Baytown #12
Location[2]	29.76928, -95.01749	29.76990, -95.01617	29.77180, -95.01392
Distance from SO_2 Source [2]	3,193 m	3,200 m	3,312 m
Wind Direction	S, SE (dominant)	S, SE (dominant)	S, SE (dominant)
Grade	<1%	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	None	None	None
Wind Channeling	None	None	None
Downwind[2]	Yes (NW)	Yes (NW)	Yes (NW)
Obstructions and Height	None	Hedgerow (3 m E)	Highway (7 m SW) Building (8 m SE)
Distance from Site to Obstructions	None	Hedgerow (26 m E)	Highway (44 m SW) Building(45 m SE)
Road/Site Access	Yes	Yes	No
Electricity Available <18 m	Yes	No	Yes
Pros	• Downwind • Space available • Power available	• Downwind • Level ground • Space available	• Downwind • Space Available • Power available
Cons	None	• No Power	• No access
Viable Site (yes, no, or preferred)	Preferred	No	No

DRAFT

Site Number	Baytown #13	Baytown #14	Baytown #15
Location[2]	29.72944, -94.98631	29.72472, -95.00234	29.72705, -95.00970
Distance from SO_2 Source [2]	2,220 m	1,228 m	1,945 m
Wind Direction	E, SE, S, SW	E, SE, S, SW	E, SE, S, SW
Grade	NA	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; Bay (W)	None	Yes: Bay (S, W)
Wind Channeling	None	None	None
Downwind[2]	No	No	No
Obstructions and Height	None	Church (6 m N) Building (5m S)	Trees (5 m W, 9 m S, 9 m N)
Distance from Site to Obstructions	None	Church (24 m N) Building (17 m S)	Trees (7 m W, 6 m S, 6 m N)
Road/Site Access	Yes	Yes	No
Electricity Available <18 m	Yes	No	Yes
Pros	• Level Ground • Space available • Power available	• Level ground • Space available • Power available	• Level ground • Space Available • Power available
Cons	• Property owner declined	• None	• No access • Numerous obstructions
Viable Site (yes, no, or preferred)	No	Yes	No

DRAFT

Site Number	Baytown #16	Baytown #17	Baytown #18
Location[2]	29.72550, -95.00781	29.73330, -95.00314	29.72936, -95.01003
Distance from SO_2 Source [2]	2,055 m	1,131 m	1,719 m
Wind Direction	E, SE, S, SW	E, SE, S, SW	E, SE, S, SW
Grade	NA	<1%	<1%
Flood Plains	No	No	No
Mountain/Valley Winds	None	None	None
Water Body Within 1,000 m	Yes; Bay (S, W)	None	Yes; Bay (S, W)
Wind Channeling	None	None	None
Downwind[2]	No	No	No
Obstructions and Height	Trees (11 m NE)	Trees (12 m S)	
Distance from Site to Obstructions	Trees (24 m NE)	Trees (27 m S)	
Road/Site Access	Yes	Yes	No
Electricity Available <18 m	Yes	Yes	Yes
Pros	• Level ground • Space available • Power available	• Level ground • Space available • Power available	• Level ground • Space Available • Power available
Cons	• None	• High voltage power line easement	• No access
Viable Site (yes, no, or preferred)	Yes	No	No

[1]Based on 40 Code of Federal Regulations Part 58 and *SO_2 NAAQS Designations Source-Oriented Monitoring Technical Assistance Document*
[2]Based on Google Earth
E – east
m – meter
N – north
NE – northeast
NW – northwest
S – south
SE – southeast
SO_2 – sulfur dioxide
SW – southwest
W – west
> – greater than
< – less than
– number
% – percent

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References

Griffith, G. E., S. A. Bryce, J. M. Omernik, J. A. Comstock, A. C. Rogers, B. Harrison, S. L. Hatch, and D. Bezanson. *Ecoregions of Texas*. (2 sided color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia: U.S. Geological Survey, 2004. Scale 1:2,500,000.

"IEM : Site Locator." Iowa Environmental Mesonet. 2016. Accessed April 06, 2016. https://mesonet.agron.iastate.edu/sites/locate.php?network=TX_ASOS.

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